

APPENDIX G

DIVERSION AND PELICAN LAKE CUTOFF CHANNELS HYRAULICS AND BRIDGE TECHNICAL MEMORANDUM

To: File	
From: Matt Redington, P.E.	Project: Watertown South Connector
CC:	
Date: March 6, 2007; revised April 2007, May 2008	Job No: 39319

RE: Hydraulic Analysis for Watertown South Connector from SD 20 to US 81

Background

In the portion of the South Connector project from SD 20 to US 81, there is a complex interaction between the Big Sioux River and Pelican Lake. Flows from the Big Sioux River are partially diverted into Pelican Lake through a man-made trapezoidal-shaped channel (referred to as the Diversion Channel). This channel starts at the Big Sioux River just south of Highway 212, and travels southwest toward Pelican Lake, (see Figure G-1 and Site Photos in Figures G-2, G-3, and G-4).

The water diversion occurs through the combined use of a spillway in the Big Sioux River and a weir (Weir #1 on Figure G-1) at the upper end of the Diversion Channel. The river spillway allows water to pool at the junction of the Diversion Channel and the Big Sioux River. The Diversion Channel weir controls the amount of flow into Pelican Lake.

During periods of high flow in the Big Sioux River, water passes freely over the Diversion Channel weir and into Pelican Lake. During times when Pelican Lake is receiving high inflows from the Pelican Lake watershed and the Big Sioux River is experiencing low flows, water flows in a reverse direction (to the northeast) in the Diversion Channel. The condition used for design analysis was for high flow events, when water flows into Pelican Lake from the Big Sioux River.

There is a second Diversion Channel weir (Weir #2 on Figure G-1) which is located near Pelican Lake. This weir is located on the south bank of the Diversion Channel. During higher flow events, the water surface elevation of Pelican Lake rises and water begins to back up in the Diversion Channel. Once Diversion Channel water surface elevations exceed the top of south bank weir elevation, water spills out of the Diversion Channel and into another channel (referred to as the Pelican Lake Cutoff Channel). This channel returns flows back to the Big Sioux River. This channel is meandering, and has not been significantly modified from its natural state. The relationship of the Big Sioux River, the Diversion Channel, Pelican Lake, and the Pelican Lake Cutoff Channel are shown in Figure G-1.

Waterway Regulations

The Big Sioux River is currently undergoing a flood map revision by the U.S. Army Corps of Engineers (USACE). With the revised flood map, the Big Sioux River will have a floodway. All construction improvements within the floodway must result in a “no-rise” of the floodway water surface elevations.

The Diversion Channel and the Pelican Lake Cutoff Channel are in a Zone A flood area. No change is planned to the zone status of the Diversion and Pelican Lake Cutoff Channels as a

result of the Big Sioux River remapping efforts. In Zone A areas, Federal regulations permit a rise in water surface elevations. City of Watertown regulations, however, prohibit a rise in these channels that is greater than 0.10 feet. Figure G-1 shows the flood zones for each of the waterways and the roadway alignment options that are under consideration for Segment 2A.

This hydraulic analysis considered Build Alternative Options 1, 2, 3, and 4.

Big Sioux River

Option 1

The Option 1 roadway alignment encroaches on the USACE-proposed Big Sioux River floodway. The USACE hydraulic model was used to determine the impact that Option 1 would have on water surface elevations.

In addition to meeting the “no-rise” criteria in the Big Sioux River, it is important not to significantly lower water surface elevations. The reason for this is that any changes to water surface elevations could result in a change to the way flows split between the Diversion Channel and the Big Sioux River. In essence, modifications to water surface elevations (increases or decreases) could change the way flows enter Pelican Lake. Furthermore, changes to the flow split could result in velocity changes within the Big Sioux River and the Diversion Channel.

The existing alignment of Broadway Street South crosses the Big Sioux River floodway downstream from the Diversion Channel-Big Sioux River split. The water surface elevations on the river, and hence the degree of flow split to the Diversion Channel, are influenced by the vertical profile of this roadway. Option 1 would involve rebuilding a portion of Broadway Street South. In order to minimize impacts to water surface elevations and minimize any changes to the distribution of flows between the Big Sioux River and the Diversion Channel, Option 1 was designed to match the roadway profile of the existing Broadway Street South in order to change water surface elevations as little as possible.

Table 1 shows existing and proposed conditions water surface elevations at various locations within the Big Sioux River. Table 1 also shows the change in elevation from existing to proposed conditions. As can be seen by examining the tables, impacts to water surface elevations are negligible.

**Table 1
Water Surface Elevations for Existing Conditions and with Option 1**

Location	10- Year	25- Year	50- Year	100- Year	100-Year Floodway	500- Year
Upstream Face of Broadway Street Bridge	1713.98	1714.98	1716.01	1717.20	1717.48	1719.18
	1713.98	1714.98	1716.01	1717.14	1717.46	1719.19
				(-0.06)	(-0.02)	(+0.01)
700 Feet Upstream from Broadway Street	1714.19	1715.06	1716.06	1717.24	1717.51	1719.19
	1714.19	1715.07	1716.08	1717.19	1717.49	1719.20
		(+0.01)	(+0.02)	(-0.05)	(-0.02)	(+0.01)
1100 Feet Upstream from Broadway Street	1714.36	1715.14	1716.13	1717.28	1717.55	1719.20
	1714.36	1715.15	1716.15	1717.25	1717.54	1719.24
		(+0.01)	(+0.02)	(-0.03)	(-0.01)	(+0.04)
Downstream Face of Big Sioux River Weir	1714.59	1715.23	1716.19	1717.32	1717.57	1719.22
	1714.59	1715.24	1716.21	1717.29	1717.56	1719.25
		(+0.01)	(+0.02)	(-0.03)	(-0.01)	(+0.03)
Upstream Face of U.S. 212 Big Sioux River Bridge	1714.60	1715.24	1716.22	1717.35	1717.58	1719.23
	1714.60	1715.25	1716.24	1717.32	1717.57	1719.26
		(+0.01)	(+0.02)	(-0.03)	(-0.01)	(+0.03)
	Existing water surface elevations					
	Water surface elevations with South Connector Option 1					
	Water elevation increases from existing to Option 1					

Impacts to channel flow velocities were also examined. At 1100 feet upstream from Broadway Street, Big Sioux River velocities increase from 1.6 fps (feet per second) under existing conditions to 1.7 fps under Option 1 conditions for the 50 year event. At this same location, velocities increase from 1.5 fps to 1.7 fps for the 100 year event. Changes to energy grade elevations within the hydraulic modeling do not indicate that there would be a significant change to the flow split between the Big Sioux River and the Diversion Channel.

