To

Patrick Laux, PE

From

Jerry Shadewald
Mark Mathu

Date

September 18, 2013
Revised November 8, 2013

Subject

B-44-126 (WIS 441 over Fox River and CN Railway)

HNTB Job Number

44386

Technical Memorandum

This memorandum summarizes the concepts considered for expanding the WIS 441 bridges over the Fox River in eastern Appleton to four lanes in each direction and to three lanes in each direction plus an additional northbound auxiliary lane north of the WIS 96 overpass. This expansion is being considered as part of the US 41/WIS 441 Operational Needs Study being conducted for the Wisconsin Department of Transportation.

All options for the WIS 441 bridges include redecking. This memorandum assumes that the deck has reached the end of its useful life at the time of structure widening; redecking also allows relocating the crown point of the bridge deck to match the new roadway section. Span lengths of new bridges or widened portions of existing bridges will match the span lengths of the existing bridge, in order to keep piers in line to assist river navigation.

New lines of girders will be the same depth as the existing lines of girders, and hinge and expansion joint locations on the existing bridge deck will be replicated on the widened bridge deck. The foundations will match the existing foundation system – steel piles for the abutments and the six piers on the river bank, and spread footings for the four piers in the river bed.

All of the options considered can be constructed in stages and maintain at least one lane of traffic in each direction at all times.

B-44-126 TYPICAL SECTION - EXISTING STRUCTURE

Figure shows the existing bridge over the Fox River and Canadian National (CN) Railroad. The bridge is 1629'-4" long, 11 spans, and has two (2) 12'-0" lanes, a 10'-0" exterior shoulder and a 6'-0" interior shoulder in each direction. The abutments and the six piers on both sides of the river bank (one on the south side and six on the north) are founded on steel piles; the four piers in the river are spread footings on cofferdam seal slabs. The two bridge decks are supported on steel plate girders spaced at 11'-8" with depths varying from 72" to 48" along the length of the bridge.

Span 3 has clearance for a 100'-0" wide navigation channel in the Fox River.

The vertical clearance over the CN Railway tracks is shown as 23'-6" in the existing plans; 23'-0” minimum vertical clearance is required by Facilities Development Manual (FDM) 11-35. The horizontal clearance at the CN tracks is 20'-11"; 9'-0" minimum horizontal clearance is required per the AREMA Manual for Railway Engineering Chapter 28.

The vertical clearance over STH 96 is shown as 28'-0” in the existing plans; 16'-4” minimum vertical clearance is required by FDM 11-35.

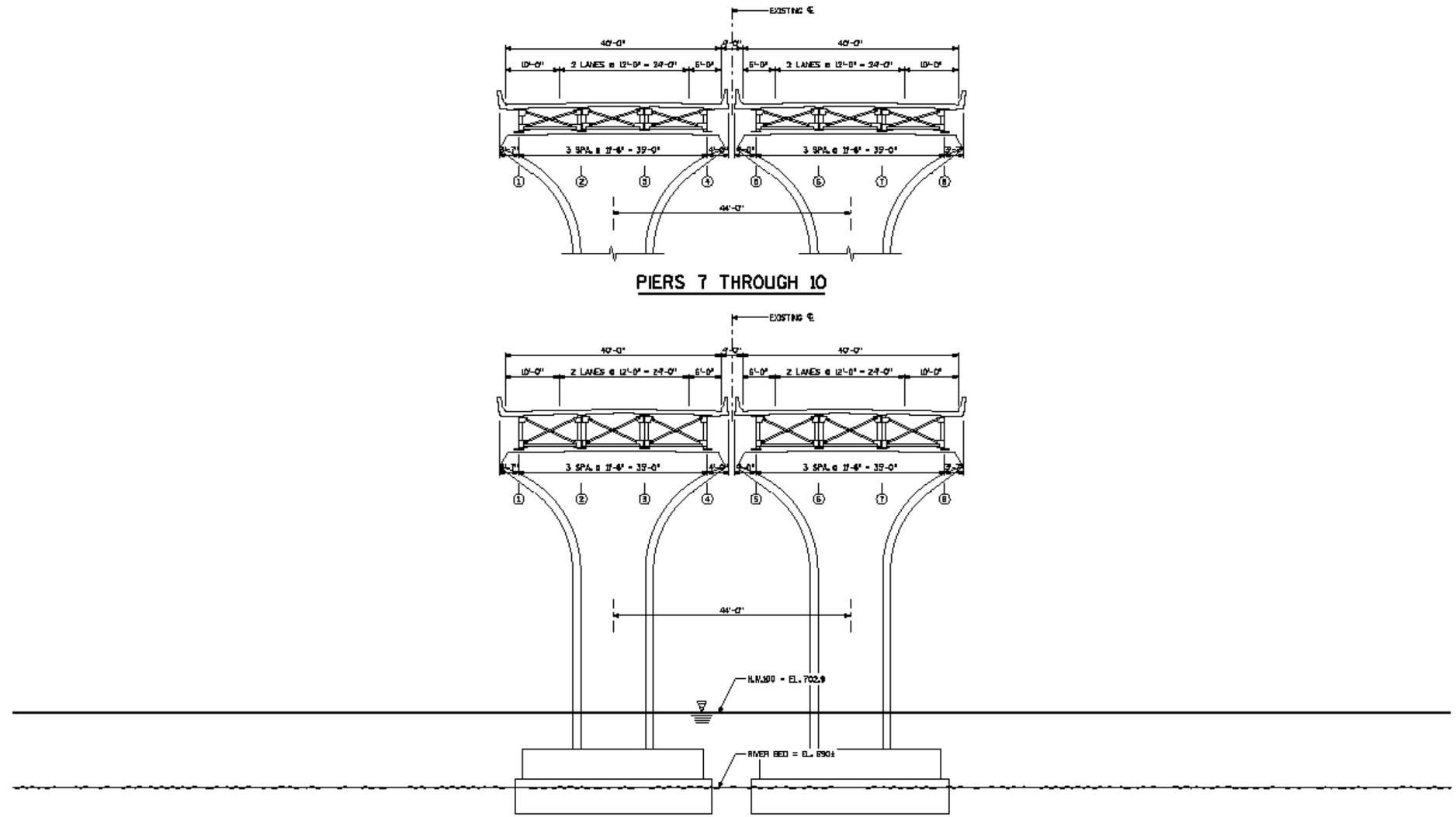

EXISTING ℄
40'-0"
2'-0"
40'-0"
10'-0"
2 LANES @ 12'-0" = 24'-0"
6'-0"
6'-0"
2 LANES @ 12'-0" = 24'-0"
10'-0"
3 SPA. @ 17'-6" = 39'-0"
3 SPA. @ 17'-6" = 39'-0"
1
2
3
4
5
6
7
8
44'-0"
PIERS 7 THROUGH 10
EXISTING ℄
40'-0"
2'-0"
40'-0"
10'-0"
2 LANES @ 12'-0" = 24'-0"
6'-0"
6'-0"
2 LANES @ 12'-0" = 24'-0"
10'-0"
3 SPA. @ 17'-6" = 39'-0"
3 SPA. @ 17'-6" = 39'-0"
1
2
3
4
5
6
7
8
44'-0"
H.W.100 = EL. 702.9
RIVER BED = EL. 690±
PIERS 1 THROUGH 6
B-44-126 TYPICAL SECTION - EXISTING BRIDGE (LOOKING NORTH)

Figure 1

B-44-126 TYPICAL SECTION – CONCEPT 1

This concept, Figure 2, widens WIS 441 on the west side of the existing bridge. The centerline of the new roadway is shifted 45'-5" west of the existing centerline.

The southbound lanes are located on an entirely new bridge. The northbound lanes are located on the existing bridge girders and piers. New cross frames are added between existing girders 4 and 5. Existing girder 8 is removed for the entire length of the bridge and girder 7 is removed south of the WIS 96 overpass. A new exterior girder, spliced into the existing girder lines, is required for the tapered lane transition at WIS 96.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel; however the channel will need to be shifted 7' south to clear the new piers on the southbound bridge.

Vertical clearance over the CN tracks and WIS 96 will be controlled by the existing girders and will remain unchanged. Horizontal clearance to the CN tracks is reduced to 17'-1". A railroad crash wall is not required for solid single shaft piers per Bridge Manual 13.2.4.

Figure 3 shows the plan view of the roadway transition to the new location of B-44-126. Slope intercept lines are also shown in Figure 9 to show approximate impacts. The geometry of the roadway is shifted to the west from B-44-125 to the Fox River.

There is existing storm sewer in the northwest quadrant of B-44-126. For more detailed information the on the existing storm sewer see section “Existing Storm Sewer”on page 24.

