

APPENDIX G

BIG SIOUX RIVER HYRAULICS AND BRIDGE
TECHNICAL MEMORANDUM

To: File	
From: Matt Redington, P.E.	Project: Watertown Connector
CC:	
Date: January 9, 2007; rev. 5/18/07, 8/29/07, 9/18/07	Job No: 39319

RE: Analysis of the 20th Avenue South Bridge Crossing over the Big Sioux River

Introduction

The existing 20th Avenue South bridge crosses over the Big Sioux River south of Watertown, South Dakota. The structure is a 50 foot long slab bridge. The crossing is designed to pass smaller flows from the Big Sioux River underneath the bridge. Flows from larger events spill over the top of a lowered roadway profile located to the west of the bridge. The lowered section will be referred to in this memo as the spillway. Figures G-1 and G-2 show photographs of the existing bridge and the spillway.

The proposed alignment of roadway Segment 1 follows closely to the alignment of existing 20th Avenue South. The existing roadway is approximately 22 feet wide, while the proposed roadway is approximately 58 feet wide. At the location of the Big Sioux River, the proposed centerline is approximately 13.5 feet south of the existing centerline. The proposed crossing will be designed so that roadway overflow is eliminated for the 100-year and more frequent events. Although it is not a design criteria, the freeboard requirement for 100-year events results in the roadway profile being elevated high enough that the 500-year event does not overtop the roadway.

National Flood Insurance Program Mapping

Watertown is a participating community in the Federal Emergency Management Agency's (FEMA) National Flood Insurance Program. As part of this program, a Flood Insurance Study (FIS) was created for the City of Watertown. The Big Sioux River was mapped as a part of this study. The map for the segment of the river in the Project area became effective (regulatory) on July 4, 1989.

Watertown is in the process of having its FIS updated. As part of this effort, the Big Sioux River has been remodeled and remapped by the U.S. Army Corps of Engineers (USACE). The USACE has performed a detailed study so that the Big Sioux River will be considered a Zone AE upon adoption of the maps by FEMA. The updated mapping for the City of Watertown is effective on September 28, 2007.

The areas of flooding as determined by the USACE in their remodeling and remapping efforts are shown in Figure G-3. This mapping shows the limits of the 100-year and 500-year floodplains, and the 100-year floodway for the Big Sioux River. Because this area has a floodway, a Letter of Map Revision (LOMR) is required if work within the floodway will result in any increase to 100-year water surface elevations. A LOMR involves hydraulic modeling of the impacted waterway to determine water surface elevation impacts, and creation of new regulatory floodplain maps. It also involves notification of impacted property owners as to the degree of impact on their property.

The limits of the floodway show the extent to which floodplains can be filled for development without water surface elevations increasing by more than one foot. A "no-rise" means that hydraulic modeling for the proposed 20th Avenue South crossing alternatives shall not show an increase in water surface elevations for the 100-year event anywhere along the Big Sioux River. Per discussion with Michelle Saxman, the South Dakota Floodplain Administrator, a water surface increase of 0.01 ft qualifies as a rise and would require a LOMR.

Performance of Existing Bridge

Based on discussions with SDOT personnel, the existing crossing overtops frequently. The property on the south side of 20th Avenue South has been protected through the use of raised berms. These berms were built to prevent water that overtops the roadway from damaging the property. The top of berm elevation is approximately 1715. This elevation corresponds well to the 100-year floodplain elevation of 1714.8 at this location. The top of roadway elevation (the spillway) varies between 1710 and 1711.

HDR acquired the Corps of Engineers' HEC-RAS model that was used to create the updated floodplain mapping. This HEC-RAS model was used for hydraulic modeling of a replacement structure for 20th Avenue South. The flows included with the HEC-RAS model (the flows in the FIS) were used in the hydraulic analysis (HDR did not perform a hydrologic analysis).

The modeling uses a 100-year flow of 4,320 cubic feet per second (cfs). For existing conditions, approximately one-fourth of the total flow (920 cfs) is capable of being passed beneath the bridge during a 100-year flood event. The remaining portion of the 100-year flow (3400 cfs) passes over the spillway.

Bridge Crossing Considerations

The South Dakota Department of Transportation has indicated that the proposed roadway and the 20th Avenue South bridge replacement should be designed so current criteria can be met. The criteria states that there shall be 2-feet of freeboard between the bottom of the bridge girder and the 100-year water surface elevation. Per the proposed FEMA floodplain mapping, the 100-year water surface elevation is 1714.80 feet on the upstream side of the existing 20th Avenue South bridge. Based on the 100-year water surface elevation, the proposed bridge will need to have a bottom of girder elevation of approximately 1716.80 feet or higher. This is approximately 12 feet above the invert of the Big Sioux River. The existing overbank on the upstream side of the crossing is at an elevation of approximately 1710.

Under existing conditions, the channel has a general tendency to flow at a 45 degree angle to 20th Avenue South. The majority of the 100-year flow spills directly over the roadway at the 45 degree direction. Under proposed conditions, the modeling geometry was modified to take into account all of the 100-year flow passing beneath the bridge in a skewed bridge alignment. This skewed bridge alignment shortens the width of the effective bridge opening area that is available for flows to pass beneath the bridge. For modeling purposes, in order to take into account the effect of the skew on hydraulic performance, the cross section of the channel beneath and adjacent to the structure was modified (shortened).

Due to the desire to limit increases to water surface elevations under proposed conditions and the requirement to pass the 100-year event beneath a skewed bridge opening, the proposed structure will need to be significantly longer than the existing structure. Modeling was performed in HEC-RAS to determine the performance of various bridge lengths. Tables G1, G2, G3 and G4 illustrate the base flood elevation differences with various bridge length alternatives for the 10-year, 50-year and 100 year flood events. Figure G-6 shows a cross section of the bridge deck and a cross section of the river channel in a direction parallel to 20th Avenue South (this is not the skewed hydraulic section).

Table G1 - Floodway Analysis Results

Location *	Distance Upstream from 20 th Ave South (miles)	Difference in 100-Year Floodway Water Surface Elevations between Proposed Conditions with Alternate Bridge Lengths and Proposed FIS		
		365 feet (no increase in elevations)	265 feet	165 feet
20 th Ave South	-	-0.04	-0.01	+0.04
600' Upstream of 20 th Avenue South	0.12	-	+0.12	+0.49
Hwy 81	0.66	-	+0.08	+0.34
South Broadway	1.61	-	+0.04	+0.21
Hwy 212	1.91	-	+0.04	+0.19
BNSF Railroad	2.15	-	+0.03	+0.15
4 th Avenue South	2.47	-	+0.02	+0.11
McKinley Park	2.75	-	+0.02	+0.09
Kemp Avenue	2.89	-	+0.02	+0.09
3 rd Avenue North	3.03	-	+0.01	+0.09
Bramble Park Road	3.35	-	+0.01	+0.07
10 th Avenue North	3.67	-	+0.01	+0.05
14 th Avenue North	4.32	-	+0.01	+0.04

In order to minimize the length of the proposed bridge crossing, HDR recommends overbank grading in the vicinity of the proposed bridge crossing. The overbanks, the flat areas adjacent to the channel that flood once the channel flow capacity is exceeded, are at an elevation of approximately 1710. By excavating soil to lower the overbank elevation by 2-3 feet, the flow capacity underneath the proposed bridge would be increased. This increase in overbank flow capacity would allow for a shorter and more economical bridge. Figure G-6 shows an area of overbank grading beneath a proposed bridge alternate.