Options 2, 3, and 4

Roadway alignment Options 2, 3, and 4 fall outside of the effective flow area of the Big Sioux River. The effective flow area is the portion of the floodplain that allows the passage or movement of flood waters. Under 50-year and 100-year events, flood waters are present in the area of these proposed alignments. In this area, however, velocities are minimal and there is insignificant movement or passage of flood water. As a result, placement of embankment in this area will not lead to changes in water surface elevations. Under extreme conditions, such as during the 500-year event, the area of the Option 2, 3, and 4 alignments would change to effective flow conditions. Options 2, 3, and 4 roadways would be overtopped during the 500-year event, however, and the presence of the roadway embankments would have a minimal impact to water surface elevations due to the vast extent of the floodplain under such conditions.

The Diversion and Pelican Lake Cutoff Channels

Major flooding occurred in Watertown along the Big Sioux River in 1997. During this flood event, water flowed into Pelican Lake from the Diversion Channel and also through the Pelican Lake Cutoff Channel back to the Big Sioux River. Aason Engineering of Watertown, South Dakota was hired by the City of Watertown to take hourly field measurements during the 1997 flood event.

For a separate project, Aason Engineering was hired to design structures for a rail spur which crossed the Diversion and Pelican Lake Cutoff channels. This project required hydraulic modeling to determine hydraulic impacts to the waterways. Using the data that was collected for the City of Watertown, Aason Engineering was able to calibrate their hydraulic model to a known historic event, the 1997 flood.

Three different Big Sioux River flow events were modeled by Aason Engineering: 4,500 cfs, 4,300 cfs, and 3,200 cfs. The 4,500 cfs flow was modeled to represent 1997 flooding conditions. The 4,300 cfs was modeled to represent the 100-year flow the USACE was going to use in their Big Sioux River remapping efforts. The 3,200 cfs flow was modeled to represent the existing 100-year regulatory mapping. Flow split analyses were performed to determine the portion of these flows which went into the Diversion and Pelican Lake Cutoff Channels.

Hydraulic Modeling for Proposed Conditions

The model that Aason Engineering developed for the rail spur project was provided to HDR for use in analyzing the impacts of the proposed South Connector roadway structures across the Diversion and Pelican Lake Cutoff Channels. Flows corresponding to the 4,300 cfs Big Sioux River condition were used to determine if “no-rise” criteria could be met.

Because there are box culverts on the Diversion and Pelican Lake Cutoff Channels for the rail line, modeling was performed for box culverts at the proposed waterway crossings. Although modeling by Aason Engineering showed that the existing culverts did not cause a significant increase to water surface elevations (less than 0.10 feet), HDR modeling showed that additional culverts on these channels would cause a cumulative increase to water surface elevations greater than 0.10 feet. For this reason, it was decided that bridges would be more appropriate for crossing the waterways. Modeling of bridges in these locations showed much smaller impacts to water surface elevations.

In order to minimize the impact to water surface elevations, a slab bridge design was chosen. The slab bridge design results in the bottom elevation of the bridge being raised above 100 year flood elevations. Hydraulic modeling demonstrated that the slab bridge design results in water surface elevation increases of less than 0.10 feet. Due to the at-grade rail crossings that are located in close proximity to the waterway crossings, it is not possible to use a concrete girder bridge type and have the low chord of the bridge structures elevated above the 100 year water surface. Having the low chord of the structure within the water results in water surface elevation increases greater than 0.10 feet, and could also result in floating debris being trapped against the bridge during flooding events.

Bridge Characteristics

The only culvert or bridge that exists in the Diversion Channel is a 4 barrel/12 foot span by 8 foot rise concrete box culvert. All South Connector roadway options would require crossing the Diversion Channel with a new bridge as shown on Figure G-1.

One culvert and one bridge currently cross the Pelican Lake Cutoff Channel as shown on Figure G-1. The culvert is a 3 barrel/12 foot span by 6 foot rise concrete box culvert used for the rail spur. The bridge is a 34 foot long, 2 span concrete slab bridge with vertical abutments for Broadway Street South.

For all South Connector options, concrete slab bridges are proposed for both the Diversion and Pelican Lake Cutoff Channel crossings. The abutments for the proposed bridges would be sloped at 2 feet horizontally to 1 foot vertically. The piers would be aligned to the direction of flow.

Diversion Channel Bridges

The Option 1 bridge would cross the Diversion Channel at a skew of approximately 15 degrees, and would be located about 420 feet upstream of the existing rail spur culvert. The bridge would have 3 spans and be approximately 66 feet long. Two sets of 14” wide H-piles would be placed within the channel near the toe of the channel side slopes.

The Option 2 bridge would cross perpendicular to the Diversion Channel and would be located approximately 250 feet upstream of the existing rail spur culvert. The bridge would have 3 spans and would be approximately 60 feet long. Two sets of 14” wide H-piles would be placed within the channel near the toe of the channel side slopes.

The Option 3 bridge would cross the Diversion Channel at a 24 degree skew. It is located approximately 140 feet downstream from the existing rail spur culvert. The bridge would have 3 spans and would be approximately 74 feet long. Two sets of 14” wide H-piles would be placed within the channel near the toe of the channel side slopes.

The Option 4 bridge would cross the Diversion Channel at a 35 degree skew to the channel approximately 320 feet downstream from the rail spur culvert. The bridge would have 3 spans and be approximately 83 feet long. Two sets of 14” wide H-piles would be placed within the channel near the toe of the channel side slopes.

The proposed bridge sections for Options 1, 2, 3, and 4 at the Diversion Channel are shown in Figures G-5a and G-5b.

Table 2 shows the impacts to the 100-year water surface elevations at the upper end of the Diversion Channel (downstream from the weir), that would occur as a result of the bridge options. These elevation increases meet the criteria for Zone A flood areas, and meet the local requirement that any increases be less than 0.10 feet.

**Table 2
Diversion Channel Water Surface Elevation Changes for Alignment Options 1, 2, and 4.**

	Option 1	Option 2	Option 3	Option 4
Water Surface Elevation Change at Diversion Channel	+0.03 ft	+0.06 ft	+0.03 ft	+0.05 ft

Pelican Lake Cutoff Channel Bridges

Options 1 and 2 would involve replacement of the existing Broadway Street South bridge over the Pelican Lake Cutoff Channel. The Option 1 bridge would cross at approximately a 45 degree skew to the channel, about 24 feet to the east (downstream) of the existing bridge location.

The Option 2 bridge would cross perpendicular to the channel, approximately 30 feet west (upstream) from the existing bridge. The bridges for Options 1 and 2 would have a single span and be approximately 50 ft long. Two sets of 14” wide H-piles would be placed within the channel near the toe of the channel side slopes.

The Option 3 bridge would cross perpendicular to the channel, approximately 325 feet west (upstream) from the existing bridge. Under the Option 3 scenario, the existing Broadway Street bridge would remain in place. The Option 3 bridge would have 3 spans, and would be approximately 80 ft long. Two sets of 14” wide H-piles would be placed within the channel. Placement of roadway embankment within the channel would be required for this option.