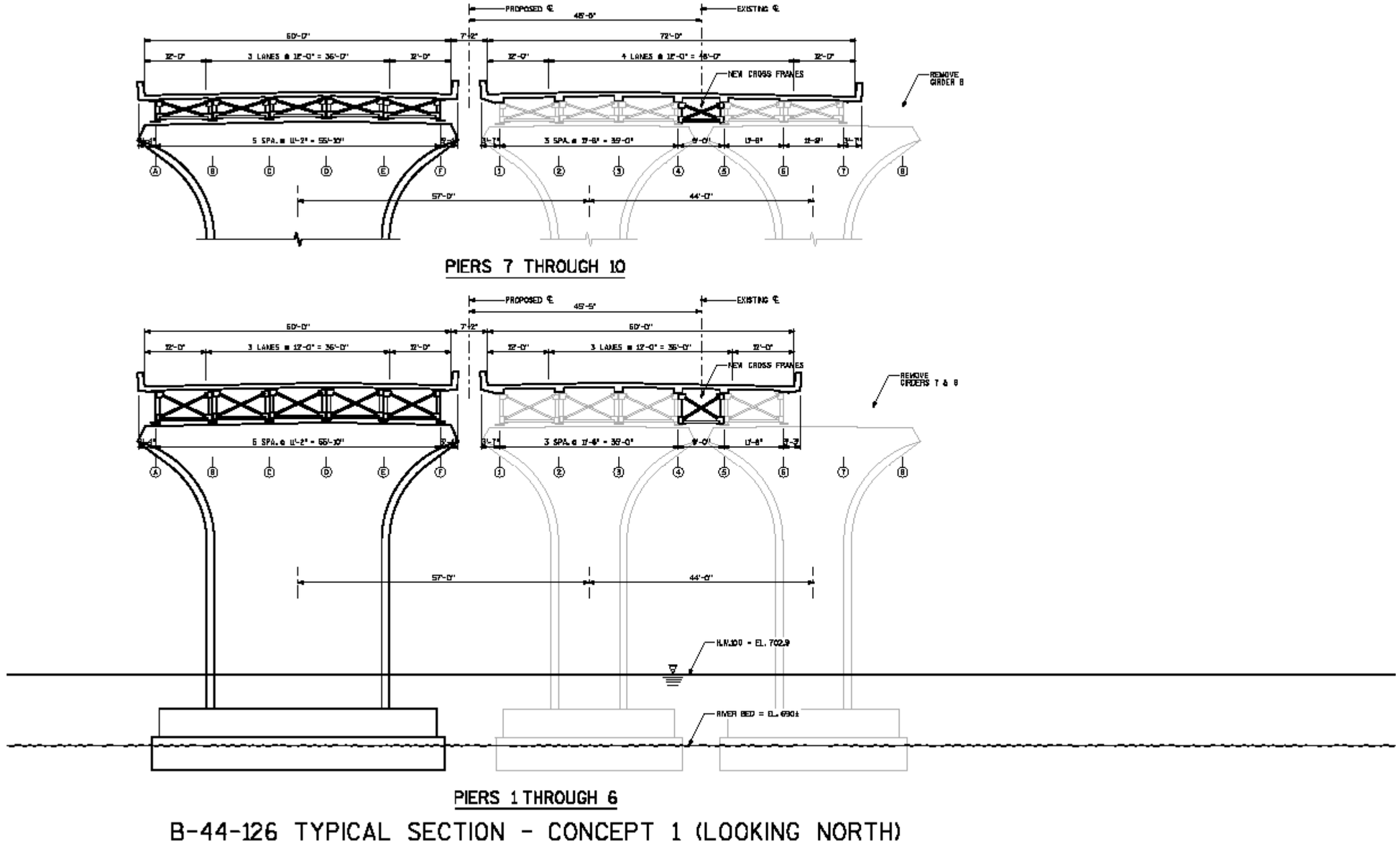

PROPOSED ℄
EXISTING ℄
45'-5"
60'-0"
7'-2"
72'-0"
12'-0"
3 LANES @ 12'-0" = 36'-0"
12'-0"
4 LANES @ 12'-0" = 48'-0"
12'-0"
NEW CROSS FRAMES
REMOVE GIRDER 8
5 SPA. @ 11'-2" = 55'-10"
3 SPA. @ 17'-8" = 53'-0"
9'-0"
17'-8"
11'-9"
A
B
C
D
E
F
1
2
3
4
5
6
7
8
57'-0"
44'-0"
PIERS 7 THROUGH 10
PROPOSED ℄
EXISTING ℄
45'-5"
60'-0"
7'-2"
60'-0"
12'-0"
3 LANES @ 12'-0" = 36'-0"
12'-0"
3 LANES @ 12'-0" = 36'-0"
12'-0"
NEW CROSS FRAMES
REMOVE GIRDERS 7 & 8
6 SPA. @ 11'-2" = 66'-10"
3 SPA. @ 17'-8" = 53'-0"
9'-0"
17'-8"
A
B
C
D
E
F
1
2
3
4
5
6
7
8
57'-0"
44'-0"
H.W.100 = EL. 702.9
RIVER BED = EL. 690±
PIERS 1 THROUGH 6
B-44-126 TYPICAL SECTION - CONCEPT 1 (LOOKING NORTH)

