# BSDMS Summary Report

**72 Minnesota River at CR 14 near Lac qui Parle, MN**

## Site Location:

**Site ID:** 72

**Site Name:** Minnesota River at CR 14 near Lac qui Parle, MN

**County:** Chippewa

**Nearest City:** Lac qui Parle

**State:** MN

**Latitude:** 445935

**Longitude:** 0955003

**USGS Station ID:**

**Route Number:** 14

**Route Class:** County

**Service Level:** Mainline

**Route Direction:** NA

**Highway Mile Point:**

**Stream Name:** Minnesota River

**River Mile:**

**Contact:**

David Mueller
U.S. Geological Survey
9818 Bluegrass Parkway
Louisville, KY 40299

**Publication:**

Mueller, D.S., and Hitchcock, H.A., 1998, Scour measurements at contracted highway crossings in Minnesota, 1997: ASCE, Water Resources Engineering '98, Memphis, TN, p. 210-215.

## Site Description:

CR 14 over Minnesota River is located in a rural area. Satellite images show four oxbow lakes in the vicinity of the bridge, however, the current channel is relatively straight having a sinuosity of 1.07. The flood plane to the left is wide as indicated by the oxbow lakes. The highway on the left floodplain is overtopped at the 25-year flood (17,500 cfs). The approach from the right is much steeper with a much narrower flood plain. The floodplains are primarily forest and with some pasture.

In 1994 a relief bridge in the left approach was apparently removed and the main channel bridge widened.

## Elevation Reference

**Datum:** MSL

**MSL (ft):**

**Description of Reference Elevation:**

All elevations and stages are referenced to mean sea level, based on the elevation of the finished bridge deck, take from the plans dated 5-4-1990.

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## Stream Data

| | | | |
|---|---|---|---|
| **Drainage Area (sq mi):** | 4100 | **Floodplain Width:** | Wide |
| **Slope in Vicinity(ft/ft):** | | **Natural Levees:** | Unknown |
| **Flow Impact:** | Straight | **Apparent Incision:** | None |
| **Channel Evolution** | Unknown | **Channel Boundary:** | Alluvial |
| **Armoring:** | Unknown | **Banks Tree Cover:** | Medium |
| **Debris Frequency:** | Unknown | **Sinuosity:** | Sinuous |
| **Debris Effect:** | Both | **Braiding:** | None |
| **Stream Size:** | Medium | **Anabranching:** | None |
| **Flow Habit:** | Perennial | **Bars:** | Narrow |
| **Bed Material:** | Unknown | **Stream Width Variability:** | Equiwidth |
| **Valley Setting:** | Low | | |

## Roughness Data

**Manning's n Values**

| | Left Overbank | Channel | Right Overbank |
|---|---|---|---|
| **High:** | | | |
| **Typical** | 0.11 | 0.03 | 0.085 |
| **Low:** | | | |

## Bed Material

| Measurement Number | Yr | Mo | Dy | Sampler | D95 (mm) | D84 (mm) | D50 (mm) | D16 (mm) | SP | Shape | Cohesion |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | | | | BM-54 | 2.8 | 1.4 | 0.48 | 0.09 | 2.65 | | Non-Cohesive |
| 2 | | | | BM-54 | 14 | 12 | 0.6 | 0.17 | 2.65 | | Non-Cohesive |

### Bed Material Comments

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**Measurement No:** 1

The bed material sample was collected from the upstream bridge face during low flow. The material appears to be medium sand mixed with some small shells and has the following grain size distribution:

| Size (mm) | 16 | 8 | 4 | 2 | 1 | .5 | .25 | .125 | .062 | .016 | .004 | .002 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| % < than | 100 | 67.4 | 64.8 | 61.1 | 56.7 | 45.4 | 20.8 | 13.1 | 7.9 | 3.3 | 2.4 | 1.9 |

There were no lithologic logs on the bridge plans in which to compare the samples.

