DATA BASE FOR ASSESSMENT OF STREAMBED SCOUR AND CHANNEL INSTABILITY AT SELECTED BRIDGES IN INDIANA, 1991–95

U.S. GEOLOGICAL SURVEY
Open-File Report 97-419

Prepared in cooperation with the
INDIANA DEPARTMENT OF TRANSPORTATION

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By MARK S. HOPKINS and BRET A. ROBINSON

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CONVERSION FACTORS

Multiply	By	To obtain
inch (in.)	25.4	millimeter
foot (ft.)	0.3048	meter

Data Base for Assessment of Streambed Scour and Channel Instability at Selected Bridges in Indiana, 1991–95

By Mark S. Hopkins *and* Bret A. Robinson

Abstract

The U.S. Geological Survey, in cooperation with the Indiana Department of Transportation, has collected data at 5,587 bridges in Indiana built with federal aid. These data, which can be useful for assessing streambed scour and channel instability, are maintained in a computerized data base at the U.S. Geological Survey in Indianapolis, Indiana. The data elements are grouped under one of five headings: General Site Characteristics, Observed and Calculated Scour Characteristics, Bridge Characteristics, Stream Characteristics, and Debris Characteristics. The description of the data in each group includes the element name; examples of the data from bridge number 89-54 crossing Lick Creek in Wayne County, Indiana; and a brief description of each element. The data already have been used in Indiana to produce an observed-scour index and a potential-scour index and may be useful in other applications as well. For computers with Internet access, the files containing the data for all 5,587 sites are available for downloading at the following URL:

http://www-dinind.er.usgs.gov/db.html

or can be obtained on diskette from the U.S. Geological Survey by mailing a request specifying choice of format and a blank 3.5-inch, double-sided, high-density diskette to:

USGS WRD
attn. Scour Data Base Administrator
5957 Lakeside Boulevard
Indianapolis, IN 46278

The data are available in ASCII format and PARADOX format.

INTRODUCTION

As a result of the failure of the Silver Bridge in Point Pleasant, W. Va., in 1967, the U.S. Congress established the Federal Aid Highway Act of 1968 that called for the establishment of National Bridge Inspection Standards (National Transportation Safety Board, 1988). Following the April 1987 failure of Schoharie Creek Bridge in New York (Zembrzuski and Evans, 1989) and the associated loss of 10 lives, the National Transportation Safety Board (NTSB) recommended that the National Bridge Inspection Standards be modified to include an assessment of instability problems caused by geomorphic change.

To implement the NTSB recommendation, the U.S. Geological Survey (USGS) developed a method for assessing channel instability and streambed scour near bridges (Simon and others, 1989). The Simon method called for an inspector to visit each site and to record observations of the general geomorphic characteristics on a data-collection form. This method was developed by the USGS in Tennessee and was designed specifically for the geographical provinces of that area. In 1991, the USGS, in cooperation with the Indiana Department of Transportation (INDOT), began collecting data at 5,587 bridges in the State of Indiana that were built or maintained with federal aid. Initially, the data were collected to enable INDOT to identify bridges with existing channel-instability or streambed-scour problems using the

Simon method. Subsequently, however, it became necessary to develop an alternative method, which, although similar to the Simon method, was more appropriate for the geographic provinces of Indiana. This method is referred to as the "INDOT Potential-Scour method" (Merril Dougherty, Indiana Department of Transportation, oral commun., 1995). This report describes the different types of data collected, defines the element names under which these data are stored in the data base, and provides the necessary information to access the data. This report also describes how these data are used to assess observed- and potential-scour conditions in Indiana.

STREAMBED-SCOUR AND CHANNEL-INSTABILITY DATA BASE

The following description of the streambed-scour and channel-instability data base includes information regarding data collection and recording conventions; names, definitions, and abbreviations for data elements; and data-access instructions. Also included are sections on applications and uses of the data base to assess scour and streambed-channel instability in Indiana.

Data-Collection Techniques

The data for each bridge were collected during a site visit by one or more inspectors. Distances and depths were measured in feet using either a 4-ft range pole (sometimes with additional 4-ft sections attached), a 150-ft tape measure, a split-image range finder, or by pacing. Vertical angles were measured in degrees with a clinometer-equipped compass. Horizontal angles were measured at the bridge with a protractor and a straight edge. Estimates of vegetation cover and debris cover, bed and bank materials, and riprap condition were based on field observation.

Data-Base Nomenclature Conventions

In this study, several nomenclature conventions were adopted for consistency in data collection and recording. "Left" and "right" are applied in reference to an individual looking downstream. When a distance was measured upstream from a bridge, it was recorded as a positive value; distances measured downstream from a bridge were recorded as negative values. All measures of distance are reported in feet, and all angles are in degrees. All channel measurements were made assuming bankfull conditions, which is the stage of the stream as it begins to top the banks and flow onto the flood plain.

