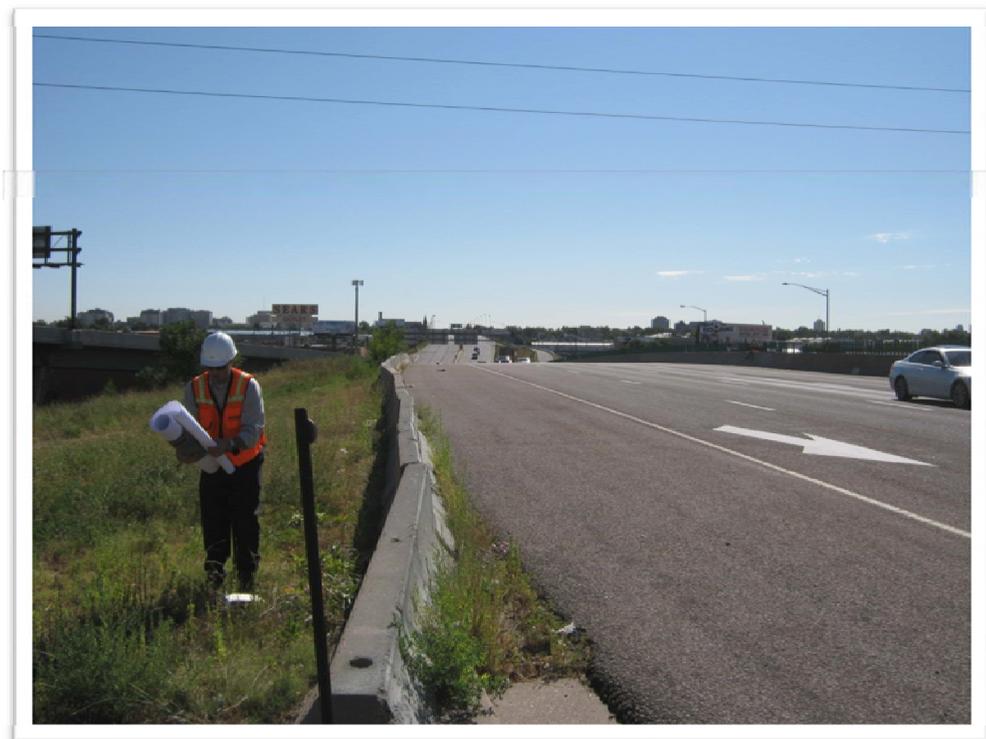
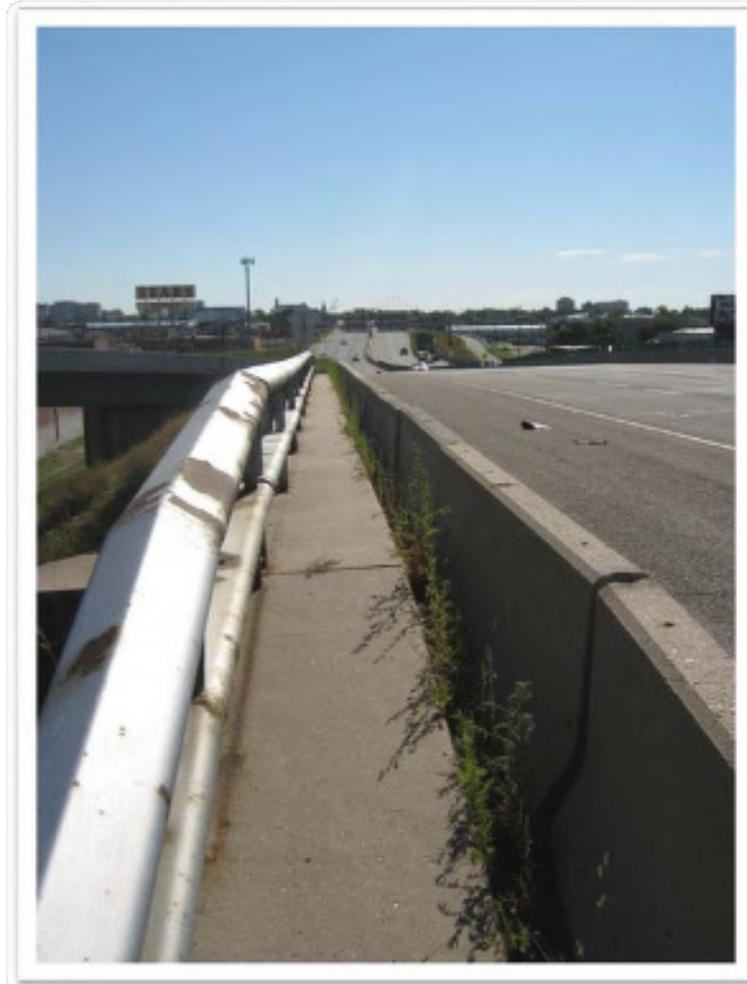