Option 3 would require placement of roadway fill within the Pelican Lake Cutoff channel. In order to not change the capacity of the channel, and to maintain the existing profile and cross section, minor channel realignment would be required in the vicinity of these encroachments. It is estimated that approximately 1,100 feet of the channel will be encroached upon.

The Option 4 bridge would cross the channel approximately 4,000 feet upstream (following the meandering of the outlet channel) from the existing bridge. The Option 4 bridge would cross perpendicular to the channel. The bridge would have 3 spans and would be approximately 80 ft long. Two sets of 14” wide H-piles would be placed within the channel. The Option 4 bridge would be placed in an oxbow location where the flow area during major events would be approximately 700 feet wide. Placement of roadway embankment within this flow area would be required in order to avoid building an extremely long and costly bridge.

The proposed bridge sections for Options 1, 2, 3, and 4 at the Pelican Lake Cutoff Channel are shown in Figures G-6a and G-6b.

Table 3 shows the impacts to the 100-year water surface elevations upstream of the proposed bridges that would occur as a result of the various alignment options. These elevation increases meet the criteria for Zone A flood areas, and meet the local requirement that any increases be less than 0.10 feet.

Table 3
Cutoff Channel Water Surface Elevation Changes for Alignment Options 1, 2, 3, and 4

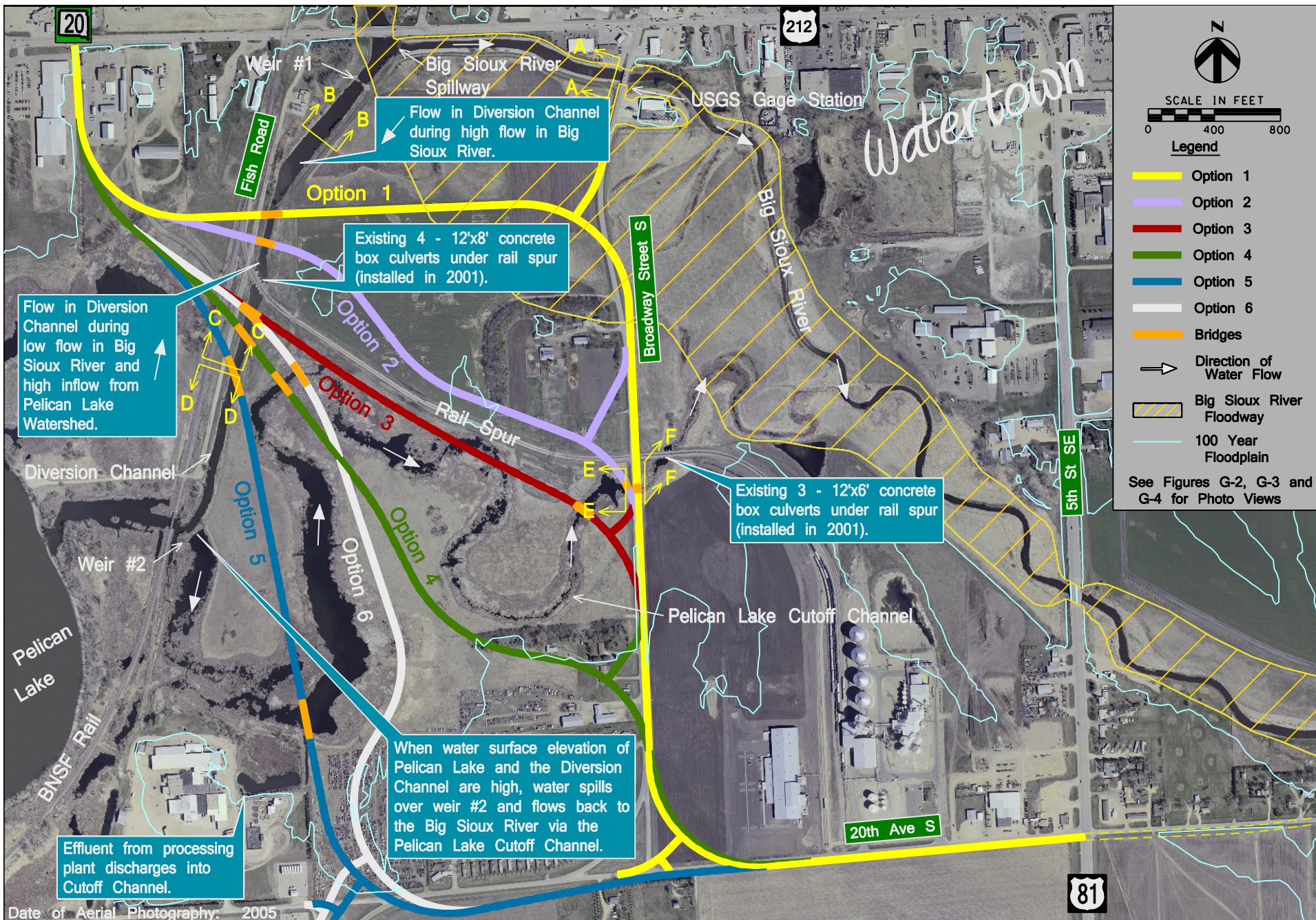
	Option 1	Option 2	Option 3	Option 4
Water Surface Elevation Change at Cutoff Channel	-0.08 ft	-0.08 ft	+0.03	+0.03 ft

Conclusion

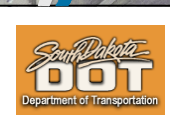
Hydraulic analyses were performed to examine the potential impacts of roadway alignment options on water surface elevations, flow velocities, and flow distributions in the Big Sioux River, the Diversion Channel, and the Pelican Lake Cutoff Channel.

Option 1 would encroach within the Big Sioux River floodway. Although hydraulic modeling suggests that water surface elevations and velocities would remain within compliance of Federal “no-rise” regulations, the City of Watertown is opposed to construction of this alternative due to the floodway encroachment and the possibility of exacerbating existing flooding problems. Options 2, 3, and 4 encroach on the floodplain of the Big Sioux River but not the floodway. These options do not have a significant impact on water surface elevations in the Big Sioux River due to the fact that these alignments are in ineffective flow areas on the fringe of the floodplain.

Crossing options over the Diversion and Pelican Lake Cutoff Channels are proposed as bridges in order to minimize increases to water surface elevations. These crossings result in increases that are less than 0.10 ft, which is in conformance with local regulations. Changes to flow velocities in these channels as a result of the proposed bridges are negligible. Option 3 would result in encroachment on the Pelican Lake Cutoff Channel. This encroachment would need to be mitigated by realignment of portions of the channel.



Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
January 2008



Hydraulic Considerations
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure G-1



View A-A
Looking West from Broadway Street S.