Figure 2

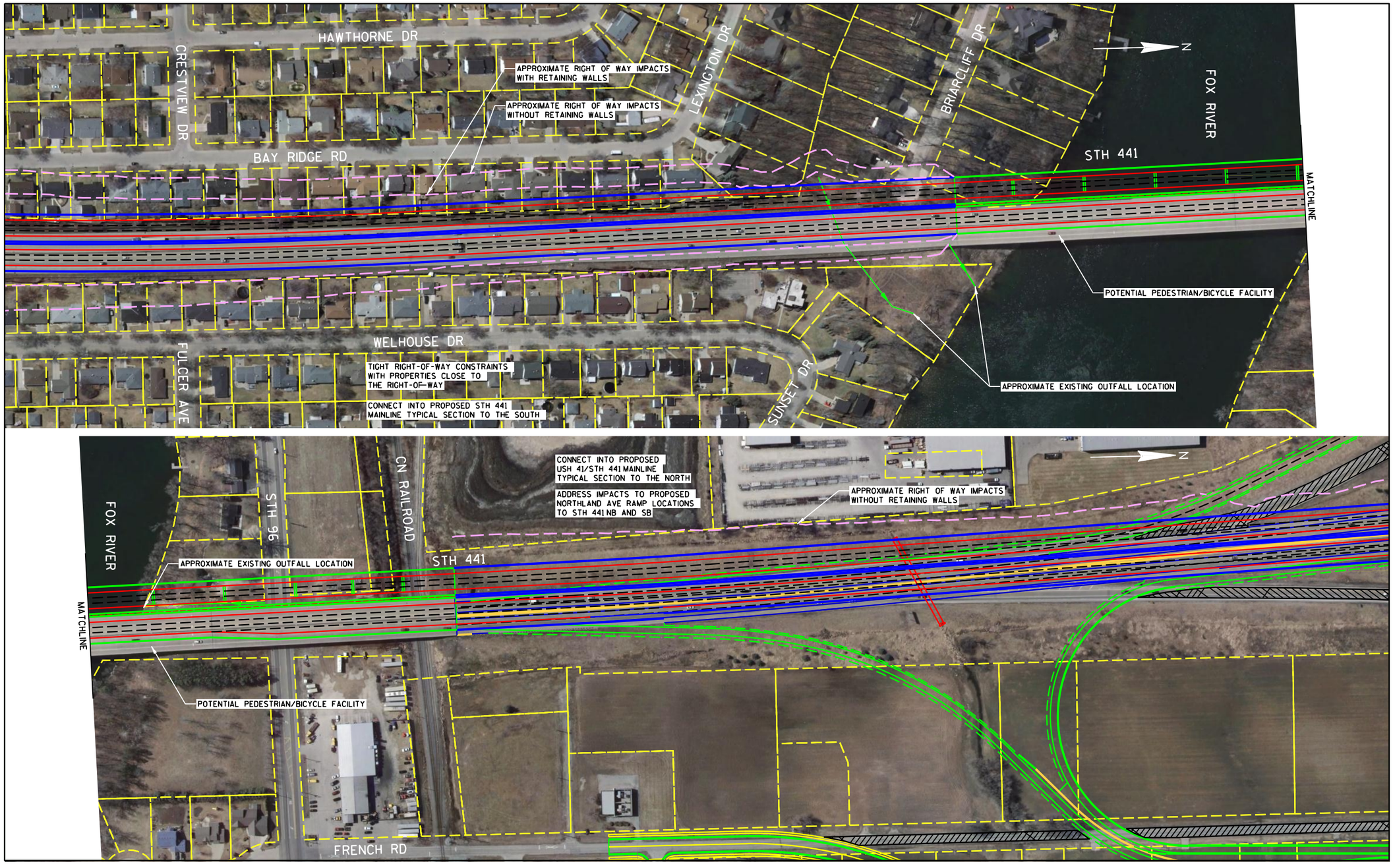

HAWTHORNE DR
CRESTVIEW DR
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
LEXINGTON DR
BRIARCLIFF DR
N
FOX RIVER
BAY RIDGE RD
STH 441
MATCHLINE
POTENTIAL PEDESTRIAN/BICYCLE FACILITY
WELHOUSE DR
FULCER AVE
TIGHT RIGHT-OF-WAY CONSTRAINTS WITH PROPERTIES CLOSE TO THE RIGHT-OF-WAY
CONNECT INTO PROPOSED STH 441 MAINLINE TYPICAL SECTION TO THE SOUTH
SUNSET DR
APPROXIMATE EXISTING OUTFALL LOCATION
CONNECT INTO PROPOSED USH 41/STH 441 MAINLINE TYPICAL SECTION TO THE NORTH
ADDRESS IMPACTS TO PROPOSED NORTHLAND AVE RAMP LOCATIONS TO STH 441 NB AND SB
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FOX RIVER
STH 96
CN RAILROAD
STH 441
APPROXIMATE EXISTING OUTFALL LOCATION
MATCHLINE
POTENTIAL PEDESTRIAN/BICYCLE FACILITY
FRENCH RD

Figure 3

B-44-126 TYPICAL SECTION – CONCEPT 2

This concept, Figure 4, widens WIS 441 on the east side of the existing bridge. The centerline of the new roadway is shifted 21'-11" east of the existing centerline.

The southbound lanes are located on the existing bridge girders and piers. The northbound lanes are located on a combination of existing and new girders and piers. New cross frames are added between existing girders 4 and 5. The new pier designs will need to adequately control settlement to limit differential deflections between existing girder 8 and new girder A.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel; however the channel will need to be shifted 2' north to clear the new piers on the northbound bridge.

Vertical clearance over the railroad is 23'-2½". Vertical clearance over WIS 96 is 27-8½". Horizontal clearance to the tracks is controlled by the existing pier and will remain unchanged.

Figure 5 shows the plan view of the roadway transition to the new location of B-44-126. Slope intercept lines are also shown in Figure 5 to show approximate impacts. The geometry of the roadway is shifted the alignment to the east from B-44-125 to the Fox River.

There is existing storm sewer in the southeast quadrant of B-44-126. For more detailed information the on the existing storm sewer see section "Existing Storm Sewer"on page 24.

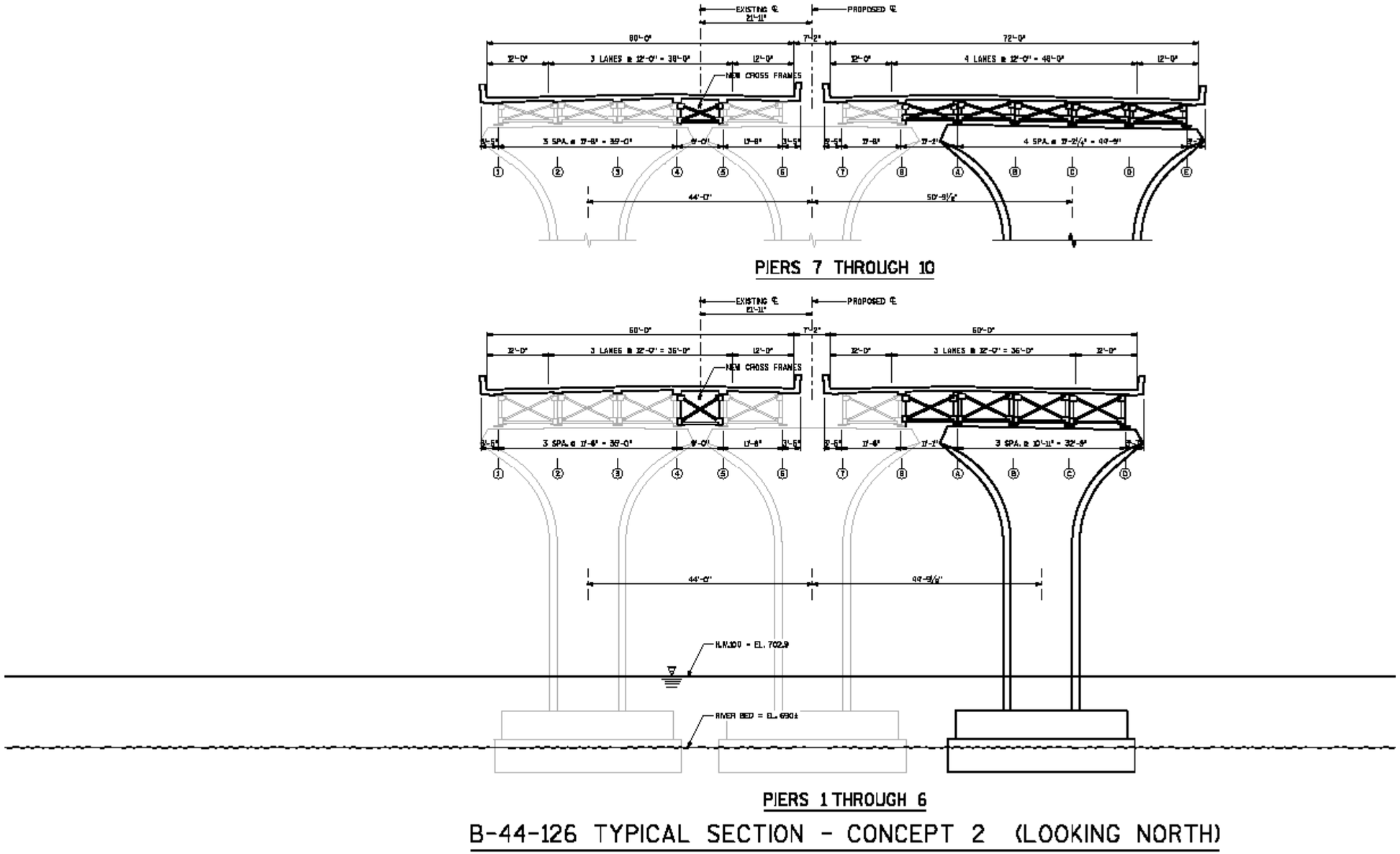

EXISTING ℄
PROPOSED ℄
80'-0"
72'-0"
12'-0"
3 LANES @ 12'-0" = 36'-0"
12'-0"
NEW CROSS FRAMES
4 LANES @ 12'-0" = 48'-0"
3 SPA. @ 17'-6" = 35'-0"
4 SPA. @ 17'-2 1/4" = 69'-9"
44'-0"
50'-9 1/2"
PIERS 7 THROUGH 10
60'-0"
3 SPA. @ 12'-0" = 36'-0"
3 SPA. @ 10'-11" = 32'-8"
H.W.100 = EL. 702.9
RIVER BED = EL. 690±
PIERS 1 THROUGH 6
B-44-126 TYPICAL SECTION - CONCEPT 2 (LOOKING NORTH)