Photograph 3 – Existing abutment looking west



Photograph 4 – West approach looking east



Photograph 5 – Existing bridge rail and deck looking east



Photograph 6 – Existing US-6 under Structure F-16-OL looking west

Appendix B

2009 Structure Inventory and Inspection Report

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G
 Mile Post (ON)11: 284.530 mi

Bridge Key: F-16-EJ Inspection Date: 12/21/2009 Sufficiency Rating: 47.8 SD

Rgn/Sectn 2E/2M:	68	Hist Signif 37:	5	UW Inspection Date 93B:	
Trans Region 2T:	02	Posting status 41:	A	SI Date 93C:	
County Code 3:	031	Service on/un 42A/B:	1 2	Bridge Cost 94:	\$ 3,058,770
DENVER		Main Mat/Desgn 43A/B:	4 2	Roadway Cost 95:	\$ 305,877
Place Code 4:	20000	Aprr Mat/Desgn 44A/B:	0 0	Total Cost 96:	\$ 4,588,155
DENVER		Main Spans Unit 45:	2	Year of Cost Estimate 97:	2006
Rte.(On/Under)5A:	1	Approach Spans 46:	0	Brdr Brdg Code/% 98A/B:	
Signing Prefix 5B:	2	Horiz Clr 47:	70.0 ft	Border Bridge Number 99:	
Level of Service 5C:	1	Max Span 48:	68.7 ft	Defense Highway 100:	0
Directional Suffix 5E:	0	Str Length 49:	130.0 ft	Parallel Structure 101:	N
Feature Intersected 6:		Curb Wdth L/R 50A/B:	0.0 ft 0.0 ft	Direction of Traffic 102:	2
BNSF RR		Width Curb to Curb 51:	140.0 ft	Temporary Structure 103:	
Facility Carried 7:		Width Out to Out 52:	148.5 ft	Highway System 104:	1
US 6 ML		Deck Area:	19,310.5 sq. ft	Fed Lands Hiway 105:	0
Alias Str No.8A:		Min Clr Ovr Brdg 53:	99.99	Year Reconstructed 106:	1966
BRIDGE ENTERPRISE, TC1889		Min Undrclr Ref 54A:	R	Deck Type 107:	1
PriI Str No. 8P		Min Undrclr 54B:	22.3 ft	Wearing Surface 108A:	6
F-16-EI		Min Lat Clrnce Ref R 55A:	R	Membrane 108B:	0
Location 9:	328.05117409	Min Lat Undrclr R 55B:	15.5 ft	Deck Protection 108C:	0
EAST EDGE OF I-25 INT.		Min Lat Undrclr L 56:	0	Truck ADT 109:	2 %
Max Clr 10:	99.99	Deck 58:	5	Trk Net 110:	1
BaseHiway Net12:	1	Super 59:	5	Pier Protection 111:	#
IrsinvRout 13A:	000000006G	Sub 60:	4	NBIS Length 112:	Y
IrsSubRout No13B:	00	Channel/Protection 61:	N	Scour Critical 113:	N
Latitude 16:	39d 43' 36"	Culvert 62:	N	Scour Watch 113M:	
Longitude 17:	105d 00' 46"	Oprrtg Rtg Method 63:	1 LF Load Factr	Future ADT 114:	154,810
Range18A:	68 W	Operating Rating 64:	56.0	Year of Future ADT 114:	2028
Township18B:	68	Inv Rtg Method 65:	1	CDOT Str Type 120A:	CIC
Section18C:	4	Inventory Rating 66:	33.1	CDOT Constr Type 120B:	0.
Detour Length 19:	2.0 mi	Asph/Fill Thick 66T:	004 "in"	Inspection Indic 122A:	
Toll Facility 20:	3	Str. Evaluation 67:	4	Inspection Trip 122AA:	
Custodian 21:	1	Deck Geometry 68:	9	Scheduling Status 122B:	
Owner 22:	1	Undrclr Vert/Hor 69:	6	Maintenance Patrol 123:	7
Functional Class 26:	02	Posting 70:	5	Expansion Dev/Type124:	1
Year Built 27:	1956	Waterway Adequacy 71:	N	Brdg Rail Type/Mod 125A/B:	U 3
Lanes on 28A:	8	Approach Alignment 72:	8	Posting Trucks 129A/B/C:	0 0 0
Lanes Under 28B:	0	Type of Work 75A:	31	Str Rating Date 130:	7/27/1995
ADT 29:	137,000	Work Done By 75B:	1	Special Equip 133:	-1
Year of ADT 30:	2008	Length of Improvment 76:	129.9 ft	Vert Clr N/E 134A/B/C:	X 99.99 0.00
Design Load 31:	6	Insp Team Indicator 90B:	GREEN TEAM (Vert Clr S/W 135A/B/C:	X 99.99 0.00
Apr Rdwy Width 32:	162.0 ft	Inspector Name 90C:	MOSST	Vertical Clr Date:	11/8/1993
Median 33:	2	Frequency 91:	24 months	Weight Limit Color: 135:	0
Skew 34:	7.00 °	FC Frequency 92A:	-1	Str Billing Type:	U
Structure Flared 35:	1	UW Frequency 92B:	-1	Userkey 1 - System:	ONSYS
Sfty Rail 36a/b/c/d:	0 0 0 0	SI Frequency 92C:	-1	Userkey 7-Update Indi:	
Rail ht36h:	38 "in"	FC Inspection Date 93A:			