In describing the relative position of an object or feature between the banks of a stream, the left bank was assigned a value of 0 percent and the right bank was assigned a value of 100 percent. Therefore, any object midway between the banks could be described as being at a position of 50 percent (recorded in the data base as "50"). For a feature such as a debris pile that extended from near the left bank to a point three-fourths of the way across the channel, this convention allowed the field inspector to record that the debris pile was continuous from 10 to 75.

For bridges with nine or fewer piers, the numbering of piers begins at the left-most pier and proceeds to the right (Pier 1–Pier 9). For bridges with more than nine piers, only the nine piers in the channel and closest to the channel were recorded, again working from left to right. The following abbreviations are used as suffixes to a root element name identifying where the data were obtained:

Suffix	Description
DS	Downstream
DSL	Downstream left
DSR	Downstream right
US	Upstream
USL	Upstream left
USR	Upstream right
L	Left
LB	Left bank
R	Right
RB	Right bank
DSLWW	Downstream left wingwall
DSRWW	Downstream right wingwall
USLWW	Upstream left wingwall
USRWW	Upstream right wingwall
1	First occurrence
2	Second occurrence
3	Third occurrence
Bed	Bed of river under bridge
Br	Under the bridge

The following terms also are used throughout the data base:

Term	Description
Site	Estimated land use or surface-cover average of USL, DSL, USR, and DSR
ND	Either no data were collected, or data were unavailable from INDOT
--	Blank data field

Data Elements

Data were collected for as many as 215 bridge-structure, streambed, and bank characteristics at each bridge site. The information was documented on field forms and later was entered into the data base. For the purpose of explanation, the data elements in this report have been grouped by data type and do not necessarily follow the order of the data base. Each grouping contains a four-column listing explaining the element name, an example of the data (for bridge number 89-54 crossing Lick Creek in Wayne County, Ind.), and the description of the element (table 1, at back of report). In some cases, the element-description column will contain information enclosed in brackets { }; this is the domain for that element field, and only those values contained in the brackets are acceptable.

General Site Characteristics

The data elements in the General Site Characteristics group summarize bridge-site and bridge-location data taken from the INDOT Inventory of Bridges on State Highway System of Indiana (Indiana Department of Transportation, 1991–95) and observations recorded at each site. These data identify the bridge and stream, the type of bridge, traffic-volume characteristics, land use near the bridge, the inspector, and the date of data collection.

Observed and Calculated Scour Characteristics

The data elements in the Observed and Calculated Scour Characteristics group document streambed-scour conditions observed at a bridge and the estimated potential for streambed scour.

Bridge Characteristics

The data elements in the Bridge Characteristics group summarize the bridge-structure data. These elements describe the pier location(s) and geometry, the abutment location(s) and geometry, the presence or absence of guide banks or wing walls, and the presence and condition of any riprap at each site.

Stream Characteristics

The data elements in the Stream Characteristics group summarize the stream-channel characteristics for the distance of two bridge lengths upstream to two bridge lengths downstream from the bridge. The channel-data elements include geometry and condition of the channel, the vegetation covering the bank, and the alignment of the banks as flow approaches the bridge opening.

Debris Characteristics

The data elements in the Debris Characteristics group summarize occurrences of, or potential for, blockage or deflection of flow caused by debris at a site. These elements describe the horizontal and vertical extent of any significant debris pile at a site. They also describe the type of debris in the debris pile, location where bank erosion is caused by a debris pile, and the potential that the site poses for accumulating debris.

Data Format and Availability

For computers with Internet access, the files containing the data for all 5,587 sites are available for downloading at

http://www-dinind.er.usgs.gov/db.html

All site data files are available in the four formats listed below. The files are compressed using a PKZIP format for DOS or a compress format for UNIX. The compressed files allow for faster downloading with fewer problems when transferring in binary format.

Data format:	File size:
PARADOX for DOS, PKZIP'd:	0.65 megabytes
ASCII, comma-delimited, PKZIP'd:	0.53 megabytes
ASCII, comma-delimited, UNIX compressed:	0.73 megabytes
ASCII, comma-delimited, text:	4.00 megabytes

This type of data is most often imported into spreadsheet or data-base software for ease of manipulation or to help find a relation between various data elements. Many text editors will allow the data to be viewed, but some editors do not have the capacity to manage files of this size.