Figure 4

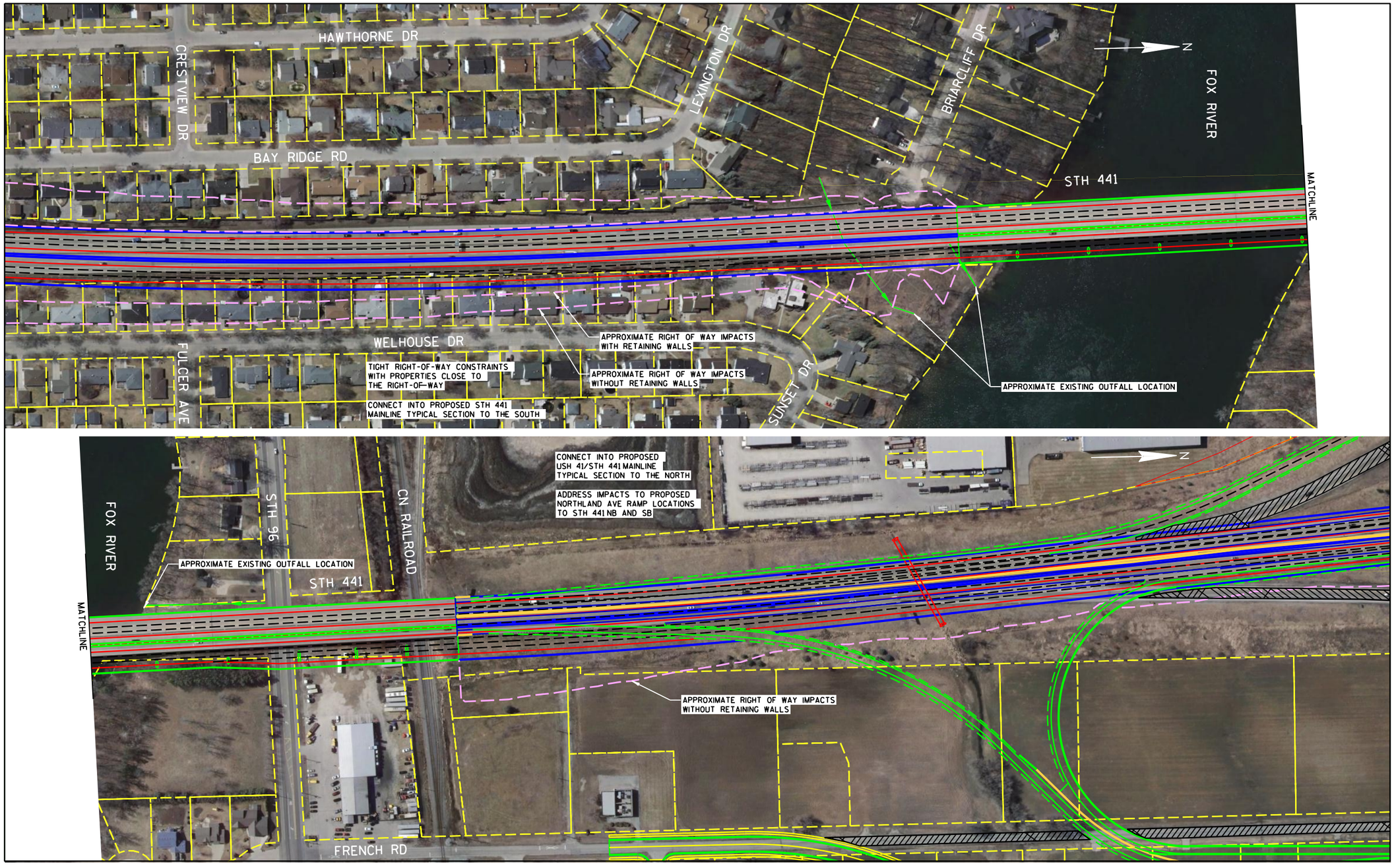

HAWTHORNE DR
CRESTVIEW DR
LEXINGTON DR
BRIARCLIFF DR
BAY RIDGE RD
FOX RIVER
N
STH 441
MATCHLINE
WELHOUSE DR
FULCER AVE
SUNSET DR
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
TIGHT RIGHT-OF-WAY CONSTRAINTS WITH PROPERTIES CLOSE TO THE RIGHT-OF-WAY
CONNECT INTO PROPOSED STH 441 MAINLINE TYPICAL SECTION TO THE SOUTH
APPROXIMATE EXISTING OUTFALL LOCATION
CONNECT INTO PROPOSED USH 41/STH 441 MAINLINE TYPICAL SECTION TO THE NORTH
ADDRESS IMPACTS TO PROPOSED NORTHLAND AVE RAMP LOCATIONS TO STH 441 NB AND SB
FOX RIVER
STH 96
CN RAILROAD
APPROXIMATE EXISTING OUTFALL LOCATION
STH 441
MATCHLINE
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FRENCH RD

Figure 5

B-44-126 TYPICAL SECTION – CONCEPT 3

This concept, Figure 6, widens WIS 441 on both sides of the existing bridge. The centerline of the new roadway matches the centerline of the existing roadway.

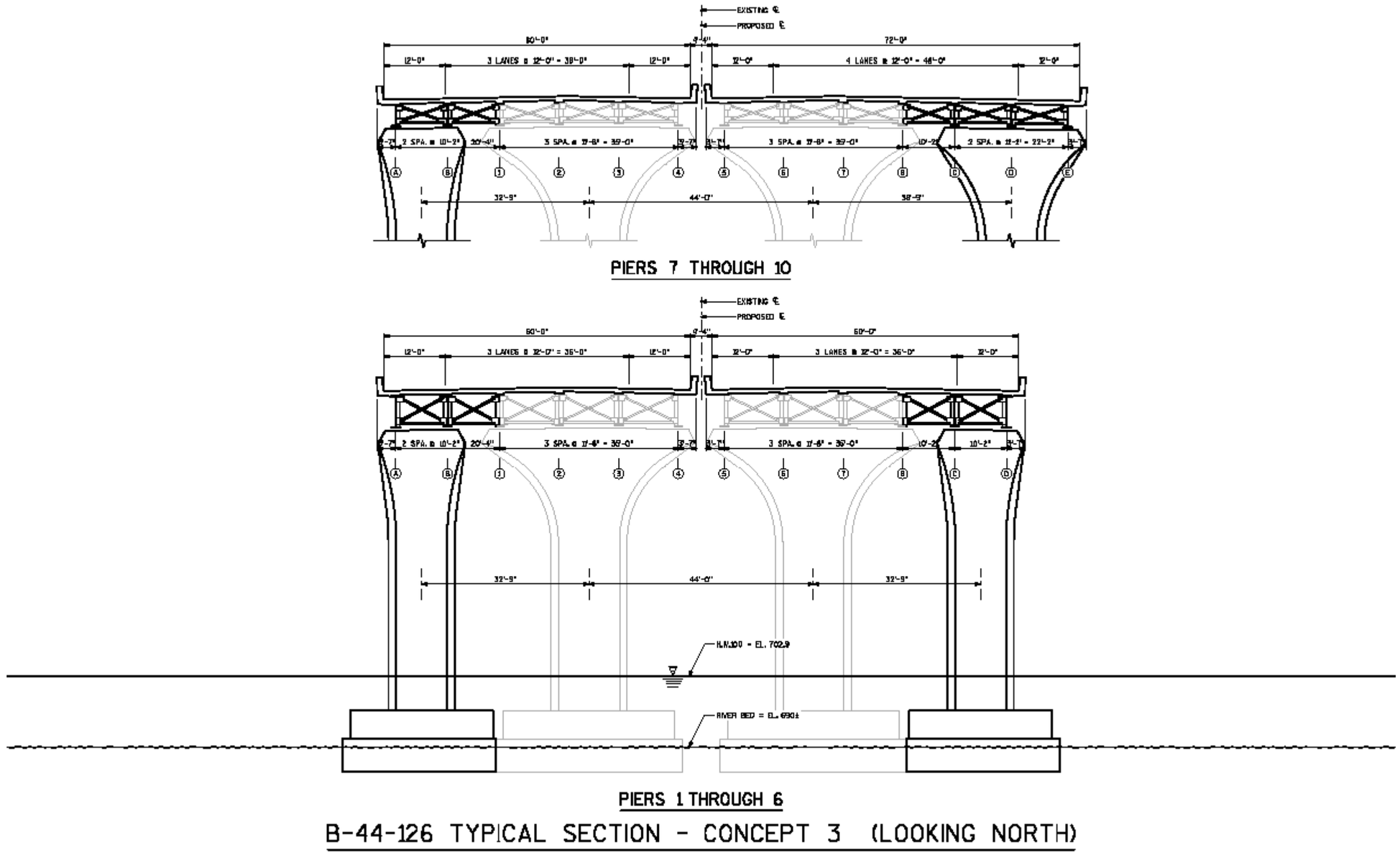
The southbound and northbound lanes are each located on a combination of existing and new girders and piers. The new pier designs will need to adequately control settlement to limit differential deflections between existing girder 1 and new girder B, and existing girder 8 and new girder C.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel in its current location.

Vertical clearance over the railroad is 23'-1¼". Vertical clearance over WIS 96 is 27-7¼". Horizontal clearance to the CN tracks is reduced to 19'-0". A railroad crash wall is not required for solid single shaft piers per Bridge Manual 13.2.4.

Figure 7 shows the plan view of the roadway connection to B-44-126. Slope intercept lines are also shown in Figure 7 to show approximate impacts. The geometry of the roadway is centered along the existing alignment.

There is existing storm sewer in the northwest and southeast quadrants of B-44-126. For more detailed information the on the existing storm sewer see section "Existing Storm Sewer"on page 24.