Date of Photo: 4-7-06



View B-B
Looking North at Pelican Lake Diversion Channel Weir

Date of Photo: Unknown

Drawn by: B. Miller
Date: 03-06-07
Checked by: J. Unruh
Date: 03-06-07
Revision Date:
April 2007



Site Photographs
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-2



View C-C
Looking North along Pelican Lake Diversion Channel



View D-D
Looking South along Pelican Lake Diversion Channel

Date of Photos: 8-9-06

Drawn by: B. Miller
Date: 03-06-07
Checked by: J. Unruh
Date: 03-06-07
Revision Date:
April 2007



Site Photographs
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-3



View E-E
Looking West from Broadway Street Bridge at Pelican Lake Cutoff Channel



View F-F
Looking Northeast from Broadway Street Bridge at Pelican Lake Cutoff Channel

Date of Photos: 8-8-06

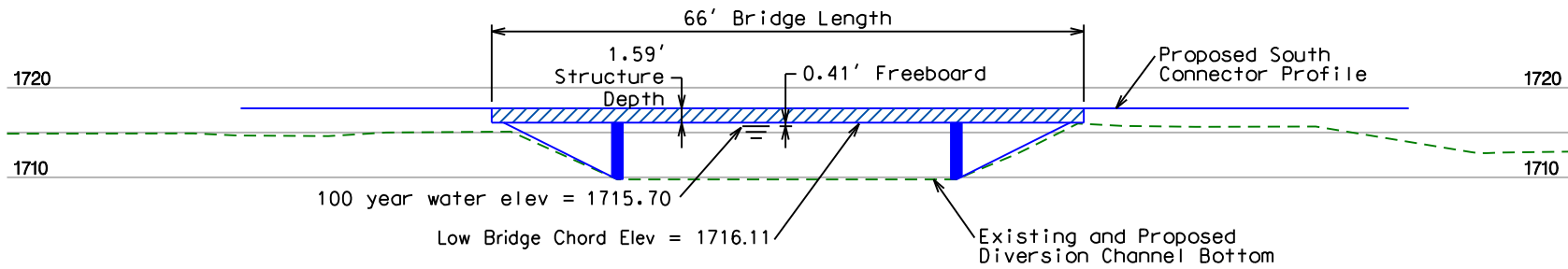
Drawn by: B. Miller
 Date: 03-06-07
 Checked by: J. Unruh
 Date: 03-06-07
 Revision Date:
 April 2007



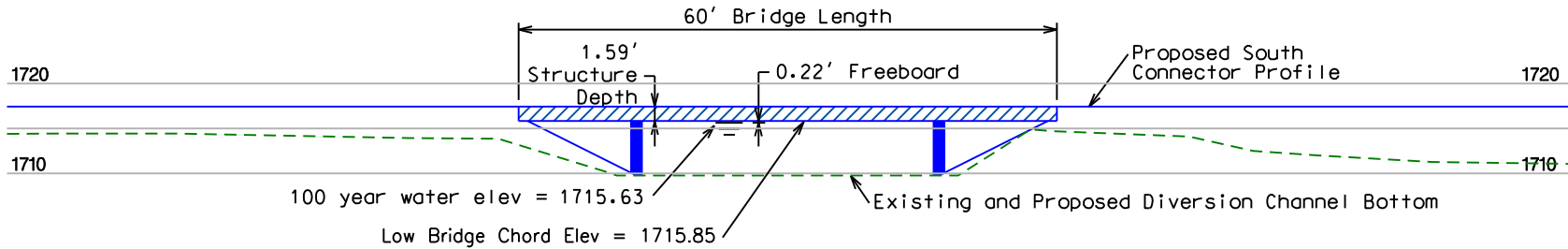
Site Photographs

Watertown South Connector - SD 20 to US 81
 Project EM 4020(01) PCN 00RW

Figure
G-4

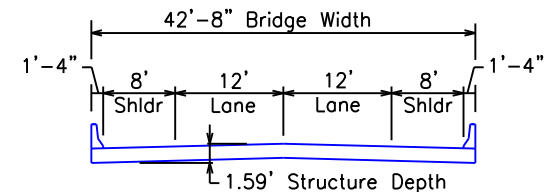


Option 1 Bridge at Pelican Lake Diversion Channel



Option 2 Bridge at Pelican Lake Diversion Channel

Scale Ratio = 1 Vertical : 1 Horizontal



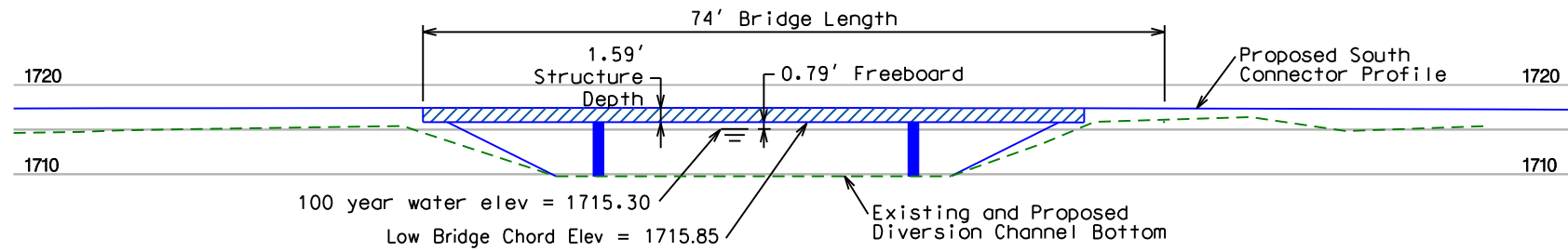
Bridge Section (All Options)

Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
May 2008

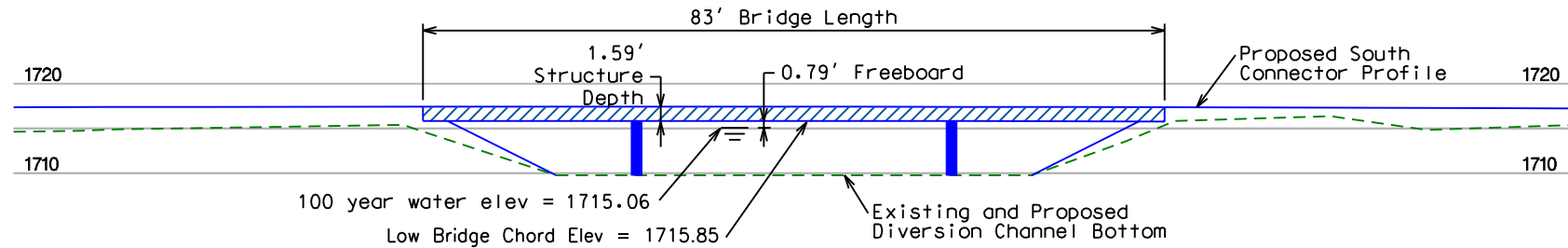


Bridge Layouts at Pelican Lake Diversion Channel
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-5a