The data files also may be obtained by mailing a request specifying choice of format and a blank 3.5-in., double-sided, high-density diskette to:

USGS, WRD
attn. Scour Data Base Administrator
5957 Lakeside Boulevard
Indianapolis, IN 46278

Applications and Uses of the Data to Assess Scour and Stream Instability in Indiana

The Simon method (Simon and others, 1989) originally was used by the USGS to record observed scour and assess potential scour and streambed instability in Tennessee. The differences in geographical provinces between Indiana and Tennessee brought about a revision of the Simon method to make it more applicable to Indiana. The results of the use of the Indiana-specific method (Robinson and Thompson, 1995) are referred to in the following two subsections.

Observed Scour Evaluation

The information contained in the data base has been used to generate an observed-streambed-scour-index value for each bridge studied. These values were arrived at by applying the methodology outlined by Robinson and Thompson (1995). Table 2 lists the observed-streambed-scour categories and the corresponding observed-streambed-scour-index value for each category. This method for indexing scour conditions is based on the perceived severity of each scour category listed in table 2. For example, "Piers(s) with footing(s) exposed," which is assigned an index value of 1, is considered to be less severe in terms of observed-streambed scour than "Piers(s) with pile(s) exposed" which has an index value of 0. The data required to generate these observed-scour scores are stored in the data base, and the final ranking values defined in table 1 (at back of report) are stored under "ObservedScour."

Table 2. Observed-streambed-scour index for the streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95

Observed-streambed-scour categories	Ranking values
No observed streambed scour	10
Scour hole(s) only	9
Local scour at abutment(s) only	8
Local scour at pier(s) only	7
Local scour at pier(s) and scour hole(s)	6
Blowhole	5
Vertical abutment(s) with footing(s) exposed	4
Sloping abutment(s) with pile(s) exposed	3
Vertical abutment(s) with pile(s) exposed	2
Pier(s) with footing(s) exposed	1
Pier(s) with pile(s) exposed	0

Potential Scour Evaluation

As a first attempt to identify bridges that may be susceptible to the effects of scour, a potential-scour index has been developed by the USGS through consultation with INDOT. This index (referred to as the "INDOT potential-streambed-scour index") gives weighting points in each of four categories that may in part control the amount of streambed scour that occurs at a given site: bed material, attack angle, debris, and contraction ratio (table 3). The total potential-scour score for a given site is calculated as the summation of the points from each category. The only exceptions are for sites where the bridge has been built on bedrock or is well protected by riprap; for these sites, the potential-scour score is set to 0. With this potential-scour weighting scheme, potential-scour scores can range from 0 (best case) to 100 (worst case). This index is limited by the fact that it does not take into consideration the overall stream geometry, bank materials, streamflow velocity, flood-channel width, and propensity for debris to accumulate at the bridge because of either bridge design or an abundance of material available upstream.

Potential Uses of the Data

State transportation departments across the country are required to evaluate existing bridges for potential streambed-scour problems. Computer models, such as defined in the Federal Highway Administration Hydraulic Engineering Circular No. 18 (Federal Highway Administration, 1991), can be used for this purpose. The data base contains much of the information needed to complete these potential-scour analyses.

Table 3. Potential-streambed-scour categories and assigned weighting points for the Indiana scour-assessment data base of selected bridges, 1991–95

Potential-scour categories	Weighting points	Element used for calculation
Bed material		BedMatBR1
Sand	30	
Silt/Clay	18	
Gravel	0	
Cobble/Boulder	-12	
Attack angle		AbutAttackL
>45°	30	
26°- 45°	24	
10°- 25°	18	
<10°	0	
Sites with high debris potential (percent of opening blocked by debris)		BlockTotal
>20%	20	
16-20%	16	
11-15%	12	
6-10%	8	
0- 5%	4	
All other sites	0	
Contraction ratio [(channel width at bridge / upstream channel width) - 1] x 100		ChannelWidthBr and ChannelWidthUS
>75%	20	
51-75%	16	
26-50%	12	
6-25%	8	
≤5%	0	

Data elements such as

pier orientation to flow
(PierAttack1-PierAttack9),

pier-nose shape
(PierShape1-PierShape9),

bed-material characteristics
(BedMatUS3, BedMatUS2, BedMatUS1,
BedMatBr3, BedMatBr2, BedMatBr1,
BedMatDS3, BedMatDS2, BedMatDS1),

and pier length-to-width ratios
(PierLength/PierWidth)

can be determined from values stored in the scour-assessment data base.

The data also may be useful in identifying trends or causes of scour and channel instability throughout the State. Analysis by geographic region or hydrologic basin may indicate that additional data, or monitoring, may be necessary in some areas.

ARCHIVED PHOTOGRAPHS

A minimum of four photographs were taken at each bridge listed in the data base—one from the bridge looking upstream, one from the bridge looking downstream, one from a position upstream looking downstream at the bridge, and one from a position downstream looking upstream at the bridge. These photographs further document the site conditions when the field data were collected and are archived at the USGS in Indianapolis.