Under existing conditions, the channel of the Big Sioux bends immediately upstream and adjacent to 20th Avenue South. Under proposed conditions, the channel would remain in its current position. Once overbank grading were to occur, however, flood waters would tend to flow more directly through the crossing. This grading would tend to shorten the flow path of the Big Sioux River by about 40 feet.

In general, shortening of a river's flow path can cause the river to become effectively steeper, thereby increasing water velocities and the potential for channel erosion. In this case, however, RAS modeling shows that the difference in velocities due to transition grading will be minimal. Upstream of the crossing, for bank full conditions, stream velocities are approximately 1.5 to 2.0 feet per second. These velocities increase by approximately 0.3 feet per second under the proposed conditions (for a 365 foot long bridge). This slight increase in velocity is due to proposed grading and a slightly more direct flow route to the bridge crossing. At the bridge crossing location, velocities decrease due to the proposed overbank grading which increases the flow area underneath the bridge. Under existing conditions with a 50 foot long bridge and roadway overtopping, the channel velocity at the crossing is approximately 2.6 feet per second. Under proposed conditions with a 365 foot long bridge and overbank grading, the velocity would decrease to approximately 0.9 feet per second.

Alternate Bridge Lengths

In addition to performing a 100-year floodway analysis, impacts to water surface elevations for the unencroached flood plain condition were examined. It is this condition that most accurately represents existing conditions. Furthermore it is important to understand the impacts to water surface elevations for flooding events that occur more frequently than the 100-year event.

The following five alternative bridge lengths were modeled in order to determine the sensitivity of the Big Sioux River water surface elevations to changes in bridge length: 565 feet, 465 feet, 365 feet, 265 feet, and 165 feet. Impacts to the 10-year, the 50-year, and the 100-year (unencroached) floodplains were determined. Table G2 shows differences in 100-year (unencroached) water surface elevations at various locations along the Big Sioux River for the alternate bridge lengths. Figures G-4 and G-5 show plan views of each of these bridge length alternatives.

Table G2 - Water Surface Elevation Increases for Alternate Bridge Lengths (100 Year Floodplain)

Location *	Distance Upstream from 20 th Ave South (miles)	Difference in 100-Year Water Surface Elevation between Proposed Conditions with Alternate Bridge Lengths and Proposed FIS **				
		565 feet	465 feet	365 feet	265 feet	165 feet
20 th Ave South	-	-0.03	-0.02	-0.01	+0.03	+0.14
600' Upstream of 20 th Avenue South	0.12	-0.02	+0.02	+0.09	+0.25	+0.71
Hwy 81	0.66	-0.01	+0.02	+0.06	+0.15	+0.45
South Broadway	1.61	-	-	+0.02	+0.04	+0.15
Hwy 212	1.91	-	-	+0.01	+0.04	+0.13
BNSF Railroad	2.15	-	+0.01	+0.02	+0.04	+0.11
4 th Avenue South	2.47	-	-	+0.01	+0.02	+0.08
McKinley Park	2.75	-	+0.01	+0.01	+0.02	+0.07
Kemp Avenue	2.89	-	-	+0.01	+0.02	+0.06
3 rd Avenue North	3.03	-	+0.01	+0.01	+0.02	+0.05
Bramble Park Road	3.35	-	-	-	+0.01	+0.03
10 th Avenue North	3.67	-	-	-	+0.01	+0.02
14 th Avenue North	4.32	-	-	-	-	+0.01

* Elevations are taken at the upstream face of the structure that is referenced unless otherwise specified. The list of structures starts with 20th Ave and proceeds in an upstream direction.

** A positive number represents a rise in the 100-year floodplain water surface elevation.

Tables G3 and G4 show the impacts to the 10-year and 50-year water surface elevations at locations upstream from the 20th Avenue South Crossing.

Table G3 - Water Surface Elevation Increases for Alternate Bridge Lengths
50-Year Flood Event

Location *	Distance Upstream from 20 th Ave South (miles)	Difference in 50-Year Water Surface Elevation between Proposed Conditions with Alternate Bridge Lengths and Proposed FIS **				
		565 feet	465 feet	365 feet	265 feet	165 feet
20 th Ave South	-	-0.07	-0.06	-0.05	-0.01	+0.08
600' Upstream of 20 th Avenue South	0.12	-0.09	-0.06	+0.01	+0.13	+0.47
Hwy 81	0.66	-0.05	-0.03	+0.01	+0.08	+0.30
South Broadway	1.61	-0.03	-0.02	-	+0.05	+0.19
Hwy 212	1.91	-0.02	-0.01	-	+0.03	+0.13
BNSF Railroad	2.15	-0.02	-0.01	-	+0.02	+0.09
4 th Avenue South	2.47	-0.01	-0.01	-	+0.01	+0.06
McKinley Park	2.75	-0.01	-0.01	-	+0.01	+0.05
Kemp Avenue	2.89	-0.01	-0.01	-	+0.01	+0.04
3 rd Avenue North	3.03	-0.01	-0.01	-	+0.01	+0.04
Bramble Park Road	3.35	-0.01	-0.01	-	-	+0.02
10 th Avenue North	3.67	-	-	-	-	+0.01
14 th Avenue North	4.32	-	-	-	-	-

Table G4 - Water Surface Elevation Increases for Alternate Bridge Lengths
10-Year Flood Event

Location *	Distance Upstream from 20 th Ave South (miles)	Difference in 10-Year Water Surface Elevation between Proposed Conditions with Alternate Bridge Lengths and Proposed FIS **				
		565 feet	465 feet	365 feet	265 feet	165 feet
20 th Ave South	-	-0.36	-0.36	-0.34	-0.31	-0.24
600' Upstream of 20 th Avenue South	0.12	-0.40	-0.37	-0.33	-0.25	-0.07
Hwy 81	0.66	-0.22	-0.21	-0.19	-0.15	-0.05
South Broadway	1.61	-0.07	-0.07	-0.06	-0.05	-0.02
Hwy 212	1.91	+0.05	-0.04	-0.03	-0.03	-0.01
BNSF Railroad	2.15	+0.04	-0.03	-0.03	-0.02	-
4 th Avenue South	2.47	+0.03	-0.02	-0.02	-0.02	-0.01
McKinley Park	2.75	+0.03	-0.02	-0.01	-0.01	-
Kemp Avenue	2.89	+0.02	-0.01	-0.01	-0.01	-
3 rd Avenue North	3.03	+0.02	-0.01	-0.01	-0.01	-
Bramble Park Road	3.35	+0.02	-	-	-	-
10 th Avenue North	3.67	-	-0.01	-0.01	-0.01	-
14 th Avenue North	4.32	-	-0.01	-0.01	-0.01	-0.01

* Elevations are taken at the upstream face of the structure that is referenced unless otherwise specified. The list of structures starts with 20th Ave and proceeds in an upstream direction.

** A positive number represents a rise in water surface elevation.

Minimal Grading Alternative

The alternatives discussed above all involve grading in the overbank area in order to increase flow capacity beneath the proposed bridge. As an alternative to performing overbank grading, a scenario was developed to determine the length of bridge required if no overbank grading was performed. Modeling of this scenario showed that the bridge would need to be approximately 700 feet long in order to achieve a no-rise. The longer bridge would be required to provide additional flow capacity that the other alternatives provided in the lowered overbank area.