B-44-126 TYPICAL SECTION - CONCEPT 3 (LOOKING NORTH)

Figure 6


HAWTHORNE DR
CRESTVIEW DR
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
LEXINGTON DR
BRIARCLIFF DR
N
FOX RIVER
BAY RIDGE RD
STH 441
MATCHLINE
WELHOUSE DR
FULCER AVE
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
TIGHT RIGHT-OF-WAY CONSTRAINTS WITH PROPERTIES CLOSE TO THE RIGHT-OF-WAY
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
SUNSET DR
APPROXIMATE EXISTING OUTFALL LOCATION
CONNECT INTO PROPOSED STH 441 MAINLINE TYPICAL SECTION TO THE SOUTH
CONNECT INTO PROPOSED USH 41/STH 441 MAINLINE TYPICAL SECTION TO THE NORTH
ADDRESS IMPACTS TO PROPOSED NORTHLAND AVE RAMP LOCATIONS TO STH 441 NB AND SB
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FOX RIVER
STH 96
CN RAILROAD
APPROXIMATE EXISTING OUTFALL LOCATION
STH 441
MATCHLINE
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FRENCH RD

Figure 7

B-44-126 TYPICAL SECTION – CONCEPT 4

This concept, Figure 8, widens the bridge on the west side of the existing structure. The centerline of the new roadway is shifted 44'-8" west of the existing centerline.

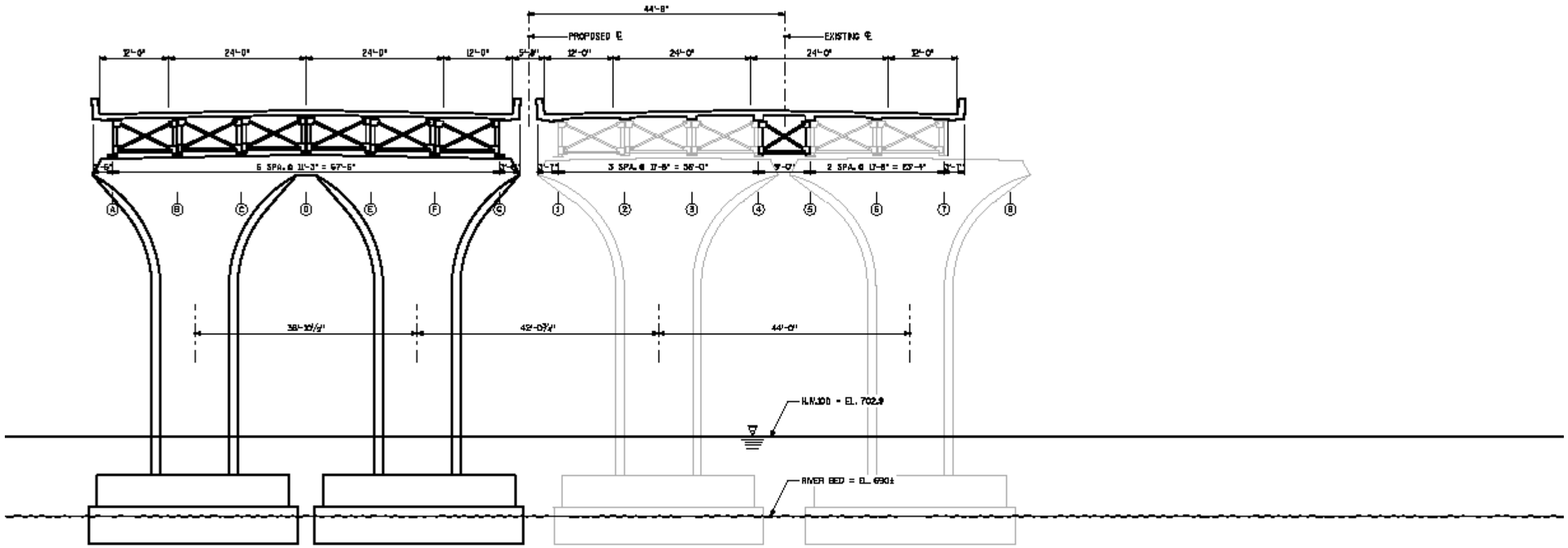
Seven new girder lines and a new set of piers for the southbound traffic is required. Existing girders 4 and 5 are retrofitted with cross frames between them and existing girder 8 is removed.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel; however, the channel will need to be shifted 13'-2" south to clear the added piers.

Vertical clearance over the CN tracks and STH 96 will be controlled by the existing girders and will remain unchanged. Horizontal clearance to the CN tracks is reduced to 16'-1". A railroad crash wall is not required for solid single shaft piers per Bridge Manual 13.2.4.

Figure 9 shows the plan view of the roadway transition to the new location of B-44-126. Slope intercept lines are also shown in Figure 9 to show approximate impacts. The geometry of the roadway is centered along the existing alignment; however, shifting the alignment to the west from College Ave (CTH CE) to the Fox River could reduce the total number of parcels impacted by the roadway expansion.

There is existing storm sewer in the northwest quadrant of B-44-126. For more detailed information the on the existing storm sewer see section "Existing Storm Sewer" on page 24.



B-44-126 TYPICAL SECTION - CONCEPT 4

LOOKING NORTH

Figure 8


HAWTHORNE DR
CRESTVIEW DR
CONNECT INTO PROPOSED
USH 41/STH 441 MAINLINE
TYPICAL SECTION TO THE NORTH
APPROXIMATE RIGHT OF WAY IMPACTS
WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS
WITHOUT RETAINING WALLS
LEXINGTON DR
BRIARCLIFF DR
N
FOX RIVER
BAY RIDGE RD
STH 441
MATCHLINE
WELHOUSE DR
FULCER AVE
TIGHT RIGHT-OF-WAY CONSTRAINTS
WITH PROPERTIES CLOSE TO
THE RIGHT-OF-WAY
APPROXIMATE RIGHT OF WAY IMPACTS
WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS
WITHOUT RETAINING WALLS
SUNSET DR
APPROXIMATE EXISTING OUTFALL LOCATION
FOX RIVER
STH 96
CN RAILROAD
ADDRESS IMPACTS TO PROPOSED
NORTHLAND AVE RAMP LOCATIONS
TO STH 441 NB AND SB
APPROXIMATE RIGHT OF WAY IMPACTS
WITHOUT RETAINING WALLS
N
APPROXIMATE EXISTING OUTFALL LOCATION
STH 441
MATCHLINE
APPROXIMATE RIGHT OF WAY IMPACTS
WITHOUT RETAINING WALLS
CONNECT INTO PROPOSED STH 441
MAINLINE TYPICAL SECTION TO THE SOUTH
FRENCH RD

Figure 9

B-44-126 TYPICAL SECTION – CONCEPT 5

This concept, Figure 10, widens the bridge on the east side of the existing structure. The centerline of the new roadway is shifted 44'-8" east of the existing centerline.

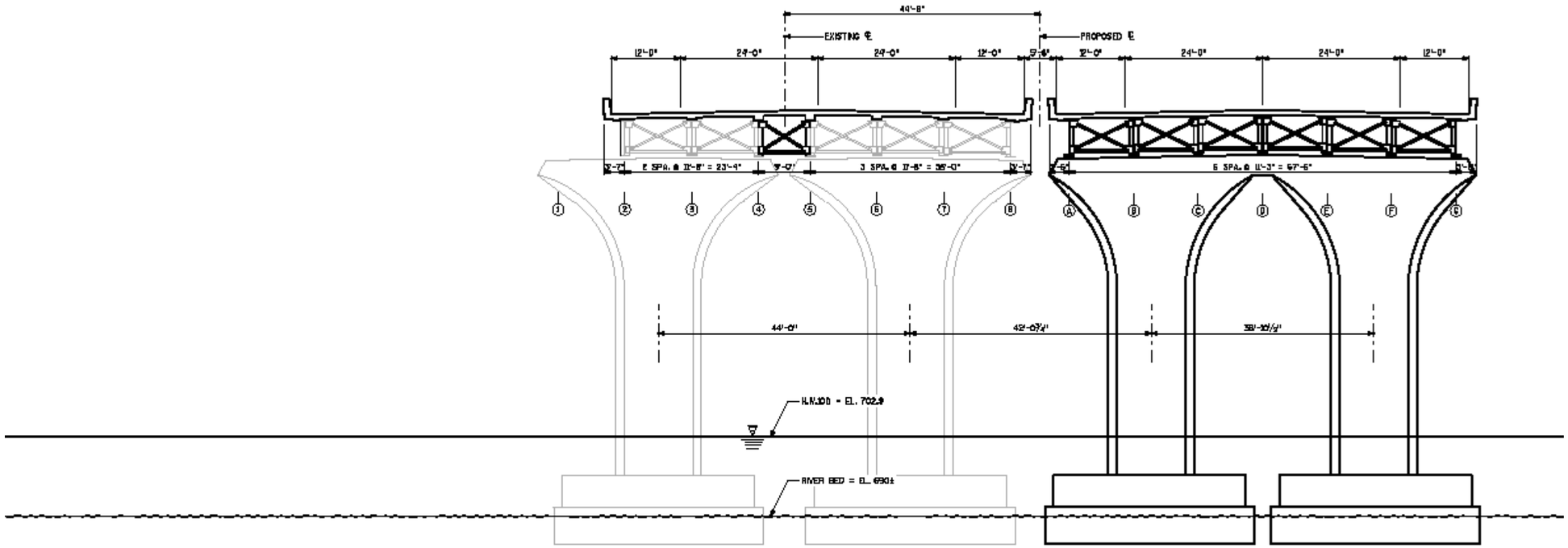
Seven new girder lines and a new set of piers for the northbound traffic is required. Existing girders 4 and 5 are retrofitted with cross frames between them and existing girder 1 is removed.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel; however the channel will need to be shifted 13'-2" north to clear the added piers.