GENERAL LIMITATIONS OF THE DATA BASE

Most bridges listed in the data base were visited during low flow. Assessing the bridges at low stages allowed for visual inspection and photographing of scour impacts; however, some streambed scouring that may have occurred during higher stages might have been obscured by deposition of sediment prior to site visits. In addition, some of the impacts attributed to scour during site visits may have resulted from processes other than stream-bridge interactions. For example, water draining from the roadway may have eroded embankment material and exposed piles under sloping abutments. Therefore, the data stored in this data base should be viewed and used with some degree of caution.

The data in the data base describe accurately the conditions that field inspectors observed during the inspection. Site conditions at most bridges will change with time. Therefore, any potential user of the data must understand that site conditions described in the data base may not reflect current site conditions.

REFERENCES CITED

Federal Highway Administration, 1991, Evaluating scour at bridges: Federal Highway Administration Hydraulic Engineering Circular 18, FHWA-IP-90-017, p. 7–8.

Indiana Department of Transportation, 1991–95, Inventory of bridges on State highway system of Indiana (published annually).

National Transportation Safety Board, 1988, Highway accident report—Collapse of New York Thruway (I-90) bridge over the Schoharie Creek, near New Amsterdam, New York, April 5, 1987: National Transportation Safety Board Report NTSB/HAR-88/02, 168 p.

Robinson, B. A. and Thompson, R.E., Jr., 1995, An Observed-Streambed-Scour Index for selected bridges in southwestern Indiana, 1991: U.S. Geological Survey, Water-Resources Investigations Report 95-4264, 6 p.

Simon, Andrew; Outlaw, G.S.; and Thomas, Randy, 1989, Evaluation, modeling, and mapping of potential bridge scour, west Tennessee: Federal Highway Administration Proceedings of the Bridge Scour Symposium, Report FHWA-RD-90-035, p. 112-129.

Zembrzuski, T.J., and Evans, M.L., 1989, Flood of April 4–5, 1987, in southwestern New York, with flood profiles of Schoharie Creek: U.S. Geological Survey Water-Resources Investigations Report 89-4084, 43 p.

SUPPLEMENTAL DATA

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95

[Example data are from bridge number 89-54 crossing Lick Creek in Wayne County, Ind.; --, blank; INDOT, Indiana Department of Transportation; ND, no data]

Element name	Maximum length and type	Example data	Element description
			General Site Characteristics
BridgeNum	16 Character	89-54	Bridge-numbering system used for this study: State Highway bridges: road number, county number (see element "Cnty" described below) and INDOT-assigned structure number (for example: 31-42-1332). Interstate bridges: proceeded by "I" and county number replaced by highway log mile; each bridge in a bridge pair is followed by N, S, E, or W, indicating direction of traffic movement (for example: I65-24-4439N). Bridges on State properties: preceded by "P" (for example: P000-24-1009). County bridges: county number followed by INDOT-assigned structure number (for example: 89-54).
Stream	25 Character	LICK CREEK	Stream name taken from INDOT Inventory of Bridges on State Highway System of Indiana; for county bridges, stream name derived from county map.
Vicinity	15 Character	RICHMOND	Nearby town shown on INDOT county map.
Inspector	17 Character	ABAUSTIN	First initial, middle initial, and last name of field inspector.
Date	8 Character	6/10/93	Date on which field data were collected.
Route	7 Character	CR 61	Number or name of road carried by bridge; CR=County Route, SR =State Route, I=Interstate, US= U.S. Route (for example: US 421).
Cnty	2 Integer	89	County number assigned alphabetically {1-92}.
BridgeLength	4 Integer	62	Length of bridge, measured abutment to abutment.
MaxSpanLen	4 Integer	17	Length of longest single span of bridge.
NumOverFlowBrL NumOverFlowBrR	2 Integer 2 Integer	0 0	Number of relief structures between bridge and valley side, left and right.
Wadeable	3 Character	YES	Notes if stream was safe for wading at time of site visit {YES or NO}. If NO, a boat was used for data collection.