Building a bridge 700 feet long in this location would have considerable impacts to properties in the crossing vicinity. On the east side of the crossing, the location of the end of the bridge is constrained by a roadway that encircles Watertown's water treatment infiltration fields. On the west, the location of the end of the bridge is constrained by a residence. In order to build a 700 foot long bridge for the Big Sioux River, overbank grading would need to occur in the vicinity of either or both of the infiltration fields and the private residence. Additionally, as the bridge alternatives become wider, it becomes necessary to grade more of the overbank (a distance further from the roadway) in order to allow water to flow effectively within the graded section. A 700 foot long bridge would likely require extensive grading on private property which would require property acquisition or easements. Figure G-7 illustrates the approximate location of overbank grading that would be required. Given the extent of impacts to adjacent properties and the large expense of such a long bridge, the 700 foot long bridge does not appear to be a reasonable alternative.

Lake Impacts

Pelican Lake is located on the west side of Watertown, to the west of the Big Sioux River. The Lake is connected to the Big Sioux River in two locations. Just downstream from the Highway 212 bridge, there is a man-made channel that allows flows to enter Pelican Lake. There is a weir at the upper end of the channel near the Big Sioux River that moderates flows out of the Big Sioux River. According to discussion with Rick Schlechter (Watertown Floodplain Administrator), when the Big Sioux River has flows exceeding the 6 to 10 year recurrence interval, water spills over the weir and flows into Lake Pelican. The second connection point of Pelican Lake to the Big Sioux River is approximately 2000 feet upstream of the Highway 81 bridge. At this location there is the natural channel that historically was the only connection to the Big Sioux River. After construction of the man-made channel, the natural channel has continued to serve as a connection only during times of extreme flow events (such as the 100 year event). Due to the connection of Pelican Lake to the Big Sioux River, it is important to understand the impacts of the project on water surface elevations at these connection points.

As can be seen in Tables G1 thru G4, there are changes to the Big Sioux River water surface elevations at the Highway 212 (Lake Pelican inlet) and the natural channel location. A summary of impacts to the water surface elevations at these locations for various bridge lengths is shown in Table G5.

Table G5 – Elevation Change at Pelican Lake-Big Sioux Connections

Man-Made Channel (Downstream from Hwy 212)					
	565 feet	465 feet	365 feet	265 feet	165 feet
10-Year	+0.05	-0.04	-0.03	-0.03	-0.01
50-Year	-0.02	-0.01	-	+0.03	+0.13
100-Year	-	-	+0.01	+0.04	+0.13
Natural Channel Connection (2000 feet Upstream of Hwy 81)					
	565 feet	465 feet	365 feet	265 feet	165 feet
10-Year	n/a	n/a	n/a	n/a	n/a
50-Year	-0.04	-0.02	-	+0.07	+0.25
100-Year	-0.01	+0.01	+0.05	+0.12	+0.38

Based on the hydraulic analysis completed on the Big Sioux River, impacts to the inlet of Pelican Lake will be negligible for bridges 265 feet or longer at the 20th Avenue South crossing. A bridge of 165 foot length at 20th Avenue South would have a small but measurable impact on inlet water surface elevations, thereby slightly increasing flows entering Pelican Lake. Impacts to the water surface elevations at the natural channel connection to Pelican Lake are negligible for bridges 365 feet or longer at the 20th Avenue South crossing. Bridges 265 feet long or shorter would have a more significant and measurable impact to water surface

elevations at the Pelican Lake natural channel connection. For the 365 foot long bridge alternate, there is no impact to water surface elevations (a “no-rise”) at either connection for the 100-year floodway condition.

Lake Kampeska is located to the northwest of Watertown. The Big Sioux River flows out of this lake approximately 3 miles upstream of the 14th Street bridge. The upper limit of the hydraulic model acquired from the USACE ends approximately 1900 feet upstream from the 14th Street crossing. This makes the distance from the upper end of the hydraulic model to Lake Kampeska more than 2.5 miles. As can be seen from Table G6, the impact at the upper end of the hydraulic model is minimal for even the shortest bridge alternate.

Table G6 – Elevation Change at Upper End of Model

	565 feet	465 feet	365 feet	265 feet	165 feet
10-Year	+0.01	-	-	-	-
50-Year	-	-	-	-	-
100-Year	-	-	-	-	+0.01

Because the impact to water surface elevations is negligible at the upper end of the hydraulic model, HDR concludes that the impact to water surface elevations in Lake Kampeska, which is located more than 2 miles upstream from the upper limit of the hydraulic model, will be also negligible.

Comparison of Existing 20th Avenue South Bridge to Other Big Sioux River Structures

In order to have a better understanding of how a proposed replacement structure at 20th Avenue South would compare to other bridges in the area, the characteristics of bridges in the FIS hydraulic model were examined within the HEC-RAS. The characteristics of other bridge crossings are described in Table G7.

Table G7 – Characteristics of Big Sioux River Bridges

Crossing *	Total Structure Length	Number of Spans	Distance from Low Chord to Channel Invert	Approximate Top of Bank Width
20 th Avenue South (existing)	50 ft	1	8.0 ft	50 ft
20 th Avenue South (proposed)	165 ft – 565 ft	varies	12 ft	varies
Highway 81	101 ft	3	14.5 ft	100 ft
South Broadway	91 ft	3	10.5 ft	110 ft
Highway 212	141 ft	4	10.0 ft	150 ft
BNSF Railroad	251 ft	19	7.5 ft	210 ft
4 th Avenue South	143 ft	5	11.5 ft	140 ft

* The list of structures starts with 20th Ave and proceeds in an upstream direction.

The fact that a majority of floodwaters pass over the top of 20th Avenue South spillway as opposed to underneath the bridge makes it especially difficult to achieve a no-rise at this location with construction of a new bridge. Under existing conditions, the low profile of the roadway (the spillway) allows floodwater to flow relatively unimpeded across 20th Avenue South. The proposed condition of raising the roadway so that it does not overtop requires a significantly longer bridge in order to limit increases in water surface elevation. In addition, the Big Sioux River crosses 20th Avenue South at a 45 degree angle, resulting in a skewed bridge alignment. This skewed alignment requires that bridge options be lengthened in order to achieve an adequate bridge opening in a direction perpendicular to the direction of flow.

Bridge Structure Options

To provide the necessary freeboard of 2 feet (SDDOT criteria) HDR looked at superstructure options with minimal depth to reduce the impact on the profile grade for 20th Avenue South. Superstructure depth and initial cost were the only criteria used for this analysis. The four options considered are as follows:

Option 1 – Cast-in-Place Continuous Concrete Slab

Advantages to this structure type are a shallow superstructure depth and low initial cost. Disadvantages are the amount of formwork required, and maximum economical span lengths of 60 feet which will require more bents. The increased number of bents would result in more piers within the water and a tendency to increase water surface elevations upstream of the bridge.

Option 2 – Prestressed Concrete I-Beam (PCB)

PCB's are consistently the most economical option for spans between 50 and 150 feet. They are durable and require little maintenance. Disadvantages for this structure type are superstructure depths that are greater than slab structures and shipping/handling restrictions. The greater structure depths would require that the roadway be elevated higher than under Option 1 in order to achieve freeboard over floodwaters.

Option 3 – Prestressed Rectangular Beams

Rectangular beams cost slightly less than I-Beams and have a lower profile, so they can be an attractive solution for shorter spans. However, their economical span length is limited to 50 feet or less.

Option 4 – Continuous Steel Beams

Steel continuous spans may be advantageous in an area with poor foundation soils, and where significant substructure movement is anticipated. Maximum span length is 90 feet for rolled beams and 350 feet for plate girders. Economically, they are a good choice after PCB's reach their limit of 150 feet. Other advantages include the ability to have curved geometric shapes and a lighter superstructure than concrete. Disadvantages for this type are higher initial and maintenance costs, plus a longer lead time.

With all of these options, stub abutments with stabilized rip rap slope protection and pile bent piers are the most economic choice due to the geometric characteristics of the crossing.