**Measurement No:** 2

The bed material sample was collected from the downstream bridge face during low flow. The material appears to consist mostly of medium to course sand mixed with some small shells and has the following grain size distribution:

| Size (mm) | 8 | 4 | 2 | 1 | .5 | .25 | .125 | .062 | .016 | .004 | .002 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| % < than | 100 | 97.1 | 91.5 | 76.7 | 51.9 | 23.4 | 18.2 | 13.2 | 5.9 | 4.8 | 4.3 |

There were no lithologic logs on the bridge plans in which to compare the samples.

## Bridge Data

**Structure No:** 6611

**Length(ft):** 189.8

**Width(ft):** 39.3

**Number of Spans:** 3

**Vertical Configuration:** Sloping

**Low Chord Elev (ft):** 935.6

**Upper Chord Elev (ft):** 937.43

**Overtopping Elev (ft):** 933.9

**Skew (degrees):** 0

**Guide Banks:** None

**Waterway Classification:** Main

**Year Built:** 1994

**Avg Daily Traffic:** 635

**Plans on File:** Yes

**Parallel Bridges** No

**Upstream/Downstream:** N/A

**Continuous Abutment:** No

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**72 Minnesota River at CR 14 near Lac qui Parle, MN**

**Distance Between Centerlines:**

**Distance Between Pier Faces:**

**Bridge Description:**

The bridge was originally designed and constructed in the mid 1940s. The original bridge had two twin-column piers located at the toe of the bank slopes. The columns were hexagonal shaped, giving them a sharp upstream and downstream nose. The foundations were poured footings with untreated timber piles beneath the footings. The abutments had 45-degree wing walls both upstream and downstream. In the early 1990s, the bridge was widened. To accommodate the wider roadway a 20-inch round concrete-filled steel pile was placed upstream and downstream of each of the existing columns. The upstream left column was reenforced with 6-inches of reenforced concrete from its base up to a level determined by the contractor in the field. The abuments were widened and reinforced and new wing walls constructed. The spill slopes at the abutments were graded to 2:1 on the left and 3.4 to 1 on the right. The spill slopes were protected with grout to the waters edge at the time of construction, then large riprap was placed on the slope below the waterline.

## Abutment Data

**Left Station:** 0

**Right Station:** 185

**Left Skew (deg):** 0

**Right Skew (deg)** 0

**Left Abutment Length (ft):** 38.3

**Right Abutment Length (ft)** 38.3

**Left Abutment to Channel Bank (ft):** 0

**Right Abutment to Channel Bank (ft):** 0

**Left Abutment Protection:**

**Right Abutment Protection**

**Contracted Opening Type:** Other

**Embankment Skew (deg):** 0

**Embankment Slope (ft/ft):** 2

**Abutment Slope (ft/ft)** 2

**Wingwalls:** Yes

**Wingwall Angle (deg):** 45

# BSDMS Summary Report

**72 Minnesota River at CR 14 near Lac qui Parle, MN**

## Pier Data

| Pier ID | Bridge Station(ft) | Alignment | Highway Station | PierType | # Of Piles | Pile Spacing(ft) |
|---|---|---|---|---|---|---|
| 1a | 134 | 0 | | Group | 2 | 35.7 |
| 1b | 134 | 0 | | Group | 2 | 25 |
| 2a | 49 | 0 | | Group | 2 | 35.7 |
| 2b | 49 | 0 | | Group | 2 | 25 |

| Pier ID | Pier Width(ft) | Pier Shape | Shape Factor | Length(ft) | Protection | Foundation |
|---|---|---|---|---|---|---|
| 1a | 1.7 | Round | | | None | Unknown |
| 1b | 3 | Sharp | | 5.8 | None | Piles |
| 2a | 1.7 | Round | | | None | Unknown |
| 2b | 4 | Sharp | | 5.8 | None | Piles |

| Pier ID | Top Elevation(ft) | Bottom Elevation(ft) | Foot or Pile Cap Width(ft) | Cap Shape | Pile Tip Elevation(ft) |
|---|---|---|---|---|---|
| 1a | | | | Unknown | |
| 1b | 915.51 | 913.01 | 7.5 | Square | |
| 2a | | | | Unknown | |
| 2b | 915.03 | 912.53 | 7.5 | Square | |