Vertical clearance over the CN tracks and STH 96 will be controlled by the existing girders and will remain unchanged. Horizontal clearance to the tracks is controlled by the existing pier and will remain unchanged.

Figure 11 shows the plan view of the roadway transition to the new location of B-44-126. Slope intercept lines are also shown in Figure 11 to show approximate impacts. The geometry of the roadway is centered along the existing alignment; however, shifting the alignment to the east from College Ave (CTH CE) to the Fox River could reduce the total number of parcels impacted by the roadway expansion.

There is existing storm sewer in the southeast quadrant of B-44-126. For more detailed information the on the existing storm sewer see section "Existing Storm Sewer" on page 24.



B-44-126 TYPICAL SECTION - CONCEPT 5

LOOKING NORTH

Figure 10


HAWTHORNE DR
CRESTVIEW DR
LEXINGTON DR
BRIARCLIFF DR
FOX RIVER
N
BAY RIDGE RD
STH 441
MATCHLINE
WELHOUSE DR
FULCER AVE
TIGHT RIGHT-OF-WAY CONSTRAINTS WITH PROPERTIES CLOSE TO THE RIGHT-OF-WAY
CONNECT INTO PROPOSED STH 441 MAINLINE TYPICAL SECTION TO THE SOUTH
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
SUNSET DR
APPROXIMATE EXISTING OUTFALL LOCATION
CONNECT INTO PROPOSED USH 41/STH 441 MAINLINE TYPICAL SECTION TO THE NORTH
ADDRESS IMPACTS TO PROPOSED NORTHLAND AVE RAMP LOCATIONS TO STH 441 NB AND SB
FOX RIVER
STH 96
CN RAILROAD
APPROXIMATE EXISTING OUTFALL LOCATION
STH 441
MATCHLINE
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FRENCH RD

Figure 11

B-44-126 TYPICAL SECTION – CONCEPT 6

This concept, Figure 12, widens the bridge equally on both sides of the existing structure. The centerline of the new roadway matches the centerline of the existing roadway.

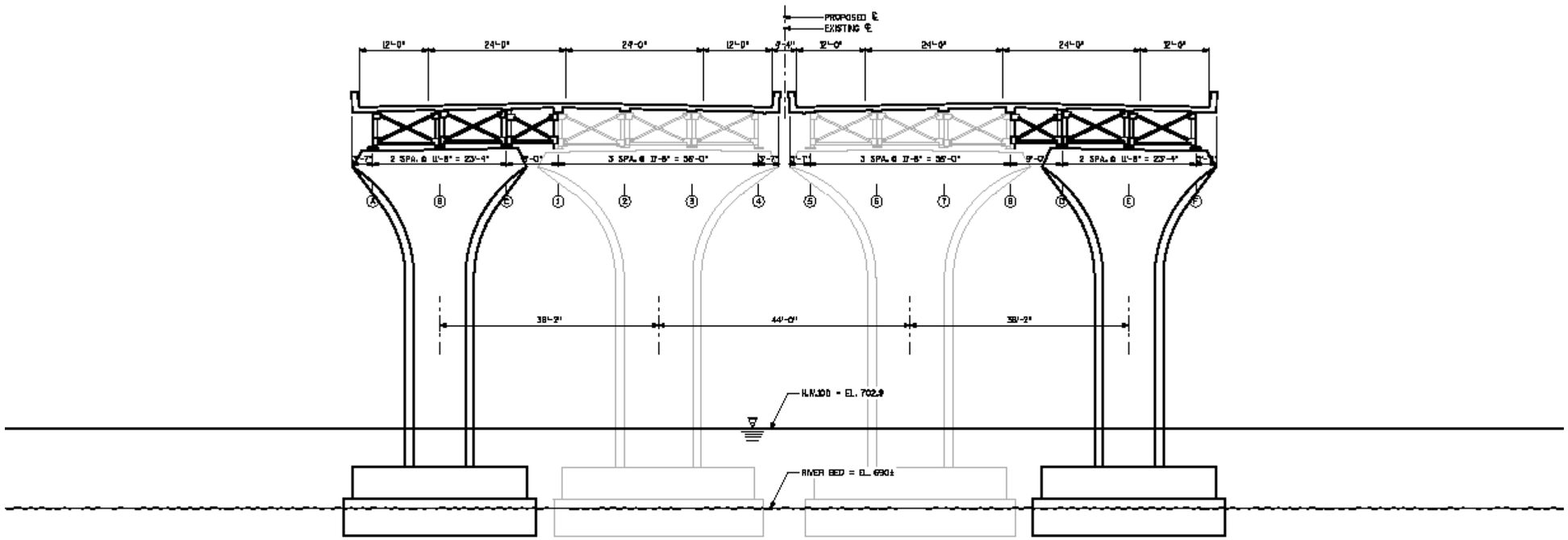
Three new girder lines and a new set of piers are required for the outside traffic lanes in each direction. Existing girders 1 & 8 are retrofitted with cross frames connecting them to the adjacent new lines of girders. The new pier designs will need to adequately control vertical settlement to limit differential settlement between the new girder lines and the existing girder lines.

There is adequate horizontal clearance in span 3 to maintain the 100'-0" wide navigation channel in its current location.

Vertical clearance over the CN tracks and STH 96 will be controlled by the existing girders and will remain unchanged. Horizontal clearance to the CN tracks is reduced to 18'-8". A railroad crash wall is not required for solid single shaft piers per Bridge Manual 13.2.4.

Figure 13 shows the plan view of the roadway connection to B-44-126. Slope intercept lines are also shown in Figure 13 to show approximate impacts. The geometry of the roadway is centered along the existing alignment.

There is existing storm sewer in the northwest and southeast quadrants of B-44-126. For more detailed information the on the existing storm sewer see section “Existing Storm Sewer” on page 24.