Opinion of Cost for Bridge Alternates

SDDOT's published *Average Unit Prices from Low Bids (2005)* for both rural and four-lane divided highways was used to determine a square-foot (SF) preliminary cost estimate of the structure. A preliminary estimate of major items was created with a 30% increase for miscellaneous items and conditional variables with our results producing a low end cost of \$85 per SF and \$110 per SF at the high end. Estimates for the range of probable cost for various bridge lengths are shown in Table G8.

Table G8 – Price Range for Bridge Alternates

	700 Foot Long Bridge	565 Foot Long Bridge	465 Foot Long Bridge	365 Foot Long Bridge	265 Foot Long Bridge	165 Foot Long Bridge
Square Feet of Deck Area	39,200 sq. ft.	31,640 sq. ft.	26,040 sq. ft.	20,440 sq. ft.	14,840 sq. ft.	9,240 sq. ft.
High End Bridge Cost	\$4,312,000	\$3,480,000	\$2,864,000	\$2,248,000	\$1,632,000	\$1,016,000
Low End Bridge Cost	\$3,332,000	\$2,689,000	\$2,213,000	\$1,737,000	\$1,261,000	\$785,000
Additional Roadway Costs*	\$0	\$65,000	\$114,000	\$162,000	\$210,000	\$258,000
Total High End Cost	\$4,312,000	\$3,545,000	\$2,978,000	\$2,410,000	\$1,842,000	\$1,274,000
Total Low End Cost	\$3,332,000	\$2,754,000	\$2,327,000	\$1,899,000	\$1,471,000	\$1,043,000

* This row accounts for the roadway cost differential for various bridge length alternates. As an example, in order to directly compare a 565 foot bridge to the 700 foot bridge, 135 feet of roadway cost is added to the 565 foot bridge cost. The estimate cost of roadway used was \$46,000/100 feet.

Permitting

Permits will need to be acquired in order to proceed with this bridge project. In particular, a Section 404 will be required from the USACE, and a Section 401 will be required from the South Dakota Department of Environment and Natural Resources. These permits are required because grading will occur within the channel of the Big Sioux River.

A Section 10 permit is not required in addition to 404 and 401 permits. This permit is required when work is being done in, over, or under a navigable water of the U.S. According to the Omaha Corps of Engineers District office, the Big Sioux River is not considered navigable at the project location.

Per discussions with FEMA and FHWA, a CLOMR/LOMR will be required for the proposed improvements if there is any increase to the 100-year water surface elevation.

Recommendations

Because the 20th Avenue South bridge crossing is immediately downstream from the City of Watertown, increases to water surface elevations could exacerbate existing flooding issues for the City and its residents. Accordingly, a solution that limits or prevents increases to water surface elevations is desirable.

A bridge 700 feet long and with no overbank grading adjacent to the channel results in no increase to the 100-year floodplain elevation or the 100-year floodway elevation. A bridge 565 feet long with overbank grading adjacent to the channel also results in no increases to the 100-year floodplain elevation or the 100-year floodway elevation. A bridge 365 feet long with overbank grading adjacent to the channel results in small increases to the 100-year floodplain but no increase to floodway elevations. HDR recommends the 365 foot

long bridge with overbank grading adjacent to the channel as the most reasonable and economical design alternative.

However, because the 365 foot bridge results in an increase to the BFE, the CLOMR/LOMR process will be pursued for the proposed 365 foot long bridge alternative. This process will involve verification of modeling impacts, submission of engineering data and map revision request to FEMA, and a potential modification to floodplain/floodway mapping if the CLOMR/LOMR is approved.



Photo 1
Looking northwest (upstream) from 20th Avenue South bridge



Photo 2
Looking southeast (downstream) from 20th Avenue South bridge

Drawn by: B. Miller
Date: 1-09-07
Checked by: J. Unruh
Date: 1-09-07
Revision Date:



Site Photographs
Watertown South Connector - Seg. 1
Project EM 4411(01) PCN 00RV

Figure
G-1



Photo 3
Looking west at spillway and away from bridge



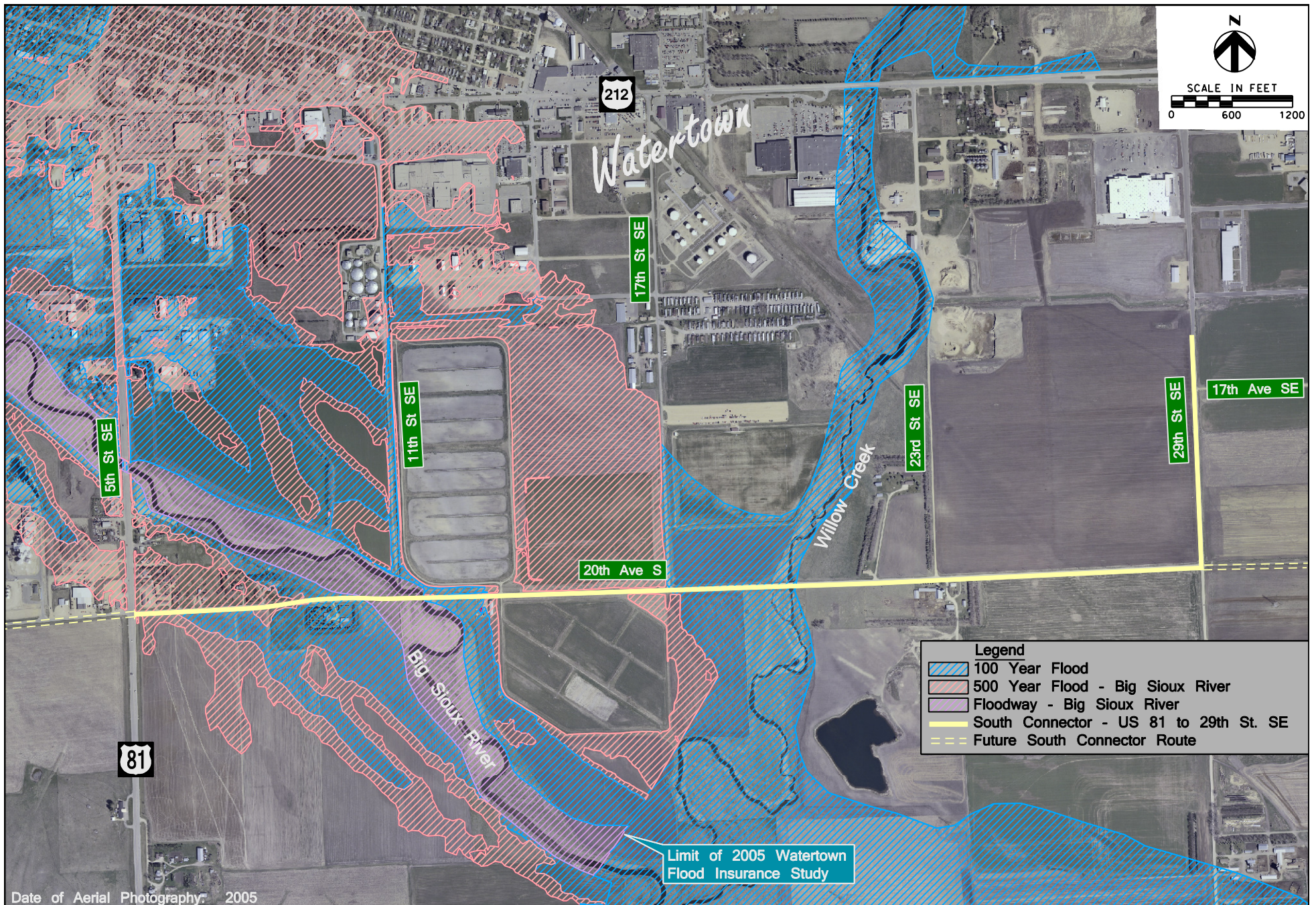
Photo 4
Looking east at spillway and toward bridge