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			General Site Characteristics—Continued
SurfaceCoverUSL SurfaceCoverUSR SurfaceCoverDSL SurfaceCoverDSR SurfaceCoverSite	12 Character 12 Character 12 Character 12 Character 12 Character	FOREST FOREST PASTURE FOREST FOREST	Dominant surface cover off each corner of the bridge, measured two bridge lengths upstream and downstream and two bridge lengths away from the bridge. The following categories were used: {>50% PAVED:greater than 50-percent impermeable surface 10–50% PAVED:10- to 50-percent impermeable surface ROW CROP:agricultural land PASTURE:fields and lawns BRUSH:weeds and undergrowth FOREST:heavily wooded area WETLAND:standing water body}
OverFlowBr	3 Character	NO	Indicates if a bridge is or is not an overflow bridge {YES or NO}.
BridgeType	8 Character	ND	Taken directly from the INDOT Inventory of Bridges on State Highway System of Indiana; no data available for county bridges.
ADT	5 Character	ND	**A**verage **D**aily **T**raffic, taken from the INDOT Inventory of Bridges on State Highway System of Indiana; ADT x 100 = average number of cars per day crossing the bridge (if ADT = 5, then 5 x 100 cars = 500 cars per day).
			Observed and Calculated Scour Characteristics
ScourHole1 ScourHole2	3 Character 3 Character	YES NO	Presence of one or as many as two scour holes that are not noted elsewhere in the data-collection and recording process {YES or NO}.
ScourHoleDist1 ScourHoleDist2	4 Integer 4 Integer	-15 0	Distance from center of scour hole to bridge face.
ScourHoleWid1 ScourHoleWid2	3 Integer 3 Integer	8 0	Width of scour hole, measured perpendicular to the channel banks where scour hole is widest.
ScourHolePos1 ScourHolePos2	3 Integer 3 Integer	55 0	Position of scour hole relative to the channel banks, measured where the scour hole is deepest and given as a percentage where left bank = 0 percent and right bank = 100 percent.
ScourHoleLen1 ScourHoleLen2	3 Integer 3 Integer	16 0	Length of scour hole, measured parallel to the channel banks where scour hole is longest.
ScourHoleDep1 ScourHoleDep2	5 Real 5 Real	2.00 0	Depth of scour hole below average bed elevation, measured where scour hole is deepest.

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
		Observed and Calculated Scour Characteristics—Continued	
PierScour1	15 Character	NONE	Scour conditions observed at each pier {NONE, LOCAL SCOUR, FOOTING EXPOSED, PILES EXPOSED, or blank if no pier}.
PierScour2	15 Character	NONE	
PierScour3	15 Character	--	
PierScour4	15 Character	--	
PierScour5	15 Character	--	
PierScour6	15 Character	--	
PierScour7	15 Character	--	
PierScour8	15 Character	--	
PierScour9	15 Character	--	
	15 Character		
AbutScourL	7 Character	NONE	Scour conditions observed at each abutment {NONE, FOOTING, PILING, or blank}.
AbutScourR	7 Character	NONE	
BlowHole	3 Character	NO	Presence or absence of a blowhole {YES or NO}.
BlowHoleLoc	4 Integer	0	Distance from blowhole to downstream face of bridge, measured where blowhole is deepest {-999 to 999}.
BlowHoleWid	3 Integer	0	Width of blowhole, measured perpendicular to flow where blowhole is widest {0 to 999}.
BlowHoleLen	3 Integer	0	Length of blowhole, measured parallel to flow where blowhole is longest {0 to 999}.
Evolution	17 Character	STABLE	Primary process affecting channel stability: {STABLE: no evidence of channel instability, though the channel may have been affected or altered by bridge construction UNDISTURBED: channel not affected by bridge or altered by bridge construction CONSTRUCTED: channelized and controlled stream reach DEGRADATIONAL: field evidence of degrading conditions AGGRADATIONAL: field evidence of aggrading conditions LATERAL MIGRATION: actively meandering streams}.
Meander1	3 Character	YES	Presence of a meander impact {YES or NO}.
Meander2	3 Character	YES	
MeanderBank1	2 Character	RB	Bank that forms the outside of the meander {LB: left bank, or RB: right bank, or blank}.
MeanderBank2	2 Character	LB	
MeanderDist1	4 Integer	175	Distance from bridge to the center of the outside of the meander bend {-999 to 999}.
MeanderDist2	4 Integer	30	