## Pier Description

**Pier ID** 1a

The bridge was originally designed and constructed in the mid 1940s. The original bridge had two twin-column piers located at the toe of the bank slopes. The columns were hexagonal shaped, giving them a sharp upstream and downstream nose. The foundations were poured footings with untreated timber piles beneath the footings. The abutments had 45-degree wing walls both upstream and downstream. In the early 1990s, the bridge was widened. To accommodate the wider roadway a 20-inch round concrete-filled steel pile was placed upstream and downstream of each of the existing columns. The upstream left column was reenforced with 6-inches of reenforced concrete from its base up to a level determined by the contractor in the field. The abuments were widened and reinforced and new wing walls constructed. The spill slopes at the abutments were graded to 2:1 on the left and 3.4 to 1 on the right. The spill slopes were protected with grout to the waters edge at the time of construction, then large riprap was placed on the slope below the waterline.

**Pier ID** 1b

The bridge was originally designed and constructed in the mid 1940s. The original bridge had two twin-column piers located at the toe of the bank slopes. The columns were hexagonal shaped, giving them a sharp upstream and downstream nose. The foundations were poured footings with untreated timber piles beneath the footings. The abutments had 45-degree wing walls both upstream and downstream. In the early 1990s, the bridge was widened. To accommodate the wider roadway a 20-inch round concrete-filled steel pile was placed upstream and downstream of each of the existing columns. The upstream left column was reenforced with 6-inches of reenforced concrete from its base up to a level determined by the contractor in the field. The abuments were widened and reinforced and new wing walls constructed. The spill slopes at the abutments were graded to 2:1 on the left and 3.4 to 1 on the right. The spill slopes were protected with grout to the waters edge at the time of construction, then large riprap was placed on the slope below the waterline.

**Pier ID** 2a

The bridge was originally designed and constructed in the mid 1940s. The original bridge had two twin-column piers located at the toe of the bank slopes. The columns were hexagonal shaped, giving them a sharp upstream and downstream nose. The foundations were poured footings with untreated timber piles beneath the footings. The abutments had 45-degree wing walls both upstream and downstream. In the early 1990s, the bridge was widened. To accommodate the wider roadway a 20-inch round concrete-filled steel pile was placed upstream and downstream of each of the existing columns. The upstream left column was reenforced with 6-inches of reenforced concrete from its base up to a level determined by the contractor in the field. The abuments were widened and reinforced and new wing walls constructed. The spill slopes at the abutments were graded to 2:1 on the left and 3.4 to 1 on the right. The spill slopes were protected with grout to the waters edge at the time of construction, then large riprap was placed on the slope below the waterline.

**Pier ID** 2b

The bridge was originally designed and constructed in the mid 1940s. The original bridge had two twin-column piers located at the toe of the bank slopes. The columns were hexagonal shaped, giving them a sharp upstream and downstream nose. The foundations were poured footings with untreated timber piles beneath the footings. The abutments had 45-degree wing walls both upstream and downstream. In the early 1990s, the bridge was widened. To accommodate the wider roadway a 20-inch round concrete-filled steel pile was placed upstream and downstream of each of the existing columns. The upstream left column was reenforced with 6-inches of reenforced concrete from its base up to a level determined by the contractor in the field. The abuments were widened and reinforced and new wing walls constructed. The spill slopes at the abutments were graded to 2:1 on the left and 3.4 to 1 on the right. The spill slopes were protected with grout to the waters edge at the time of construction, then large riprap was placed on the slope below the waterline.

## Pier Scour Data

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## Abutment Scour

| Measurement Number | Abutment | Date | Time | US/DS | Scour Depth (ft) | Accuracy | Sediment Transport |
|---|---|---|---|---|---|---|---|
| 1 | | | | Unknown | 0 | 0 | Unknown |

| Measurement Number | Velocity at Abut(ft/s) | Depth at Abut(ft) | Discharge Blocked(cfs) | Avg Velocity Blocked(ft/s) | Avg Depth Blocked(ft) |
|---|---|---|---|---|---|
| 1 | | | | | |

| Measurement Number | Embankment Length (ft) | Bed Material | D50 (mm) | Sigma | Debris Effect |
|---|---|---|---|---|---|
| 1 | | Unknown | | | Unknown |

### Abutment Scour Comments

**MeasurementNo** 1

The cross section at the bridge is deeper on the left side, which could indicate 1-2 ft of abutment scour, but the location of the pier also complicates the scour pattern and makes separating scour components difficult. All scour was classified as contraction scour since the site was both horizontally and vertically contracted.