Drawn by: B. Miller
 Date: 1-09-07
 Checked by: J. Unruh
 Date: 1-09-07
 Revision Date:



Site Photographs
 Watertown South Connector - Seg. 1
 Project EM 4411(01) PCN 00RV

Figure
G-2

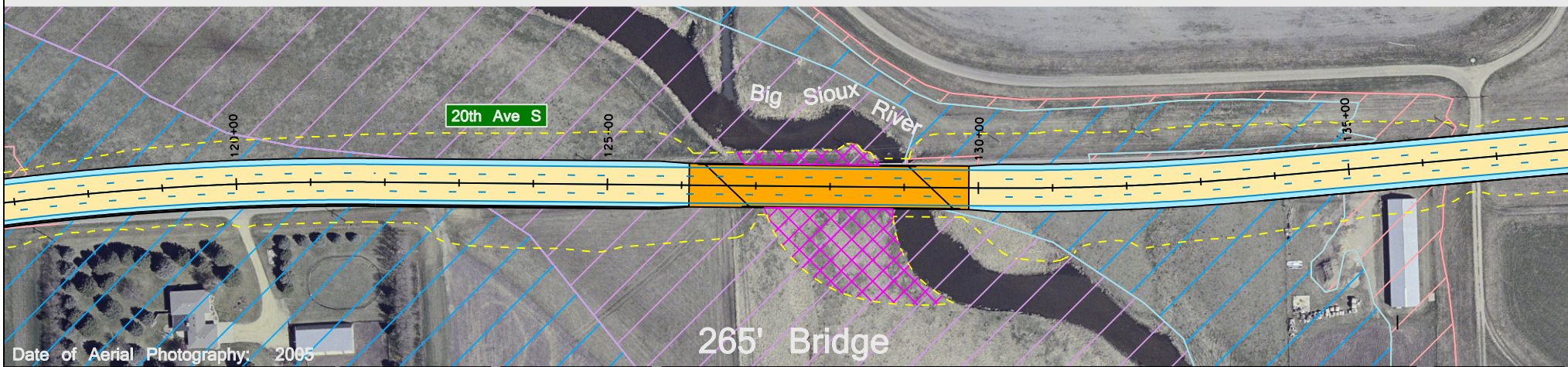
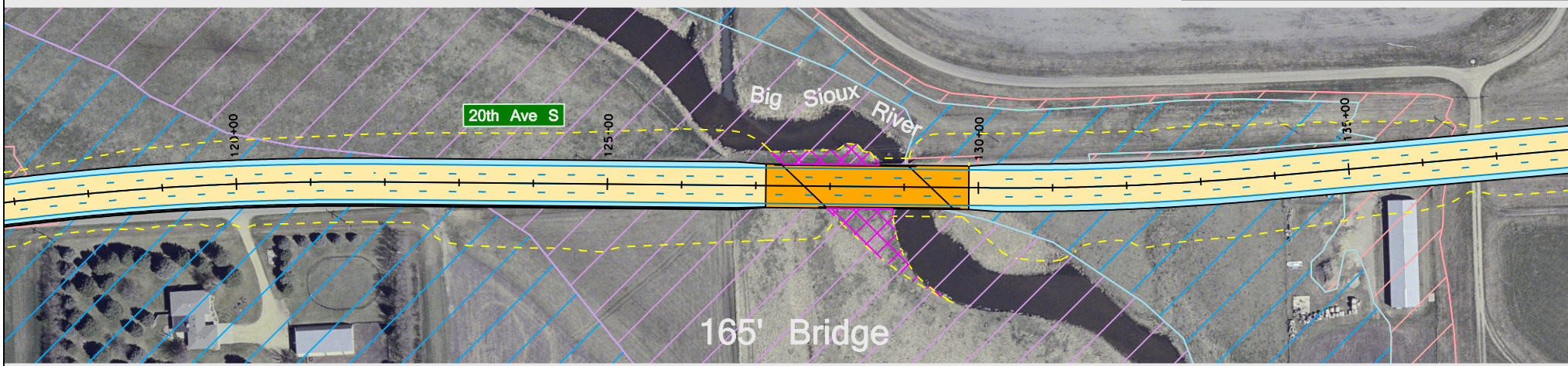


Drawn by: B. Miller
 Date: 1-09-07
 Checked by: J. Unruh
 Date: 1-09-07
 Revision Date:



Floodplain
 Watertown South Connector, Codington County, SD
 Project EM 4411(01) PCN 00RV