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Observed and Calculated Scour Characteristics—Continued
ObservedScour	3 Integer	9	Value generated by applying Robinson and Thompson's (1995) observed-scour index; range of values: 10-0, where 10 = best case and 0 = worst case.
SimonPotScour	5 Real 5 Real	8.00	Value generated by applying Simon and others (1989) potential-scour index; the range of values is dependent on bridge characteristics: a low score is the best case, and a high score is the worst case. Most bridges are in the 0 to 40 range.
INDOTPotScour	3 Integer 3 Integer	0	Value generated by applying INDOT's potential-scour index (Merril Dougherty, INDOT, oral commun., 1995); range of values: 0–100, where 0 = best case and 100 = worst case.
			Bridge Characteristics
PierShape1	11 Character	ROUND COL	Shape of the upstream nose of the pier or nose of columns:
PierShape2	11 Character	ROUND COL	{ROUND: round piers, or
PierShape3	11 Character	--	SQUARE: square piers, or
PierShape4	11 Character	--	POINTED: pointed piers, or
PierShape5	11 Character	--	ROUND COL: round columns, or
PierShape6	11 Character	--	SQUARE COL: square columns, or
PierShape7	11 Character	--	POINTED COL: pointed columns, or
PierShape8	11 Character	--	blank}.
PierShape9	11 Character	--	
PierColumns1	3 Integer	4	For piers consisting of a series of columns, the number of columns that makes up each pier {0 to 999, or ND}.
PierColumns2	3 Integer	4	
PierColumns3	3 Integer	0	
PierColumns4	3 Integer	0	
PierColumns5	3 Integer	0	
PierColumns6	3 Integer	0	
PierColumns7	3 Integer	0	
PierColumns8	3 Integer	0	
PierColumns9	3 Integer	0	

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Bridge Characteristics—Continued
PierDiagonal1	3 Character	NO	For piers consisting of a series of columns, the presence or absence of a diagonal member used to tie some or all of the columns together. ND = no data {YES, NO or ND}.
PierDiagonal2	3 Character	NO	
PierDiagonal3	3 Character	NO	
PierDiagonal4	3 Character	NO	
PierDiagonal5	3 Character	NO	
PierDiagonal6	3 Character	NO	
PierDiagonal7	3 Character	NO	
PierDiagonal8	3 Character	NO	
PierDiagonal9	3 Character	NO	
	3 Character	NO	
PierAttack1	3 Integer	-5	Measure of the angle created between the long axis of a pier and high flow approaching the bridge. If the direction of flow tends to push a pier toward the left abutment, this value is recorded as a negative value. Where the flow tends to push the pier toward the right abutment, the angle is recorded as a positive value {-90 to 90}.
PierAttack2	3 Integer	-5	
PierAttack3	3 Integer	0	
PierAttack4	3 Integer	0	
PierAttack5	3 Integer	0	
PierAttack6	3 Integer	0	
PierAttack7	3 Integer	0	
PierAttack8	3 Integer	0	
PierAttack9	3 Integer	0	
	3 Integer	0	
PierLocation1	3 Character	MCL	Records the position of each pier in relation to the flood plain, banks, and channel:
PierLocation2	3 Character	RB	{LFP: Left flood plain, or
PierLocation3	3 Character	--	LTB: Left top of bank, or
PierLocation4	3 Character	--	LB: Left bank, or
PierLocation5	3 Character	--	MCL: Main channel left, or
PierLocation6	3 Character	--	MCM: Main channel middle, or
PierLocation7	3 Character	--	MCR: Main channel right, or
PierLocation8	3 Character	--	RB: Right bank, or
PierLocation9	3 Character	--	RTB: Right top of bank, or
	3 Character	--	RFP: Right flood plain, or
			blank}

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Bridge Characteristics—Continued
PierWidth	4 Real	2.0	Width of the widest pier at the point where that pier meets the streambed {0 to 99.9, or ND}.
PierLength	6 Real	28.00	The total length of the longest pier; if PierWidth (above) is ND (no data), PierLength will incorrectly be displayed as 0 {0 to 999.9}.
AbutAttackL AbutAttackR	3 Integer 3 Integer	-5 -5	Measure of the angle created between the long axis of the abutment and the direction along which high flow approaches the abutment. If the direction of flow tends to push an abutment toward the left, this value is recorded as a negative. Where the flow tends to push an abutment toward the right, the angle is recorded as a positive value {-90 to 90}.
AbutLocationL AbutLocationR	4 Integer 4 Integer	4 0	Position of the abutments relative to the channel banks measured in feet. A measure of zero (0) denotes an abutment set in line with the channel bank. Negative values indicate the abutment projects into the main channel flow path. Positive values indicate an abutment is set back from the line of the bank {-999 to 999}.
AbutTypeL AbutTypeR	10 Character 10 Character	HARDENED HARDENED	Type of abutment: {VERTICAL: Vertical wall of concrete, steel, or wood. HARDENED: Sloping abutment of concrete or riprap. UNHARDENED: Sloping abutment. or blank}. Arched bridges and culverts are listed as having vertical abutments.
GuideBankL GuideBankR	7 Character 7 Character	ABSENT ABSENT	Presence or absence of guide banks {PRESENT or ABSENT}.
WingWallL WingWallR	3 Character 3 Character	YES YES	Presence or absence of upstream wing walls or upstream protective corner aprons {YES or NO}.
WingWallCondL WingWallCondR	7 Character 7 Character	GOOD GOOD	Relative condition of any noted upstream wing walls or protective corner aprons {GOOD, FAIR, POOR, FAILED, or blank}.
Underclearance	6 Real	9.00	Vertical distance from streambed to that component of the bridge that controls pressure flow; if greater than 35 feet, recorded as 999 in data base {0 to 999.90}.
ApproachHigherL ApproachHigherR	3 Character 3 Character	YES YES	Whether or not each road-approach section is higher in elevation than low steel {YES or NO}.
ApproachMeanderL ApproachMeanderR	3 Character 3 Character	NO NO	Whether or not each road-approach section is threatened by channel meandering that is not described by the high-flow angle of approach {YES or NO}.