## ContractionScour

| Measurement Number | Contracted Date | Contracted Time | Uncontracted Date | Uncontracted Time | US/DS | Scour Depth(ft) |
|---|---|---|---|---|---|---|
| 1 | 4/5/97 | 18:30 | 4/5/97 | 18:30 | | 3.9 |

| Measurement Number | Accuracy | Contracted Avg Vel(ft/s) | Contracted Discharge(cfs) | Contracted Depth(ft) | Contracted Width(ft) |
|---|---|---|---|---|---|
| 1 | 1.5 | 3.6 | 11800 | 25.9 | 185 |

| Measurement Number | Uncontracted Avg Vel(ft/s) | Uncontracted Discharge(cfs) | Uncontracted Depth(ft) | Uncontracted Width(ft) | Channel Contraction Ratio |
|---|---|---|---|---|---|
| 1 | | | 22.1 | | |

| Measurement Number | Pier Contraction Ratio | Scour Location | Eccent-ricity | Sediment Transport | Bed Form | Debris Effects |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| 1 | Unknown | Unknown | Unknown | nsignifican | | |

| Measurement Number | D95 (mm) | D84 (mm) | D50 (mm) | D16 (mm) | Sigma Bed Material | Bed Material |
|---|---|---|---|---|---|---|
| 1 | | | | | | Unknown |

## Contraction Scour Comments

**Measurement No.** 1

Scour at CR14 was measured on 4-4-97 and 4-5-97. The left approach was overtopped, with significant flow. Due to weather and site conditions the overflow could not be measured. The bridge substructure was partially submerged on 4-4-97, but the upper low-chord was still above the water surface. The fall through the bridge on 4-4-97 was 0.42 ft. On 4-5-97 the entire substructure was submerged both upstream and downstream and the water surface upstream and downstream was essentially the same. Discharge through the bridge, but not over the roadway, was measured on 4-5-97 and thus only scour data from 4-5-97 are reported.

The cross sections collected on 4-4-97, 4-5-97, and 7-16-97 were compared. The downstream cross sections showed good agreement among all the measurements. Upstream the 4-4-97 and 4-5-97 measurements again showed reasonable agreement. However, the measurements made on 7-16-97 were more difficult to interpret. The left side of the upstream cross sections always reflected a location near the bridge because access to the upstream left bank was hindered by the oxbow lake. Thus the cross sections at 75 and 100 ft upstream collected on 7-16-97 are actually only about 25 ft upstream on the left bank. The left side of these cross sections displays scour. It could not be determined from the data if this was a remnant of the old channel or if the scour that developed under the bridge during the flood, extended some ways upstream. Due to the uncertainty in the upstream cross sections and the consistency of the downstream cross sections, the cross section approximately 90 ft downstream collected on 4-5-97 was used as the reference surface for determining the depth of scour.

The average depth of contraction scour (3.9 ft) was determined from the difference in average elevation of the active channel bottom using the cross sections 90 ft downstream and along the upstream edge of the bridge collected on 4-5-97. Nearly 5 ft of elevation difference was observed from the downstream section to the deepest portion of the cross section collected along the upstream edge of the bridge. Due to the lack of access under the bridge, it is not know if the measured scour is the maximum scour at the site.

No hydraulic measurements are available in the approach or exit sections of the channel.

According the hydraulic analysis provided by Chippewa County the mean velocity through bridge at the overtopping flood of 17,500 cfs would be 6.3 ft/sec. On 4-5-97 only 11,800 cfs was measured going through the bridge with a mean velocity of 3.6 ft/sec and a maximum point velocity of 5 ft/sec.