B-44-126 TYPICAL SECTION - CONCEPT 6

LOOKING NORTH

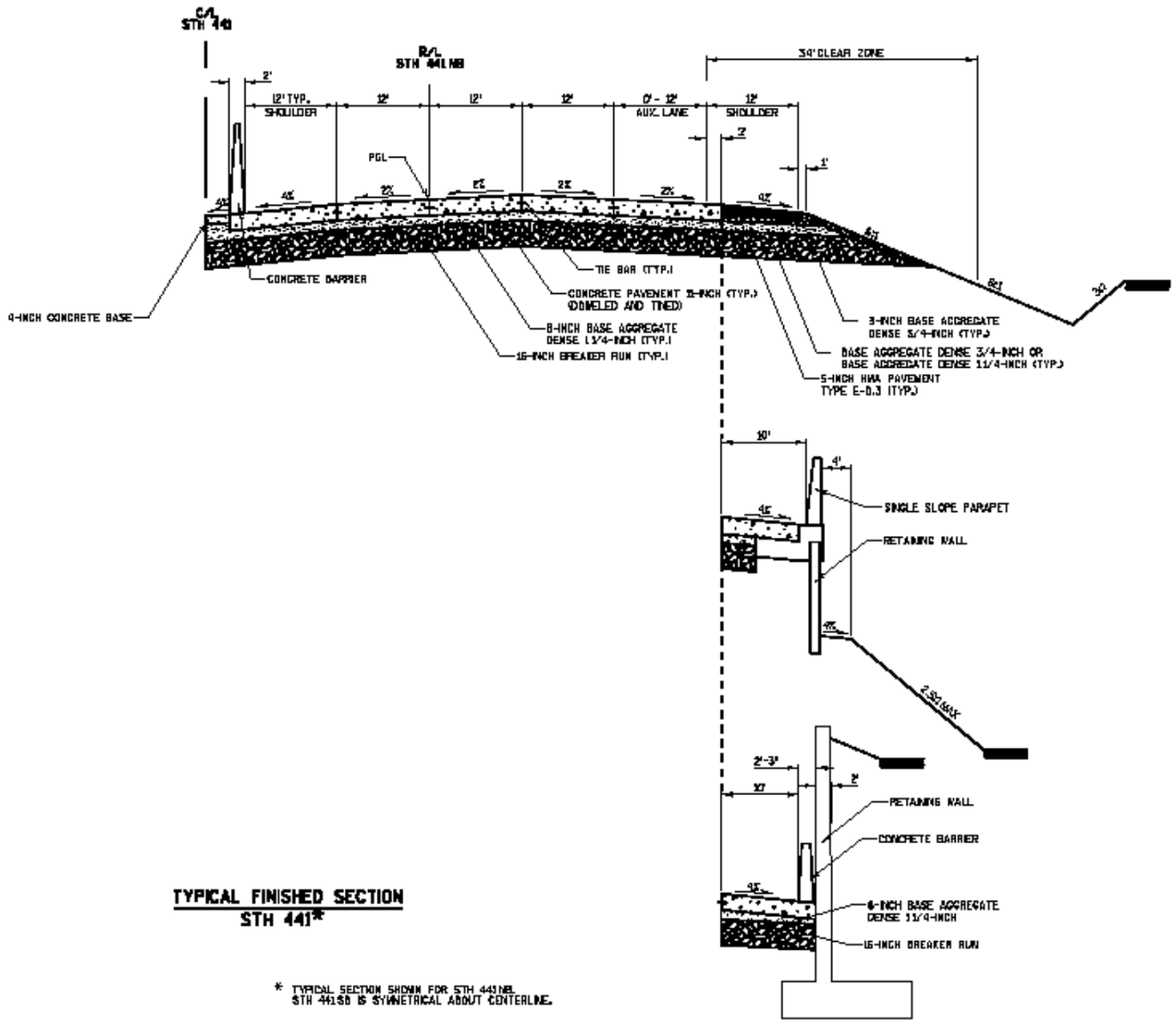
Figure 12


HAWTHORNE DR
CRESTVIEW DR
LEXINGTON DR
BRIARCLIFF DR
N
FOX RIVER
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
BAY RIDGE RD
STH 441
MATCHLINE
WELHOUSE DR
FULCER AVE
TIGHT RIGHT-OF-WAY CONSTRAINTS WITH PROPERTIES CLOSE TO THE RIGHT-OF-WAY
CONNECT INTO PROPOSED STH 441 MAINLINE TYPICAL SECTION TO THE SOUTH
APPROXIMATE RIGHT OF WAY IMPACTS WITH RETAINING WALLS
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
SUNSET DR
APPROXIMATE EXISTING OUTFALL LOCATION
CONNECT INTO PROPOSED USH 41/STH 441 MAINLINE TYPICAL SECTION TO THE NORTH
ADDRESS IMPACTS TO PROPOSED NORTHLAND AVE RAMP LOCATIONS TO STH 441 NB AND SB
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FOX RIVER
STH 96
CN RAILROAD
APPROXIMATE EXISTING OUTFALL LOCATION
STH 441
MATCHLINE
APPROXIMATE RIGHT OF WAY IMPACTS WITHOUT RETAINING WALLS
FRENCH RD

Figure 13

ROADWAY PROPOSED TYPICAL SECTION

The proposed typical section matches the USH10/STH 441 project to the south of B-44-126. There are three (3) thru lanes, up to one auxiliary lane, and twelve foot shoulders, which has a total clear roadway width of 60 to 72 feet. Concrete barrier is located in the median and on the outside where retaining walls are proposed. The pavement structure consists of 11-Inch concrete pavement, 6-Inch base aggregate dense and 16-Inch breaker run. A cut or fill retaining wall can be located on the outside shoulder of the roadway. The retaining wall in the cut condition would be a Cast-In-Place retaining wall. However, the retaining wall for the fill condition will be a MSE retaining wall. The typical section is shown in Figure 14.



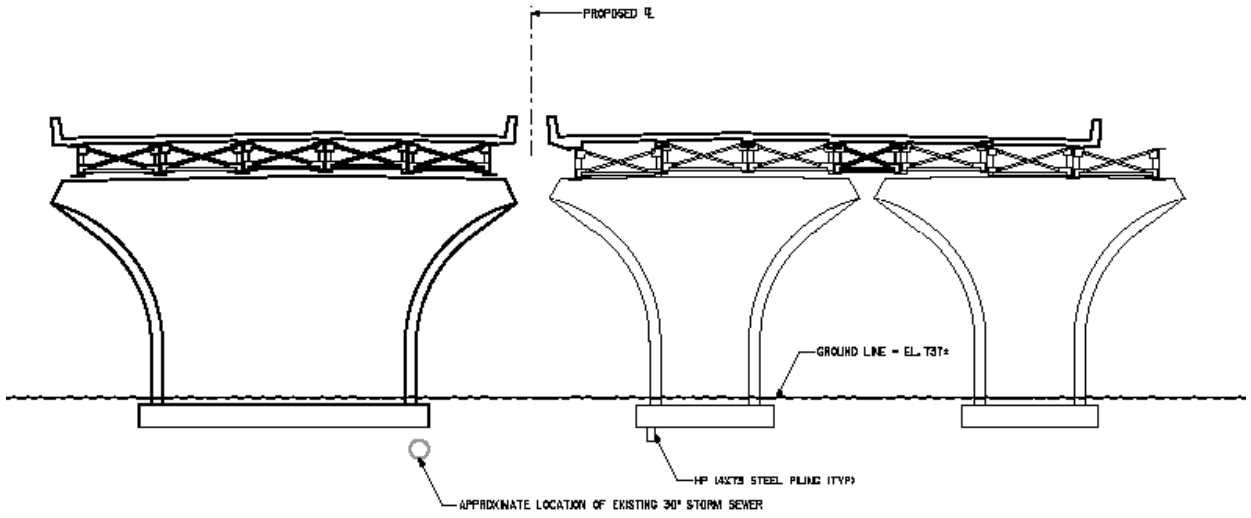
TYPICAL FINISHED SECTION
STH 441*

* TYPICAL SECTION SHOWN FOR STH 441 NB.
STH 441 SB IS SYMMETRICAL ABOUT CENTERLINE.

Figure 14

EXISTING STORM SEWER

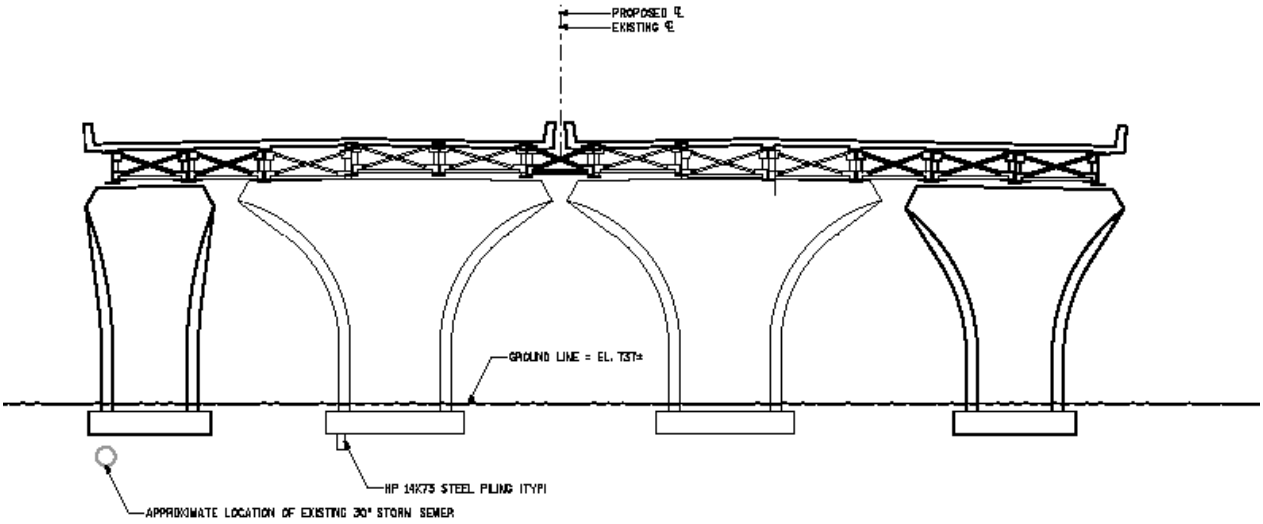
There is existing storm sewer in the northwest and southeast quadrants of the bridge, B-44-126. The existing storm sewer can be adjacent to the pier; however, it cannot go through or underneath the proposed footing or pier and would have to be relocated. In the northwest quadrant, there is a 30" storm sewer that runs parallel to WIS 441. Figures 15, 16, 17 and 18 show the approximate location of the storm sewer relative to the existing and proposed piers for concepts 1, 3, 4, and 6 described above. Based on available information, the approximate location of the storm sewer in the northwest quadrant is in conflict with the proposed pier location and would need to be replaced. In the southeast quadrant, the storm sewer runs at an angle away from WIS 441 and should not create a conflict when the bridge is widened.