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Bridge Characteristics—Continued
RipRapUSLB	3 Character	NO	Presence of riprap at each of the defined locations {YES or NO}.
RipRapUSLWW	3 Character	NO	
RipRapLB	3 Character	NO	
RipRapDSLWW	3 Character	NO	
RipRapDSLB	3 Character	NO	
RipRapUSRB	3 Character	NO	
RipRapUSRWW	3 Character	NO	
RipRapRB	3 Character	NO	
RipRapDSRWW	3 Character	NO	
RipRapDSRB	3 Character	NO	
RipRapBed	3 Character	NO	
	3 Character	NO	
RipRapCondUSLB	7 Character	--	Condition of any riprap noted at one of the defined locations: {GOOD, FAIR, POOR, FAILED, or blank}.
RipRapCondUSLWW	7 Character	--	
RipRapCondLB	7 Character	--	
RipRapCondDSLWW	7 Character	--	
RipRapCondDSLB	7 Character	--	
RipRapCondUSRB	7 Character	--	
RipRapCondUSRWW	7 Character	--	
RipRapCondRB	7 Character	--	
RipRapCondDSRWW	7 Character	--	
RipRapCondDSRB	7 Character	--	
RipRapCondBed	7 Character	--	
	7 Character	--	
BankMatUSL3	3 Character	GRV	This item describes the three most abundant particle sizes that make up the channel bank:
BankMatUSL2	3 Character	C/B	{S/C: silt/clay, or
BankMatUSL1	3 Character	SND	SND: sand, or
BankMatUSR3	3 Character	GRV	GRV: gravel, or
BankMatUSR2	3 Character	C/B	C/B: cobble/boulder, or
BankMatUSR1	3 Character	SND	BED: bedrock, or
BankMatDSL3	3 Character	GRV	C/S: concrete/steel}.
BankMatDSL2	3 Character	C/B	The first two elements modify the dominant particle size (for example: BankMatUSL3 and BankMatUSL2 modify the dominant particle size BankMatUSL1). Bank material composed of 10 percent gravel, 25 percent sand, and 65 percent silt/clay is described as a gravely, sandy, silt/clay. At some sites, not all three terms are needed.
BankMatDSL1	3 Character	SND	
BankMatDSR3	3 Character	SND	
BankMatDSR2	3 Character	C/B	
BankMatDSR1	3 Character	GRV	
	3 Character	SND	
Trib1	3 Character	NO	Presence of a tributary {YES or NO}.
Trib2	3 Character	NO	
Trib3	3 Character	NO	

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Bridge Characteristics—Continued
TribDist1 TribDist2 TribDist3	4 Integer 4 Integer 4 Integer	0 0 0	Distance from tributary to face of the bridge {-999 to 999}.
TribBank1 TribBank2 TribBank3	2 Character 2 Character 2 Character	-- -- --	Tributary entry, left or right bank {LB: left bank, or RB: right bank, or blank}.
			Stream Characteristics
CutBank	3 Character	YES	Presence or absence of cutbank {YES or NO}.
CutBankImpact	4 Character	RB	Bank where the cutbank is located {LB: left bank, or RB: right bank, or NONE}.
CutBankDist	4 Integer	30	Horizontal distance from bridge face to center of cutbank scarp {-999 to 999}.
FlowDepth	5 Real	1.00	Water depth in the thalweg measured where the thalweg intersects the upstream face of the bridge {0 to 99.9}.
HighFlowAngle	3 Integer	-5	An estimation of the angular relation between bankfull flow approaching the bridge and bankfull flow exiting the bridge. If the direction of flow tends to push the bridge toward the left, this value is recorded as a negative value. A positive angle indicates that the flow tends to push the bridge toward the right {-90 to 90}.
BankHeightUSL BankHeightUSR BankHeightDSL BankHeightDSR	3 Integer 3 Integer 3 Integer 3 Integer	3 5 2 3	The vertical separation between the streambed and the top of the bank {0 to 999}.
BankAngleUSL BankAngleUSR BankAngleDSL BankAngleDSR	3 Integer 3 Integer 3 Integer 3 Integer	40 35 45 35	The inclination of the channel banks above horizontal in degrees {0 to 90}.