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## Stage and Discharge Data

| Peak Discharge | | | | | Flow | | Peak Stage | | | | | Stage | Water | Return |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| year | mo | dy | hr | mi | (cfs) | Qacc | year | mo | dy | hr | mi | (ft) | Temp (C) | Period(yr) |
| | | | | | | | 1997 | 4 | 5 | 18:30 | | 939 | | |
| | | | | | | | 1997 | 4 | 4 | 16:10 | | 937.5 | | |
| | | | | | | | 1997 | 7 | 16 | 9:00 | | 928.9 | | |

## Hydrograph

## Supporting Files

CR14MR.XLS - Excel 97 workbook containing the following worksheets:
Summary - summary of basic site, bridge, and scour data
q-4597 - discharge measurement notes from 4-5-97
q-71697 - discharge measurement notes from 7-16-97
US0-71697 - cross section along upstream edge of bridge collected on 7-16-97
US75-71697 - cross section 75 ft upstream of bridge collected on 7-16-97
US100-71697 - cross section 100 ft upstream of bridge collected on 7-16-97
DS0-71697 - cross section along downstream edge of bridge collected on 7-16-97
DS25-71697 - cross section 25 ft downstream of bridge collected on 7-16-97
DS50-71697 - cross section 50 ft downstream of bridge collected on 7-16-97
DS100-71697 - cross section 100 ft downstream of bridge collected on 7-16-97
US0-4597 - cross section along upstream edge of bridge collected on 4-5-97
DS0-4597 - cross section along downstream edge of bridge collected on 4-5-97
DS25-4597 - cross section 25 ft downstream of bridge collected on 4-5-97
DS50-4597 - cross section 50 ft downstream of bridge collected on 4-5-97
DS90-4597 - cross section 90 ft downstream of bridge collected on 4-5-97
US0-4497 - cross section along upstream edge of bridge collected on 4-4-97
DS0-4497 - cross section along downstream edge of bridge collected on 4-4-97
DS50-4497 - cross section 50 ft downstream of bridge collected on 4-4-97
DS80-4497 - cross section 80 ft downstream of bridge collected on 4-4-97

DS-BRG-R.jpg - photo looking from the right bank across the downstream edge of the bridge on 4-4-97
DS-BRG-L.jpg - photo looking from the left bank across the downstream edge of the bridge on 4-5-97
DS-CHL-797.jpg - photo looking downstream on 7-16-97
DS-CHL-2-797.jpg - photo looking downstream from the right bank on 7-16-

97
DS-RB-BE.jpg- photo looking at bank erosion on the downstream right bank on 7-16-97
EMB-FP-L.jpg - photo of the road overflow in the left floodplain on 4-4-97
Loc-Map.jpg - location map
Satellite_Image.jpg - satellite image of area from TerraServer
US-BRG-L.jpg - photo looking from the left bank across the upstream face of the bridge on 4-5-97
US-BRG-R.jpg - photo looking from the right bank across the upstream face of the bridge on 4-4-97
US-CHL-797.jpg - photo of the upstream channel on 7-16-97
US-FP-L-797.jpg - photo from the left approach looking upstream towards the main channel on 7-16-97
US-FP-OX-797.jpg - photo from bridge looking upstream into the oxbow lake on the left floodplain on 7-16-97
US-FP-497 - photo of upstream left floodplain in April 1997
US-LB-BE1.jpg - photo of bank erosion on left upstream bank on 7-16-97
US-LB-BE2.jpg - photo of bank erosion on left upstream bank on 7-16-97
Topo.jpg - scan of USGS topographic map
Pier-1990.jpg - pier details from 1990 bridge plans
Abut-L-1990.jpg - left abutment details from 1990 bridge plans
Abut-R-1990.jpg - right abutment details from 1990 bridge plans
Brg-Pln-1990.jpg - bridge plan overview, 1990
Brg-Pln-1946.jpg - bridge plan overview, 1946
HYD_ANAL1.jpg - page 1 of the hydraulic analysis
HYD_ANAL2.jpg - page 2 of the hydraulic analysis