Figure
 G-3



Date of Aerial Photography: 2005

Drawn by: B. Miller
Date: 1-09-07

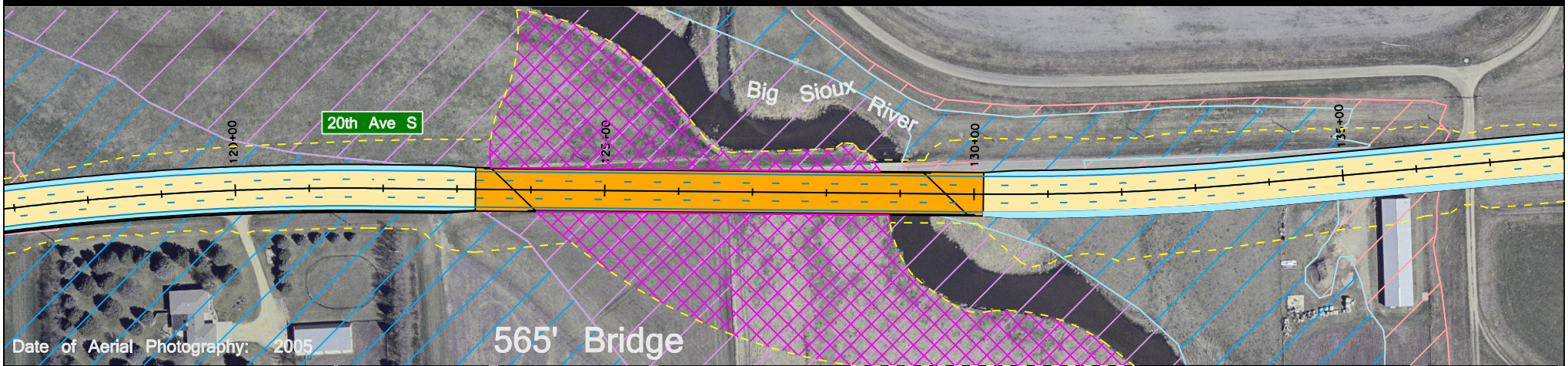
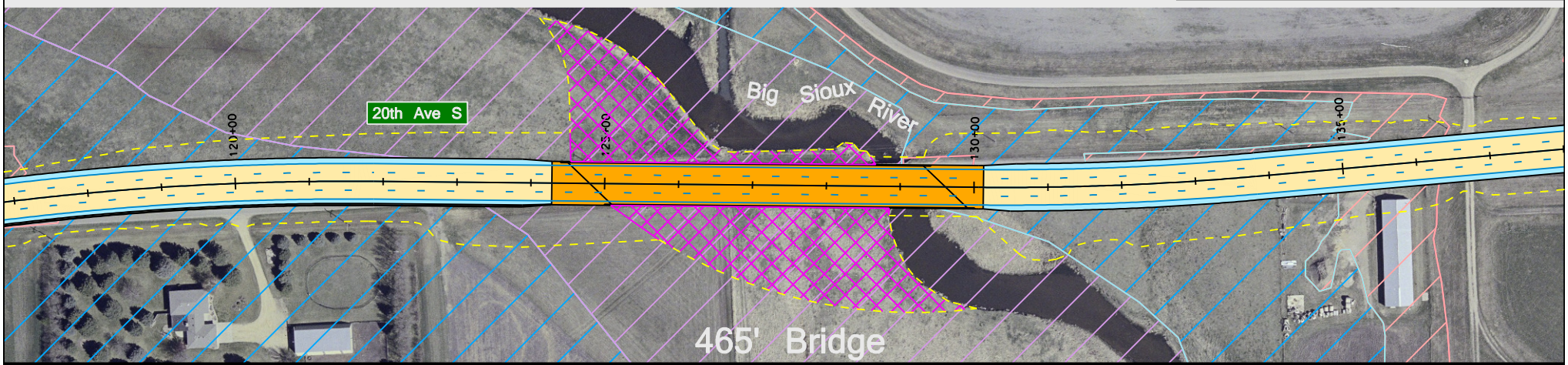
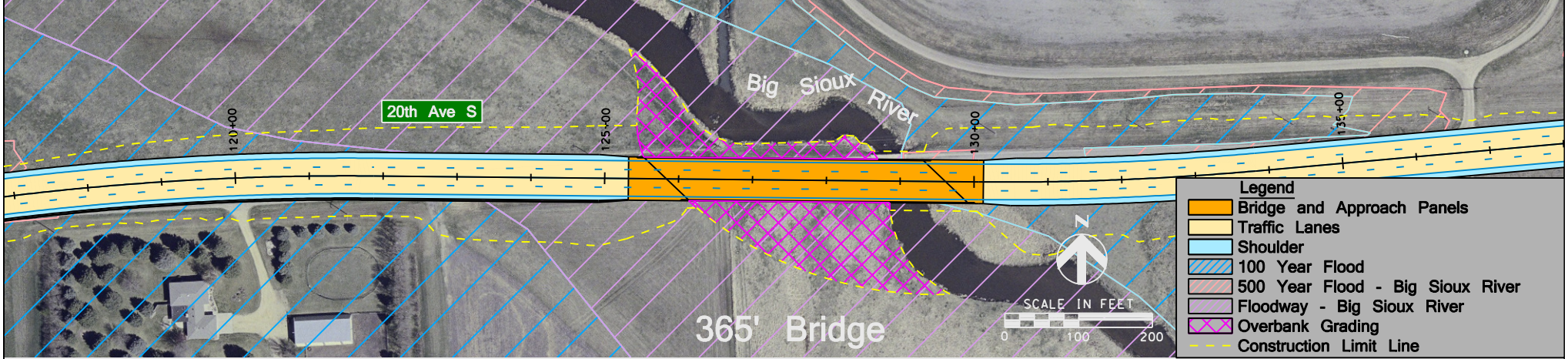
Checked by: J. Unruh
Date: 1-09-07

Revision Date: Sep 2007



Bridge Options at Big Sioux River
Watertown South Connector, Codington County, SD
Project EM 4411(01) PCN 00RV

Figure
G-4



Date of Aerial Photography: 2005

Drawn by: B. Miller
Date: 1-09-07

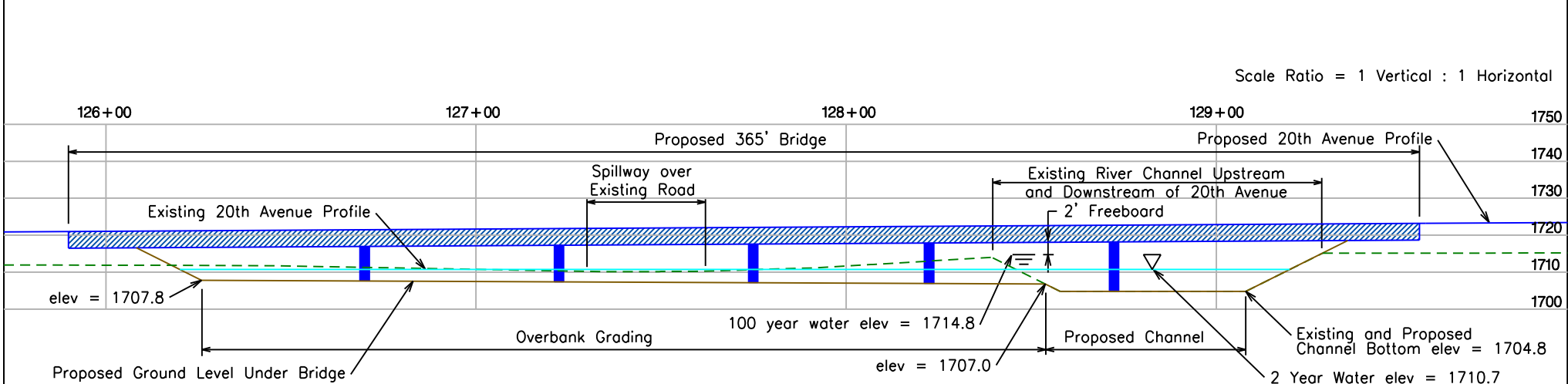
Checked by: J. Unruh
Date: 1-09-07

Revision Date: Sep 2007

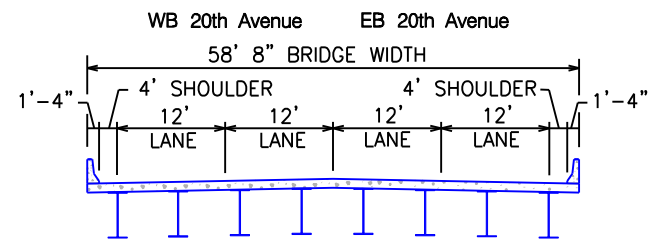


Bridge Options at Big Sioux River
 Watertown South Connector, Codington County, SD
 Project EM 4411(01) PCN 00RV

Figure
G-5



**20th Avenue Bridge Profile
 at Big Sioux River Crossing
 365' Long Bridge Option**
 (Profile for 165' through 565' bridge options would be similar)