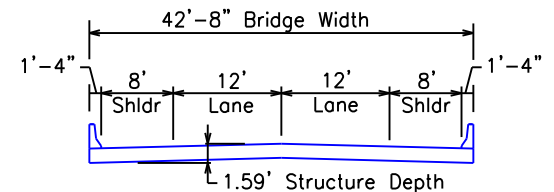


Option 3 Bridge at Pelican Lake Diversion Channel



Option 4 Bridge at Pelican Lake Diversion Channel

Scale Ratio = 1 Vertical : 1 Horizontal



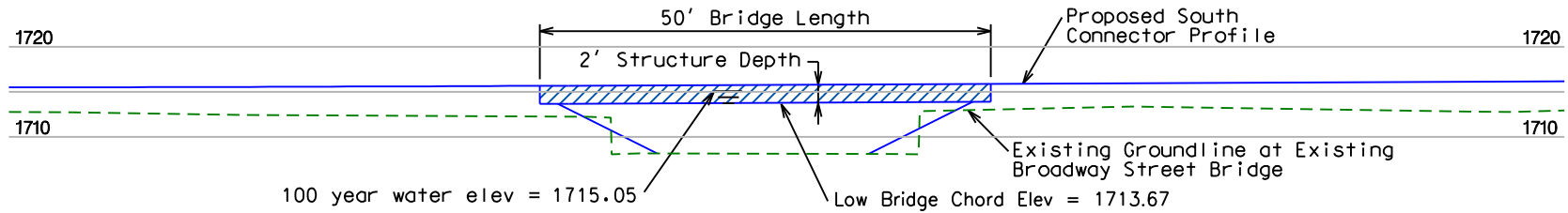
Bridge Section (All Options)

Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
May 2008

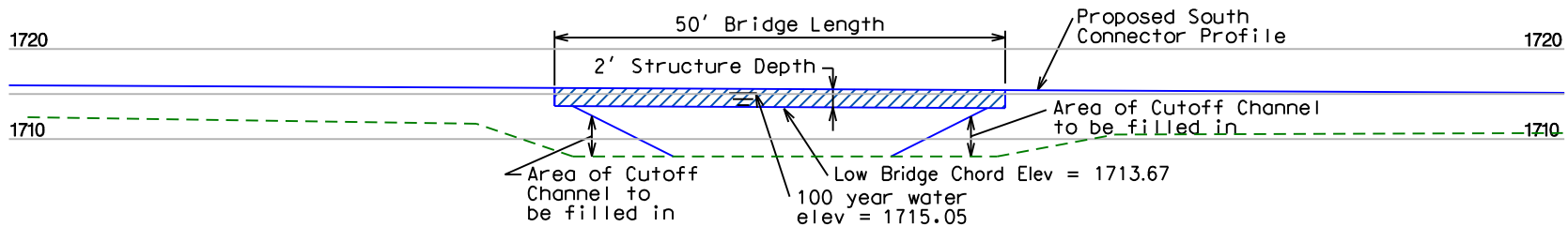


Bridge Layouts at Pelican Lake Diversion Channel
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-5b

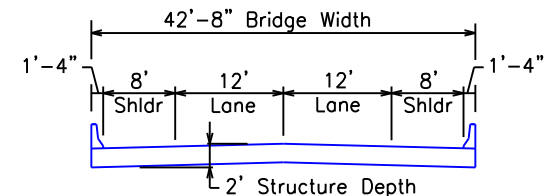


Option 1 Bridge at Pelican Lake Cutoff Channel



Option 2 Bridge at Pelican Lake Cutoff Channel

Scale Ratio = 1 Vertical : 1 Horizontal



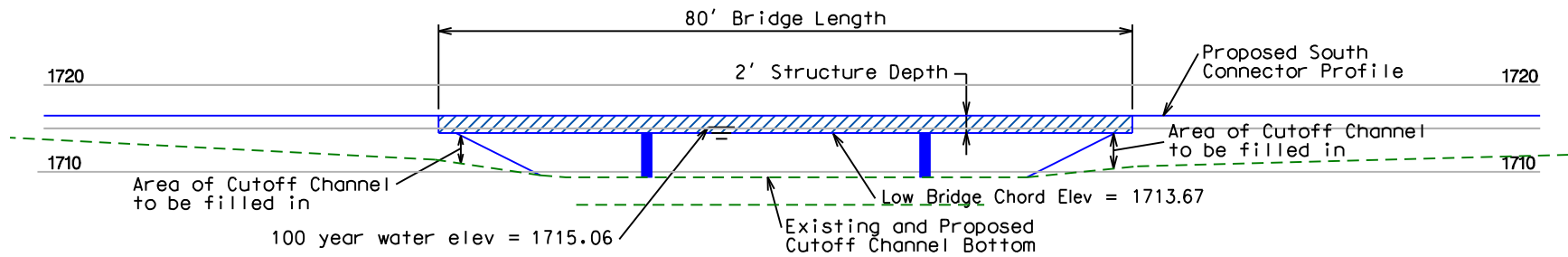
Bridge Section (All Options)

Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
May 2008

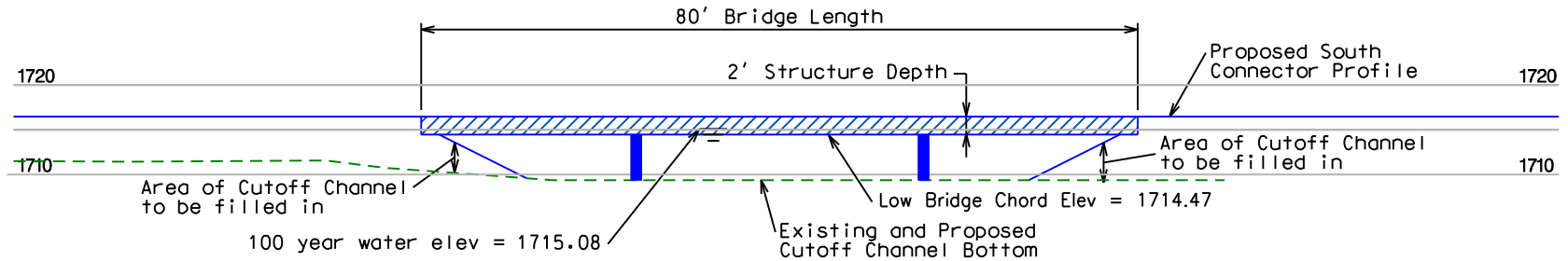


Bridge Layouts at Pelican Lake Cutoff Channel
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-6a