B-44-126 PIER 10 - CONCEPT 1

LOOKING NORTH

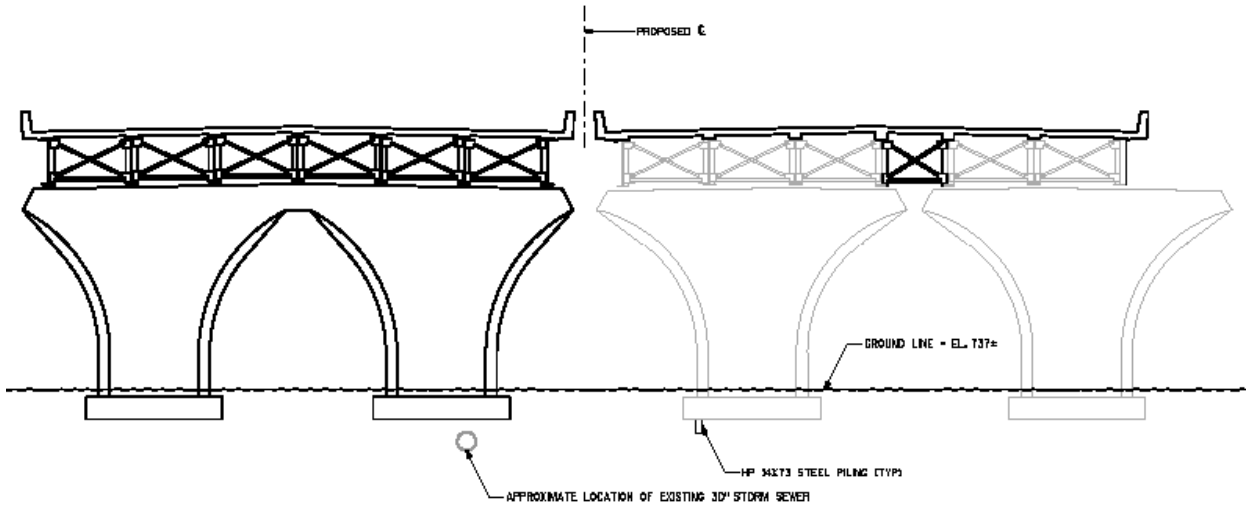
Figure 15



B-44-126 PIER 10 - CONCEPT 3

LOOKING NORTH

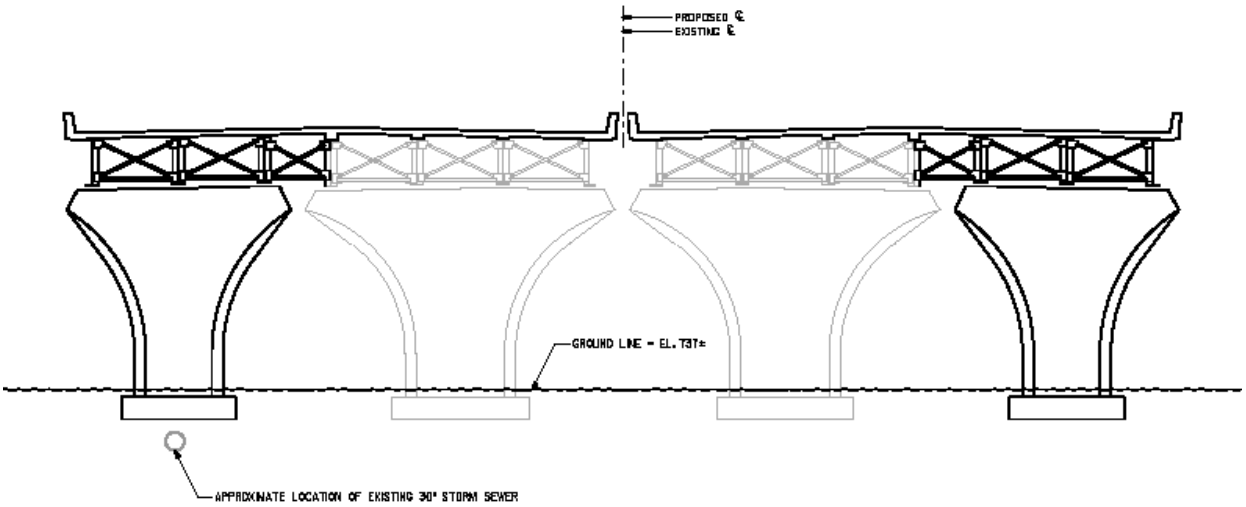
Figure 16



B-44-126 PIER 10 - CONCEPT 4

LOOKING NORTH

Figure 17



B-44-126 TYPICAL SECTION - CONCEPT 6

LOOKING NORTH

Figure 18

Real Estate Costs

The expansion of WIS 441 will have real estate impacts south of the Fox River and north of the CN Railroad. Using the existing horizontal alignment and expanding WIS 441 to the outside results in real estate impacts for 27 properties on the east side of WIS 441 and 28 properties on the west side of WIS 441. Along the east side of WIS 441, the real estate impacts include relocating 26 properties and acquiring right of way on one additional property. Along the west side of WIS 441, the real estate impacts include relocating 26 properties and acquiring right of way on two additional properties. The cost to purchase the property, raze and remove the buildings and relocate the occupants is shown in Table 1. Retaining walls can be used to minimize the number of relocations along WIS 441 south of the Fox River and north of the CN Railroad. Along the east side of WIS 441, the real estate impacts include relocating one property and acquiring right of way on 26 properties. Along the west side of WIS 441, the real estate impacts include relocating 6 properties and acquiring right of way on 17 properties. The costs for the retaining walls include cost for construction, real estate costs and a contingency for maintenance costs for the retaining wall.

Table 1: Real Estate Costs

	East side of WIS 441 costs	West side of WIS 441 costs	Total Costs
No Retailing Wall	$5,165,185	$5,166,885	$10,332,070
Retailing Wall	$5,374,810	$5,234,550	$10,609,360

The preferred alternative is to construct WIS 441 without any retaining walls between the Fox River and CN Railroad. Without constructing retaining walls, there will be better water quality with a decreased amount of storm sewer and ability to accommodate ditching along WIS 441; reduced construction complexity for constructing retaining walls adjacent to buildings; and reduced risk of property damage during construction.

FUTURE ANALYSIS

The proposed channel shift in Concepts 1, 2, 4 and 5 will require coordination with the United States Coast Guard, United States Army Corps of Engineers and Wisconsin Department of Natural Resources in the pre-NEPA screening. An alternative to shifting the navigation channel would be to change the individual span lengths of spans 1-4 of the new bridge (southbound lanes for option 1 and the northbound lanes for option 2) to have the new piers clear the existing navigation channel. For concept 4, an alternative to shifting the navigation channel would be to change some of the span lengths to shift pier 3 out of the current navigation channel, such as changing spans 3 and 4 of the new southbound bridge from 162'+162' to 169'+155'. This has the drawback of putting the existing and new piers 3 out of line, a hazard to water craft out of the shipping channel. Concept 5 cannot accommodate a similar shift in the pier 3 location because the new northbound bridge uses part of the existing pier 3 for support

Current WisDOT bridge design policy requires a 10" thick deck on the bridges; the existing bridge decks are 9" thick. The redecked bridges will need a deck thickness less than the 10" standard in order to get a suitable live load rating. The Bridge Manual recognizes using thinner decks in Table 17.5-2. New decks located only on new girders will be the standard 10" thickness.

The deck replacement, new girder lines and new substructure units should be designed using the current AASHTO load and resistance factor bridge design specifications. The existing bridge girders should be load rated using the AASHTO load factor rating methodology, per the Bridge Manual 45.3.3. The existing bearings and piers will be adequate for the live load occurring after the bridge is widened. Per the AASHTO LRFD Bridge Design Specifications section 3.6, the live load on the existing bridge is (3 lanes)(85%)/4 girders = 0.64 lanes per girder. For the four lane configuration, the live load on the widened bridge will be (6 lanes)(65%)/7 girders = 0.56 lanes per girder. For the three lane configuration with an auxiliary lane, the live load on the typical widened bridge section will be (5 lanes)(65%)/6 girders = 0.54 lanes per girder; the live load on the widened northbound bridge section north of WIS 96 is (6 lanes)(65%)/7 girders = 0.56 lanes per girder.

Another item for future analysis would be to consider adding a pedestrian/bike/multi-use path across the bridge to create a crossing over the Fox River. Concepts 1 and 2 would allow for the reuse of existing girders to provide the multi-use path, eliminating girder removal costs, keep a more symmetrical loading on the piers and be more aesthetically pleasing. Any option for pedestrian/bike/mulit-use connections will require additional study to plan, design and cost estimate approximate connections on either end of the bridge and integration into the overall regional pedestrian/bike plan.