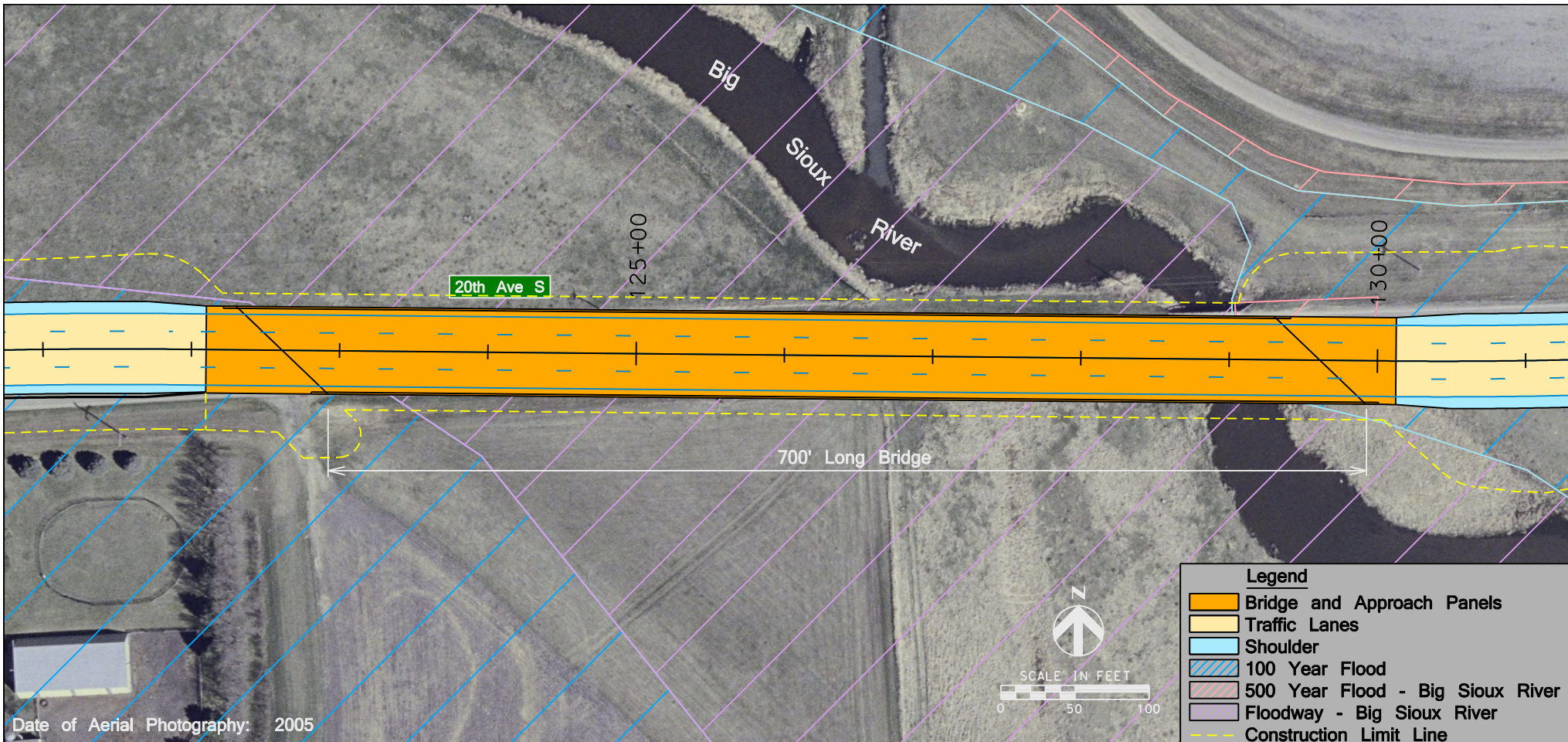
**20th Avenue Bridge Section
 at Big Sioux River Crossing
 (looking east)**

Drawn by: B. Miller
 Date: 1-09-07
 Checked by: J. Unruh
 Date: 1-09-07
 Revision Date: Sep 2007



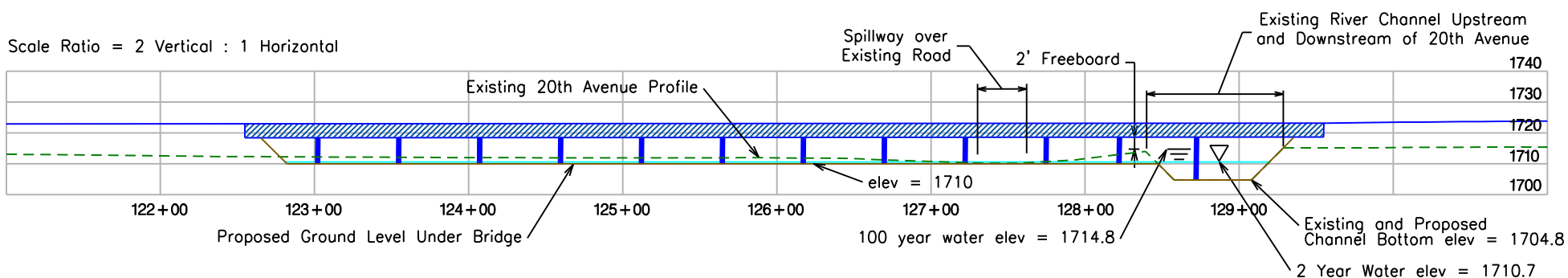
Bridge Layout at Big Sioux River
 Watertown South Connector, Codington County, SD
 Project EM 4411(01) PCN 00RV

**Figure
 G-6**



Date of Aerial Photography: 2005

Scale Ratio = 2 Vertical : 1 Horizontal



Drawn by: B. Miller
Date: 1-09-07
Checked by: J. Unruh
Date: 1-09-07
Revision Date: Sep 2007



700' Long Bridge Option at Big Sioux River
Watertown South Connector, Codington County, SD
Project EM 4411(01) PCN 00RV

Figure G-7

To: Watertown South Connector Process Team Members:
 SDDOT - Terry Keller (Office of Project Development)
 Watertown - Herb Blomquist, Director of Public Works
 FHWA - Ginger Massie

From: HDR Project: Watertown South Connector – EM 4411(01) PCN 00RV

Date: October 27, 2008; rev 1/29/09

RE: Environmental Assessment (EA) Update – Big Sioux River Floodplain Impacts

Section 3.15 (Floodplain) of the EA contained the following statement (page 3-20, paragraph 2):

“If building within a floodway causes an increase in the level of the base flood elevation (BFE), approval is required from FEMA through a LOMR. The BFE includes the floodplain and the floodway. Due to the increase in the 100-year floodplain elevation, it is anticipated that a LOMR would be required for the 365-foot bridge alternate.”

The results of the LOMR process were slightly different than anticipated in the EA. The following table summarizes the steps taken as part of the LOMR process:

Date	Activity
2/1/08	Conditional Letter of Map Revision (CLOMR) application package submitted to FEMA.
4/18/08 & 4/30/08	FEMA provided comments on CLOMR application. The main comments included: <ul style="list-style-type: none"> • HEC-RAS model needed some minor refinements • Elevation survey of structures within affected floodplain required • Notices to be sent to affected property owners • Topographic exhibit to be modified to show all areas of potential impact
6/2/08	City of Watertown sent out notification letter to approximately 70 affected landowners.
6/6/08 to 6/20/08	Building elevation survey completed for 44 structures within the affected floodplain area.
7/10/18	Supplemental CLOMR package submitted to FEMA with items that addressed FEMA comments.
8/28/08	FEMA suggested modification of the “existing conditions” hydraulic model to achieve “no-rise” condition for 365’ long bridge.
9/9/08	Revised hydraulic model submitted to FEMA with incorporation of FEMA suggestion.
9/30/08	FEMA issued final determination for CLOMR application (attached to this memo). The main elements of the final determination included: <ul style="list-style-type: none"> • Page 1 paragraph 5 of the determination letter concurred with the “no-rise” condition: <i>“As a result of the revised hydraulic analysis, updated topographic information, and proposed project, no changes will occur to the Base Flood Elevations (BFEs) along the Big Sioux River compared to the effective BFEs.”</i> • Completion of the floodplain map revision process (LOMR) is still required, however, based on the statement on page 2 paragraph 1: <i>“As a result of the revised hydraulic analysis, updated topographic information, and proposed project, the width of the regulatory floodway along the Big Sioux River will increase in some areas and decrease in other areas compared to the effective floodway width.”</i> All other conditions of the CLOMR approval related to tasks that must be completed after construction of the project is complete.