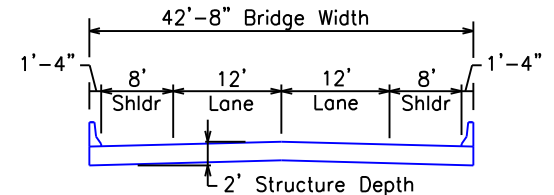


Option 3 Bridge at Pelican Lake Cutoff Channel



Option 4 Bridge at Pelican Lake Cutoff Channel

Scale Ratio = 1 Vertical : 1 Horizontal



Bridge Section (All Options)

Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
May 2008



Bridge Layouts at Pelican Lake Cutoff Channel
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure
G-6b

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION HYDRAULIC DATA SHEET

County Codington Project No. P 4020(01) PCN 00RW Sec. 1 Township 116 N Range 53 W
 Existing Station 30+72 Over Pelican Lake Diversion Channel Drainage Area N/A^A Direction of Flow (N S E W)^C
 Preliminary X Final _____ Q-Design Yr. Frequency 100-year^B Observed H.W. Elev. Not Provided
 BRIDGE NO. 15-179-183 LOCATION Watertown South Connector, 0.4 miles South East of US 212 Junction

Cross Section	Q _d cfs	W.W. Area sq. ft.	V fps	S _o ft./ft.	Bottom		H.W. ft.	d _n ft.	C.L. FL Elev.	D.H.W. Elev.		Ch. Ch.	Degree Skew
					Structure	Ch.				Culv. Inlet	Bridge		
Trapezoid 2:1 S:S I	1400 ^B	452	3.1	0.0 ^C		Trapezoid BW = 30		9.4	1705.9		1717.4	No	20°RHF ^D
Rectangle II	1414 ^B	428	3.3	0.0 ^C	4B = 48'		11.1	10.9	1706.3 ^E	1717.4		No	20°RHF ^D
Round													
Arch													

Type: I. Berm-Type Bridge II. RCBC with 0° FWVs at inlet and outlet^F
 Size: I. See Location Entry II. 4 - 12' X 10'^G
 Proposed Location: I. CL West Berm Toe Sta. 30+30, Elev. 1705.9'; CL East Berm Toe Sta. 30+87.9, Elev. 1705.9' II. Sta. 30+72
 Notes or Remarks: _____

^A No drainage area was shown for this station since upstream the Big Sioux River splits into the lower reach and this diversion channel.
^B Steady discharges for this crossing were taken from the Flood Insurance Study (FIS) effective January 16, 2009. Model boundary conditions were taken from the FIS and the FEMA HEC-RAS model. Depending on the proposed structure, the flow characteristics change at the split flow location of the Big Sioux River, hence the different flow values for the two options.
^C It's proposed that the drainage structures be placed at zero channel gradient since the channel can flow in either direction depending on flows in the Big Sioux and Pelican Lake water levels.
^D A 20° skew angle is needed to match the well defined man-made channel.

<u>Distribution</u>		^E This location is considered a Topeka Shiner stream; therefore, lower the box flow line 1.0' to 1705.3' and place stream bed material in the box
Hydraulics	X	^F Because of the well defined man-made channel, 30° FWVs offered little to no hydraulic benefit.
Bridge	X	^G Several bridge lengths and culvert sizes were evaluated with little difference in water surface elevations.
Bridge Maint.	X	Final options were chosen based on smallest acceptable sizes and engineering judgment.
Rd. Design	X	
Foundations	X	
Environmental	X	During TS&L, determine type of required erosion control to be provided and verify high water marks.
Right-of-Way	X	
PIC	X	^H Codington County and the City of Watertown are participating in the FEMA program. This structure is in the 100-year and 500 year floodplain but off of the main channel.
FHWA	X	For additional hydraulic design supporting information, contact the hydraulic engineer.
City	Watertown	Vertical Datum Used: NAVD 88: <u>X</u> NGVD 29: <u>Unknown:</u>
County	Aberdeen	Topeka Shiner Stream: Yes <u>X^E</u> No <u>_____</u> 404 Permit: Yes <u>X</u> No <u>_____</u>
Region	Watertown	FEMA Floodplain: Yes <u>X^H</u> No <u>_____</u> OHW elev. = <u>_____</u>
Area Engineer	SVM	In-Place Structure: <u>This is a new alignment and structure.</u>
Checked	RAP	100-Yr. DHW Elev. (existing): <u>1717.3'</u>
Reviewed	RAP	

Revision No. _____ Date: _____
 Supplement No. _____ Date: _____ Prepared By: Richard A. Phillips
 Hydraulic Engineer

Date: 8/13/2009

Reviewed By: _____
 SDDOT Bridge Hydraulic Engineer

Date: _____

SOUTH DAKOTA DEPARTMENT OF TRANSPORTATION HYDRAULIC DATA SHEET

County Codington Project No. P 4020(01) PCN 00RW Sec. 6 Township 116 N Range 52 W
 Existing Station 54+30 Over Pelican Lake Cutoff Channel Drainage Area N/A^A Direction of Flow (N S E W)^C
 Preliminary X Final _____ Q-Design Yr. Frequency 100 -Year^B Observed H.W. Elev. Not Provided
 BRIDGE NO. 15-185-186 LOCATION Watertown South Connector, 1.0 mile South East of US 212 Junction

Cross Section	Q _d cfs	W.W. Area sq. ft.	V fps	S _o ft./ft.	Bottom		H.W. ft.	d _n ft.	C.L. FL Elev.	D.H.W. Elev.		Ch. Ch.	Degree Skew
					Structure	Ch.				Culv. Inlet	Bridge		
Trapezoid <u>2:1 S:S</u> I	592	329	1.8	0.0 ^C		Trapezoid BW = 26'		8.8	1707.5		1716.3	No	0°
Rectangle II	592	592	1.0	0.0 ^C	5B = 70		9.1	9.0	1707.2	1716.3		No	0°
Round													
Arch													

Type: I. Berm-Type Bridge II. RCBC with 30° FWWs at inlet and 0° FWWs at outlet
 Size: I. See Location Entry II. 5-14'X11' RCBC
 Proposed Location: I. CL West Berm Toe Sta. 54+17, Elev. 1707.5'; CL East Berm Toe Sta. 54+43, Elev. 1707.5' II. Sta. 54+30
 Notes or Remarks: _____

^A No drainage area was shown for this station receives overflow from Pelican Lake and the Big Sioux River and serves as an equalizer.
^B Steady discharges and model boundary conditions for this crossing were taken from Aason Engineering's HEC-RAS model of the railroad crossing.
^C It's proposed that the drainage structure be placed at zero channel gradient since the channel acts as an equalizer depending on flows in the Big Sioux and the Pelican Lake water levels.