Inspector Name: MOSST

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G

Mile Post (ON)11: 284.530 mi

Element Inspection Report

Elm/Env	Description	Units	Total Qty	% in 1	CS 1	% in 2	CS 2	% in 3	CS 3	% in 4	CS 4	% in 5	CS 5
13/4	Unp Conc Deck/AC Ovl	(SF)	19,311	0 %	0	100 %	19,311	0 %	0	0 %	0	0 %	0
107/4	Paint Stl Opn Girder	(LF)	2,540	77 %	1,953	15 %	370	7 %	181	1 %	36	0 %	0
205/4	R/Conc Column	(EA)	9	56 %	5	11 %	1	22 %	2	11 %	1	0 %	0
215/4	R/Conc Abutment	(LF)	300	42 %	125	25 %	75	33 %	100	0 %	0	0 %	0
234/4	R/Conc Cap	(LF)	135	0 %	0	37 %	50	56 %	75	7 %	10	0 %	0
304/4	Open Expansion Joint	(LF)	142	58 %	82	42 %	60	0 %	0	0 %	0	0 %	0
308/4	Constr Non Exp Jt	(LF)	300	0 %	0	100 %	300	0 %	0	0 %	0	0 %	0
311/4	Moveable Bearing	(EA)	40	28 %	11	28 %	11	45 %	18	0 %	0	0 %	0
313/4	Fixed Bearing	(EA)	20	0 %	0	0 %	0	100 %	20	0 %	0	0 %	0
321/4	R/Conc Approach Slab	(EA)	2	100 %	2	0 %	0	0 %	0	0 %	0	0 %	0
325/4	Slope Prot/Berms	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
326/4	Bridge Wingwalls	(EA)	4	75 %	3	25 %	1	0 %	0	0 %	0	0 %	0
331/4	Conc Bridge Railing	(LF)	260	92 %	240	8 %	20	0 %	0	0 %	0	0 %	0
334/4	Metal Rail Coated	(LF)	260	45 %	118	0 %	0	45 %	116	10 %	26	0 %	0
338/4	Conc Curbs/SW	(LF)	260	0 %	0	42 %	110	29 %	75	29 %	75	0 %	0
359/4	Soffit Smart Flag	(EA)	1	0 %	0	0 %	0	0 %	0	100 %	1	0 %	0