In summary, a LOMR was required for the project but for different reasons than were stated in the EA. **SDDOT will assure that the LOMR will be completed appropriately after construction.**



Federal Emergency Management Agency

Washington, D.C. 20472

September 30, 2008

CERTIFIED MAIL
RETURN RECEIPT REQUESTED

IN REPLY REFER TO:
Case No.: 08-08-0325R

The Honorable Lavern Marquardt
Chairman, Codington County
Board of Commissioners
14 First Avenue Southeast
Watertown, SD 57201

Community: Codington County, SD
Community No.: 460260

104

Dear Mr. Marquardt :

This responds to a request that the Department of Homeland Security's Federal Emergency Management Agency (FEMA) comment on the effects that a proposed project would have on the effective Flood Insurance Rate Map (FIRM) and FIS report for Codington County, South Dakota and Incorporated Areas, in accordance with Part 65 of the National Flood Insurance Program (NFIP) regulations. In a letter dated February 15, 2008, Mr. Mathew Redington, P.E., HDR Engineering Inc., requested that FEMA evaluate the effects that new topographic data, a detailed hydraulic analysis, and proposed bridge modifications along the Big Sioux River from approximately 280 feet downstream to approximately 250 feet upstream of 20th Avenue Southeast would have on the flood hazard information shown on the effective FIRM and FIS report.

All data required to complete our review of this request for a Conditional Letter of Map Revision (CLOMR) were submitted with letters from Mr. Redington.

Because this revision request also affects the City of Watertown, a separate CLOMR for that community was issued on the same date as this CLOMR.

We reviewed the submitted data and the data used to prepare the effective FIRM for your community and determined that the proposed project meets the minimum floodplain management criteria of the NFIP. We believe that, if the proposed project is constructed as shown on the drawing entitled "Proposed Layout 370' - 4 1/4" Prestressed Girder Bridge," prepared by HDR Engineering Inc., dated July 10, 2008, and the data listed below are received, the floodplain boundaries of the base (1-percent-annual-chance) flood and the 0.2-percent-annual-chance flood will be delineated as shown on the drawing entitled "Topographic Exhibit," prepared by HDR Engineering Inc., submitted February 1, 2008.

As a result of the revised hydraulic analysis, updated topographic information, and proposed project, no changes will occur to the Base Flood Elevations (BFEs) along the Big Sioux River compared to the effective BFEs.

As a result of the revised hydraulic analysis, updated topographic information, and proposed project, the width of the Special Flood Hazard Area (SFHA), the area that would be inundated by the base flood, along the Big Sioux River will decrease compared to the effective SFHA width. The maximum decrease in SFHA width, approximately 1,015 feet, will occur at 20th Avenue Southeast.

As a result of the revised hydraulic analysis, updated topographic information, and proposed project, the width of the regulatory floodway along the Big Sioux River will increase in some areas and decrease in other areas compared to the effective floodway width. The maximum increase in floodway width, approximately 60 feet, will occur at 20th Avenue Southeast. The maximum decrease in floodway width, approximately 220 feet, will occur just downstream of 20th Avenue Southeast.

Upon completion of the project, your community may submit the data listed below and request that we make a final determination on revising the effective FIRM and FIS report.

- Detailed application and certification forms, which were used in processing this request, must be used for requesting final revisions to the maps. Therefore, when the map revision request for the area covered by this letter is submitted, Form 1, entitled "Overview & Concurrence Form," must be included. (A copy of this form is enclosed.)
- The detailed application and certification forms listed below may be required if as-built conditions differ from the preliminary plans. If required, please submit new forms (copies of which are enclosed) or annotated copies of the previously submitted forms showing the revised information.

Form 2, entitled "Riverine Hydrology & Hydraulics Form"

Form 3, entitled "Riverine Structures Form"

Hydraulic analyses, for as-built conditions, of the base flood; the 10-percent-, 2-percent-, and 0.2-percent-annual-chance floods; and the regulatory floodway, together with a topographic work map showing the revised floodplain and floodway boundaries, must be submitted with Form 2.

- Because we are preparing a revised countywide FIRM and FIS report for Codington County, South Dakota and Incorporated Areas, upon completion of the project for which this CLOMR is issued, please comply with one of the following alternative requirements:
 - If the revised countywide FIRM and FIS report become effective before completion of the 20th Avenue Southeast Bridge project, the hydraulic model submitted for the project Letter of Map Revision (LOMR) that follows this CLOMR must tie into the hydraulic model used to prepare the newly effective FIRM and FIS report. Therefore, please submit a hydraulic model and an annotated FIRM in which the revised SFHA and floodway boundary delineations tie into the SFHA and floodway boundary delineations in the hydraulic model used to prepare the newly effective FIRM and FIS report at the upstream and downstream ends of the revision.
 - If the LOMR submittal for the 20th Avenue Southeast Bridge is received before the revised countywide FIRM and FIS become effective, then the SFHA and floodway boundary delineations must tie into the currently effective information.
- Effective October 1, 2007, FEMA revised the fee schedule for reviewing and processing requests for conditional and final modifications to published flood information and maps. In accordance

with this schedule, the current fee for this map revision request is \$4,800 and must be received before we can begin processing the request. Please note, however, that the fee schedule is subject to change, and requesters are required to submit the fee in effect at the time of the submittal. Payment of this fee shall be made in the form of a check or money order, made payable in U.S. funds to the National Flood Insurance Program, or by credit card (Visa or MasterCard only). The payment, along with the revision application, must be forwarded to the following address:

FEMA National Service Provider
3601 Eisenhower Avenue
Alexandria, VA 22304-6425

- As-built plans, certified by a registered professional engineer, of all proposed project elements
- Community acknowledgment of the map revision request
- A copy of the public notice distributed by your community stating its intent to revise the regulatory floodway, or a statement by your community that it has notified all affected property owners and affected adjacent jurisdictions
- A letter stating that your community will adopt and enforce the modified regulatory floodway, OR, if the State has jurisdiction over either the regulatory floodway or its adoption by your community, a copy of your community's letter to the appropriate State agency notifying it of the modification to the regulatory floodway and a copy of the letter from that agency stating its approval of the modification

After receiving appropriate documentation to show that the project has been completed, FEMA will initiate a revision to the FIRM and FIS report.

The basis of this CLOMR is, in whole or in part, a channel-modification/bridge project. NFIP regulations, as cited in Paragraph 60.3(b)(7), require that communities assure that the flood-carrying capacity within the altered or relocated portion of any watercourse is maintained. This provision is incorporated into your community's existing floodplain management regulations. Consequently, the ultimate responsibility for maintenance of the modified channel and bridge rests with your community.

This CLOMR is based on minimum floodplain management criteria established under the NFIP. Your community is responsible for approving all floodplain development and for ensuring all necessary permits required by Federal or State law have been received. State, county, and community officials, based on knowledge of local conditions and in the interest of safety, may set higher standards for construction in the SFHA. If the State, county, or community has adopted more restrictive or comprehensive floodplain management criteria, these criteria take precedence over the minimum NFIP criteria.

If you have any questions regarding floodplain management regulations for your community or the NFIP in general, please contact the Consultation Coordination Officer (CCO) for your community. Information on the CCO for your community may be obtained by calling the Director, Mitigation Division of FEMA in

Denver, Colorado, at (303) 235-4830. If you have any questions regarding this CLOMR, please call our Map Assistance Center, toll free, at 1-877-FEMA MAP (1-877-336-2627).

Sincerely,



Beth A. Norton, CFM, Program Specialist
Engineering Management Branch
Mitigation Directorate

For: William R. Blanton Jr., CFM, Chief
Engineering Management Branch
Mitigation Directorate

Enclosures

cc: The Honorable Paul Fox
Mayor, City of Watertown

Mr. Richard Schlechter, P.E.
Planning & Zoning Official
City of Watertown

Mr. Richard Phillips
Bridge Hydraulics Engineer
Office of Bridge Design
Department of Transportation
State of South Dakota

Mr. Mathew Redington, P.E.
Project Manager
HDR Engineering Inc.