^D This location is considered a Topeka Shiner stream; therefore, lower the box flow line 1.0' to 1706.2' and place stream bed material in the

Distribution	box.
Hydraulics	KPM
Bridge	X
Bridge Maint.	X
Rd. Design	X
Foundations	X
Environmental	X
Right-of-Way	X
PIC	X
FHWA	X
City	Watertown
County	
Region	Aberdeen
Area Engineer	Watertown
Checked	SVM
Reviewed	RAP

During TS&L, determine type of required erosion control to be provided and verify high water marks.

^E Codington County and the City of Watertown are participating in the FEMA program. This structure is in the 100-year and 500 year floodplain but is located off of the main channel.

Vertical Datum Used: NAVD 88: X NGVD 29: _____ Unknown: _____
 Topeka Shiner Stream: Yes X^D No _____ 404 Permit: Yes X No _____
 FEMA Floodplain: Yes X^E No _____ OHW elev. = _____
 In-Place Structure: This is new alignment and structure.
 100-Yr. DHW Elev. (existing): 1716.2'

Revision No. _____ Date: _____
 Supplement No. _____ Date: _____ Prepared By: *Richard A. Phillips*
Hydraulic Engineer

Date: 8/30/09
 Reviewed By: _____
SDDOT Bridge Hydraulic Engineer

Date: _____

To: Terry Keller (SDDOT Office of Project Development)	
From: HDR	Project: Watertown South Connector – SD20 to US81
CC: SD Dept. of Game Fish and Parks US Fish and Wildlife Service FHWA Dept. of Public Safety/Emergency Management US Army Corps of Engineers City of Watertown SD Dept. of Environment and Natural Resources	
Date: September 4, 2009; revised 9/9/09	Proj. No: EM 4020(01) PCN 00RW

RE: Option 3 Storm Water Runoff Considerations

Background

Concerns have been raised by reviewers of the Environmental Assessment (EA) regarding storm water runoff from the proposed South Connector Roadway. Preferred Option 3, especially, is of concern because realignment of the Pelican Lake Cutoff Channel is required and the roadway will be immediately adjacent to the Cutoff Channel. This memo will document a reasonable method of mitigating storm water runoff impacts to the Cutoff Channel and the wetland areas along the Cutoff Channel.

Proposed Treatment of Storm Water Runoff

The May 2009 version of the Draft EA had noted that storm water runoff would flow through roadside ditches prior to discharge into the Cutoff Channel. However, no treatment of the runoff was proposed.

It is now proposed that several sedimentation basins be constructed at the ends of the ditches to filter/treat the runoff prior to discharge to the Cutoff Channel. EA Figures 3-4 and 3-4a are attached to this memo. These figures have been revised to illustrate the proposed roadside ditch and sedimentation basin design concepts. It is also proposed that the roadside ditches be physically separated from the Cutoff Channel by a linear mound as shown on Section B-B of Figure 3-4a.

The sedimentation basins would be sized and configured to provide adequate water quality capture volume (WQCV), i.e. to allow for sediment and contaminants to settle/filter out of the storm water runoff or to be captured and contained within the basin. For the South Connector project, storm water treatment is the main objective; storm water detention is not the major concern.

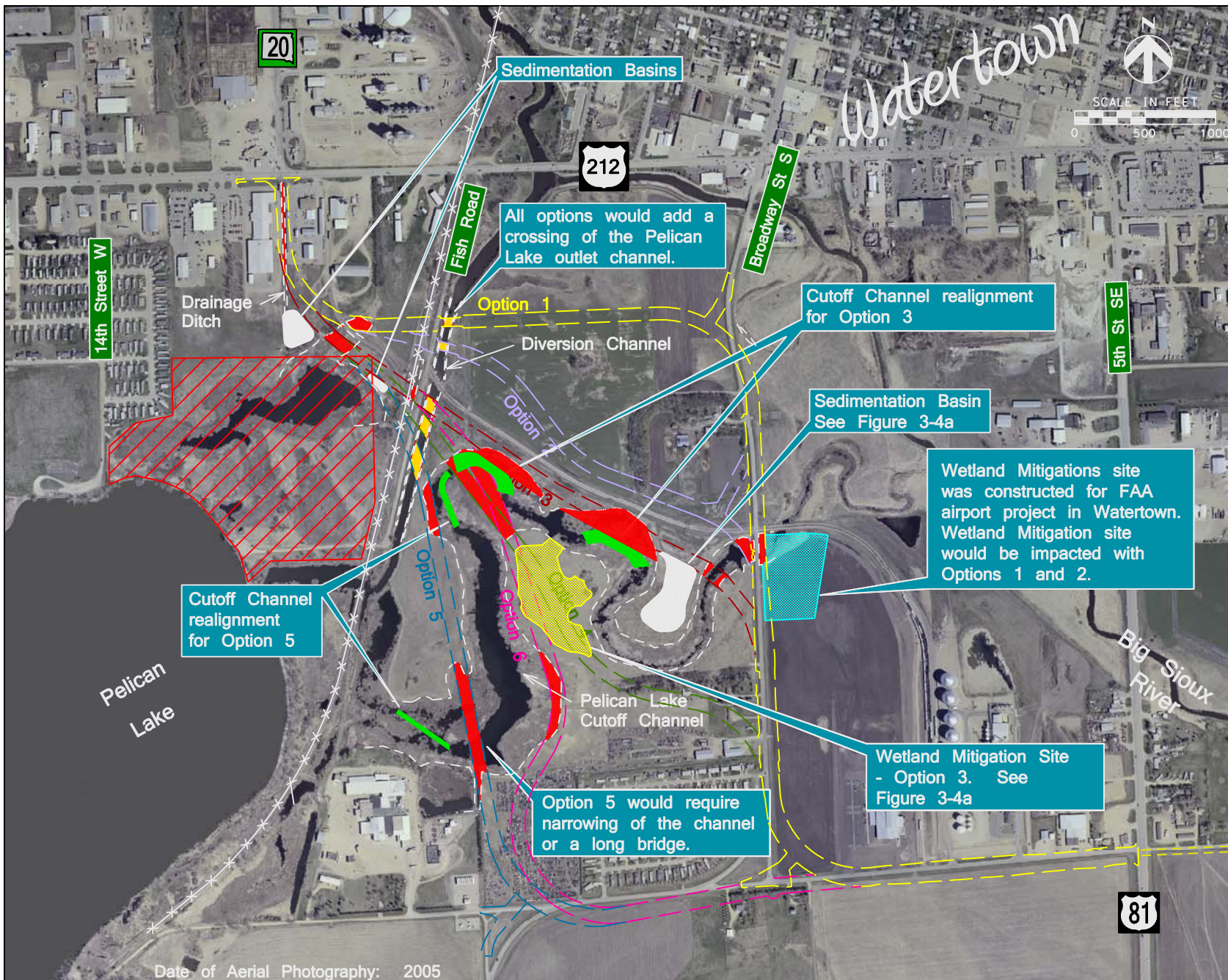
Potential features of the sedimentation basins would include a forebay (for ease of cleaning) where the storm water enters the basin and a micropool where the treated water exits the basin. The outlet would consist of a culvert, weir structure, or spillway. The ditch/sedimentation basin system would be designed in accordance with City of Watertown and SDDOT guidelines. Long-term maintenance would be the responsibility of the City of Watertown.