Elem/Env	Description	Element Notes
13/4	Unp Conc Deck/AC Ovl	4 inches of Asphalt - Raveling of asphalt along seams.
107/4	Paint Stl Opn Girder	Span 1 girders heavily blackened by train exhaust. Girders at A3; 2I to 2R have been blackened by camp Fires. R1 to R2 on top flanges where deck leaks & may be loose. Light rust/poor paint is mainly in span 1. R1 & R2 rust in span 2, mainly below joints and exterior girders and girders I & K. See tally sheet. Corners of flanges digging 1/4 inch into A-3 backwall, 2Q maybe an inch.
205/4	R/Conc Column	Col. 2I has right side (full height) spalled over 3 inches deep / behind the main vertical reinf. bars. These bars have at least 25% section loss & are bowing out (probably due to the rustpack behind them). The 12 CONSECUTIVE TIE BARS ARE ALL CORRODED THROUGH ON THIS SOUTH FACE. Banding (for attaching signs to poles) 8 bands were placed around the column to limit the bowing of the main reinf., see 2008 & 2009 PHOTOS. Column A has a 3/16 vertical crack, rust stains with delamination. Column E has vertical cracks and delamination. See 2003 & 2008 photos.

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G

Mile Post (ON)11: 284.530 mi

Elem/Env	Description	Element Notes
215/4	R/Conc Abutment	<p>Abut 1 is a tall retaining wall - with horizontal, vertical, & diagonal cracks, some with efflorescence and face of A1 right has delams. Series of 1/8 inch vertical cracks with efflorescence that extend from groundline to below girder C at A-1.</p> <p>Breastwall of A-3 cap has areas of spalled concrete with exposed corrosion in rebar, the worst is right 1/2 of A3, 2008 PHOTO. Spalling & delaminating is along moderate horizontal cracks, worst conditions is below girders D, E, F, M, N, O & P. Backwall of A-3 has light vertical, horizontal & diagonal cracks with efflorescence. Bearing seat at A-3 has areas of up to 6 inches of debris. Abut. 1 Wall is probably being pushed towards Abut 3 - A3 Rockers have rotated, girders are pushing against backwall of A3 causing minor spalling. This is not a problem yet; bridge will probably be replaced before it is very significant.</p>
234/4	R/Conc Cap	<p>Pier caps have moderate to heavy horizontal cracks with areas of shallow to deep delamination, rust stains, and many areas of efflorescence, 2009 PHOTO of typical.</p> <p>No apparent bearing loss, but unable to get bucket truck below, used long ladder in 2008 Inspection. Cap under girders 1A, 1B, and 1C shallow concrete spalled to rebar, no loss of bearing at this time. See 2003 & 2008 photos. Heavy spall with exposed rebar that is corroded, and moderate delam. cracks at P2 cap below girders 2R, 2S and 2T. See photos.</p>
304/4	Open Expansion Joint	At A-3. Asphalt covered, reopening and potholes are forming. See 2008 photo.
308/4	Constr Non Exp Jt	At A-1 & P-2 Asphalt cover cracked and leaking, noted by icicles at times.
311/4	Moveable Bearing	Rockers at P-2 & A-3 - Rockers have R2 to R3 corrosion and heavy flaking rust. 3G, 3H, 3L to 3Q have rotated to where girders are pushing against A-3 backwall and causing some minor spalling, probably due to Abut. 1 being pushed inward.
313/4	Fixed Bearing	At A-1. R1 to R2 corrosion.
321/4	R/Conc Approach Slab	Per plans - Covered with asphalt, no problems yet but edges starting to become exposed due to settling and erosion of fill at wings.
325/4	Slope Prot/Berms	Dirt slope & berm at A-3; homeless persons living on top of wide dirt berm area.
326/4	Bridge Wingwalls	<p>TALL Flared wings for retaining wall abut. 1. Joint open over 2 inches at the top of right rear, allowing some loss of backfill, 2009 PHOTOS. The left wing joint is open slightly.</p> <p>Stubs for abut. #3 cap, ok.</p>
331/4	Conc Bridge Railing	<p>Jersey barriers - In median (cast-in-place & continuous), but portable sections in front of left metal rail. Minor spalling, scale, tire marks, shrinkage, vertical cracks and delamination at base, see 2008 PHOTOS. Many vert. fiberglass glare strips on median barrier damaged, 2009 PHOTO.</p>
334/4	Metal Rail Coated	<p>Galv. Type Y at right, was new in 1998, still OK. The original Type U at left, not being used because Jersey barrier has been placed in front of it. But it has R2-R4 corrosion on left posts @ base, spots of peeling paint, with R1-R4 corrosion, on railing. See 2009 & 2003 photos.</p>
338/4	Conc Curbs/SW	<p>Many spalls along top edges some with exposed rebar. Extensive horiz. cracking along face, delamination, right side is the worst, see 2009 & 2008 PHOTOS.</p>