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Stream Characteristics—Continued
BankVegUSL	6 Character	<25%	Percent of channel bank covered by woody vegetation {< 25%, 26–50%, 51–75%, or >75%}.
BankVegUSR	6 Character	<25%	
BankVegDSL	6 Character	<25%	
BankVegDSR	6 Character	<25%	
BankErosionUSL	7 Character	FLUVIAL	Dominant mechanism of bank failure {NONE, MASS WASTING, or FLUVIAL}.
BankErosionUSR	7 Character	FLUVIAL	
BankErosionDSL	7 Character	FLUVIAL	
BankErosionDSR	7 Character	FLUVIAL	
ChannelProfileUS	6 Character	RIFFLE	Dominant channel profile upstream and downstream from the bridge {POOL or RIFFLE}.
ChannelProfileDS	6 Character	RIFFLE	
ChannelWidthUS	3 Integer	28	Horizontal distance, measured perpendicular to flow, between the bank tops {0 to 999}.
ChannelWidthBr	3 Integer	29	
ChannelWidthDS	3 Integer	18	
PointBar	3 Character	YES	Presence of any accumulation of sediment that controls the direction of flow {YES or NO}.
PointBarLocL	3 Integer	0	Left-most and right-most extent of the point bar between the left and right banks: PointBarLocL =0 percent and PointBarLocR = 50 percent would mean that the point bar extends from the left-most side of the channel to the middle of the channel {0 to 100}.
PointBarLocR	3 Integer	20	
PointBarDist	3 Integer	15	Measure of the distance from the nearest bridge face to the widest spot on the point bar {0 to 999}.
BedMatUS3	3 Character	SND	This item describes the three most abundant particle sizes contained in the channel bed upstream from the bridge, under the bridge, and downstream from the bridge:
BedMatUS2	3 Character	GRV	{S/C: silt/clay, or
BedMatUS1	3 Character	C/B	SND: sand, or
BedMatBr3	3 Character	SND	GRV: gravel, or
BedMatBr2	3 Character	GRV	C/B: cobble/boulder, or
BedMatBr1	3 Character	C/B	BED: bedrock, or
BedMatDS3	3 Character	SND	C/S: concrete/steel}.
BedMatDS2	3 Character	GRV	
BedMatDS1	3 Character	C/B	The first two elements modify the dominant particle size (for example: BedMatUS3 and BedMatUS2 modify the dominant particle size BedMatUS1. Thus bed material composed of 10 percent gravel, 25 percent sand, and 65 percent silt/clay is described as a gravely, sandy, silt/clay. At some sites, not all three terms are needed.

Table 1. Elements of streambed-scour and channel-instability data base for selected bridges in Indiana, 1991–95—Continued

Element name	Maximum length and type	Example data	Element description
			Debris Characteristics
HorzBlockL HorzBlockR	3 Integer 3 Integer	0 0	Left-most and right-most extent of debris pile between the left and right abutments: HorzBlockL = 0 percent and HorzBlockR = 50 percent would mean that the stream (or bridge opening) is blocked from the left-most side of the channel to the middle of the channel {0 to 100}.
VertBlockB VertBlockT	3 Integer 3 Integer	0 0	Position of the bottom-most and the top-most extent of the debris pile between the streambed and low steel: VertBlockB = 0 percent and VertBlockT = 75 percent would mean that the stream (or bridge opening) is blocked from the streambed to three-quarters of the way to low steel {0 to 100}.
BlockTotal	6 Real	0	Percent of the total bridge opening that is blocked by debris; this is calculated as the product of horizontal blockage and vertical blockage {0 to 100}.
DebrisType	5 Character	--	Dominant type of material within a debris pile {BRUSH, WHOLE TREES, TRASH, OTHER, or blank}.
DebrisPot	6 Character	MEDIUM	Estimate of the potential for the upstream drainage basin to produce and deliver woody debris to the bridge {LOW, MEDIUM, or HIGH}.
TrappingPot	6 Character	LOW	Estimate of the potential for the bridge to trap any debris delivered to the site {LOW, MEDIUM, or HIGH}.
MinSpanLen	3 Integer	5	Length of shortest span over main channel that could act to collect debris {1 to 999}.
DeflectFlow	3 Character	YES	Presence or absence of a debris pile large enough to significantly deflect flow {YES or NO}.
ImpactBank	2 Character	RB	Bank most impacted by flow deflected by a debris pile {LB: left bank, or RB: right bank, or blank}.
ImpactDist	4 Integer	-15	Distance from bridge to the spot on the channel bank that is most impacted by flow deflected by a debris pile. A negative number indicates the distance is downstream from the bridge {-999 to 999}.