Wetland and Hydraulic Considerations

The construction of linear mounds to separate the roadside ditch from the Cutoff Channel would increase the area of wetland impacts (from approximately 2.6 acres of impact to 3.0 acres of impact for all of Option 3). However, the proposed wetland mitigation area is 5.6 acres so a roughly 2:1 wetland replacement ratio would be provided. The hydraulic analysis indicated negligible change in flow or capacity with the relocation of the Cutoff Channel.

Recommendation

It is recommended that the concept of roadside ditches with sedimentation basin treatment be incorporated into the South Connector project. The additional wetland impacts are offset by the treatment of storm water runoff before the runoff enters the Cutoff Channel and associated wetlands. If accepted, the EA will be updated in accordance with this recommendation.



Wetland Impact Summary

Option	Wetland Impacts (Ac)
1	0.9
2	1.0
3	3.0
4	2.3
5	3.1
6	3.4

Stream Channel Realignment

Option	Realignment (ft)
1	0
2	0
3	900
4	0
5	600
6	300

Pelican Lake Game Production Area Impact Summary

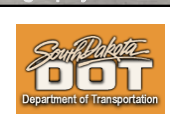
Option	Impacts (Ac)
1	0
2	0
3	0.25
4	0.25
5	0.25
6	0.25

- Legend**
- Channel Realignment
 - Existing Wetland
 - Wetland Impacted
 - Pelican Lake Game Production Area
 - Pelican Lake Outlet Channel Crossing
 - Wetland Mitigation Site Constructed in 2006
 - Wetland Mitigation Site
 - Sedimentation Basin
 - BNSF Railroad

- South Connector Roadway**
- Option 1
 - Option 2
 - Option 3
 - Option 4
 - Option 5
 - Option 6
 - Bridges

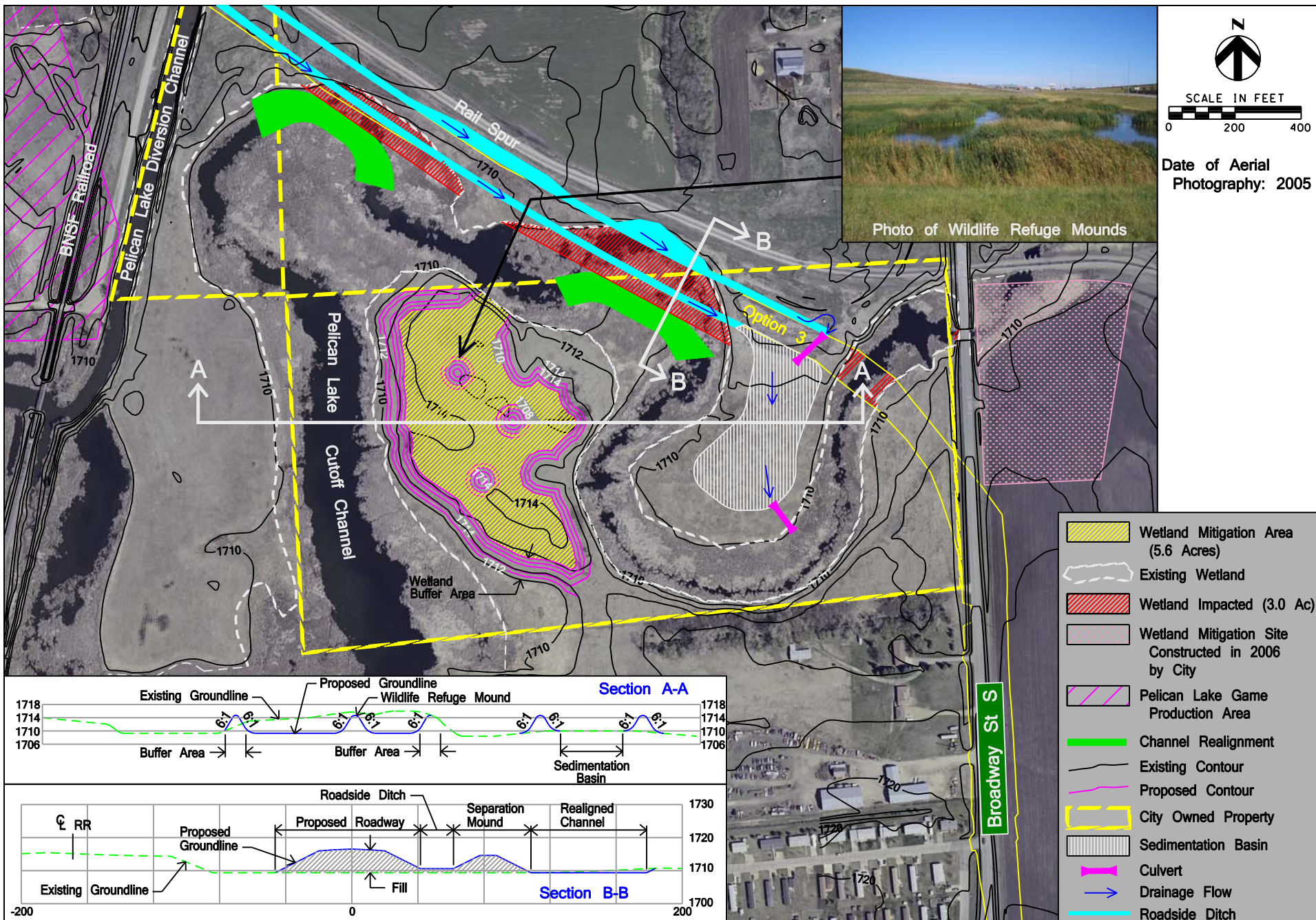
Date of Aerial Photography: 2005

Drawn by: B. Miller
Date: 03/06/07
Checked by: J. Unruh
Date: 03/06/07
Revision Date:
September 9, 2009



Natural Environment
Watertown South Connector - SD 20 to US 81
Project EM 4020(01) PCN 00RW

Figure 3-4



N
 SCALE IN FEET
 0 200 400
 Date of Aerial Photography: 2005

Photo of Wildlife Refuge Mounds

Drawn by: B. Miller
 Date: 05/13/2009
 Checked by: J. Unruh
 Date: 05/13/2009
 Revision Dates:
 September 9, 2009



Sedimentation Basin and Wetland Mitigation Concept-Option 3
 Watertown South Connector - SD 20 to US 81
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Figure 3-4a