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G _

Mile Post (ON)11: 284.530 mi

Elem/Env	Description	Element Notes
359/4	Soffit Smart Flag	<p>Areas of map cracking with moderate efflorescence and rust stains, saturation in some of these areas with stalactites and Icicles. The worst are in bays A, B, C and I. Few other trans cracks with efflor.: Span 2, 5 to 20 feet from A-3, 1/32 inch trans cracks with some differential espec bay 2Q with 1/8 inch difference, (PHOTO 11/08/93), spall in bay 2P, 5 feet from A-3, 2.5 feet x 2 feet with rebar exposed, 11/08/93 photo. Spall with exposed rebar from contamination, bay 2I, about 14 sq feet, about 15 feet from P-2, 11/08/93 & 01/07/02 photos. Right exterior bay T cracked, spalled, delamination, and rust stains whole length.</p> <p>Patches, 2 in bay 2H adjacent to girder I, 1 in bay 2L next to girder L. Shallow delam cracking in bay 2H, 12 feet from A-3. Delamination cracking and spalls in bay 2-O: Estimate about 25% total deck bad.</p>

Maintenance Activity Summary

MMS Activity	Description	Recommended	Status	Target Year	Est Cost
*398	Debris	12/18/2003	-1	2010	50000

Please correlate with other municipalities to clear the area. Remove all debris and trash from abutment 3.

355.02	Cln & Pnt	1/7/2002	-1	2011	5000
--------	-----------	----------	----	------	------

Clean and spot paint the steel girders and their bearings, Abut 3 ends & bearings espec.

*353.03	Br Dk Rpr	1/7/2002	-1	2010	75000
---------	-----------	----------	----	------	-------

Shore up 40 feet of bay 2J or replace section of deck.

360.00	App SI & S	12/21/2009	-1	2012	400
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Place fill at both sides of rear slab, there is settlement and erosion 2-3 ft. deep between roadway and wings, 2009 PHOTO.

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G _

Mile Post (ON)11: 284.530 mi

Maintenance Activity Summary

MMS Activity	Description	Recommended	Status	Target Year	Est Cost
**358.05	Substr	2/4/2008	-1	2011	5000

Column 2I needs rehabilitation of South face.

357.05	Bearings	2/4/2008	-1	2011	3000
--------	----------	----------	----	------	------

Clean and paint dirty and rusting rocker bearings at A3.

Bridge Notes

Homeless persons are living at Abutment 3 & had sleeping quarters.
 There is soot from camp fires, Abut. 3 & girders;
 Much of this was taken to a roll-off dumpster but some remains; 2008 & 2009 PHOTOS.

Colorado Department of Transportation
Structure Inspection and Inventory Report (English Units)

Highway Number (ON) 5D: 006G =

Mile Post (ON)11: 284.530 mi

Inspection Notes

Time:) 1:55 Temp.:) 55 deg. F. Weather:) Partly Cloudy Team Leader:) TAM

Scope:

NBI: Element: Underwater: Fracture Critical: Other: Type: Regular NBI

Inspector: MOSST

Inspection Team:

Inspection Date: 12/21/2009

Inspector

Inspector

Appendix C

Field Diagnostic Meeting Minutes

Field Diagnostic Meeting



Action Items Summary List

- ✓ Pam Fischhaber to check at PUC for the legal description of the existing bridge
- ✓ Andy Amparan to follow up with BNSF on legal description of the existing bridge
- ✓ Andy Amparan to check when the last maintenance project occurred (to make sure survey will be adequate to determine vertical clearances for design)
- ✓ Andy Amparan to check how often the maintenance is performed on the tracks
- ✓ Gene Eliassen to confirm if BNSF wants/needs 1 or 2 maintenance roads and on which side
- ✓ Bill Snowden to research Design Build language for BNSF & UPRR

1. Introductions

See attached sign in sheet.

2. BNSF Safety Briefing

Jerad Esquibel:

- No need since we are rained out and indoors

3. Proposed Scope of Work

Scott Waterman:

- Location: on 6th Ave. approximately 700 feet east of I-25 centerline
- Structure Sufficiency < 50 so will need a bridge replacement
- Current vertical clearance is deficient so will likely need to raise vertical profile of 6th Ave.
- Valley Highway EIS will define ultimate laneage
- FIR: August 2011
- FOR: December 2011 (IF Design/Bid/Build)
- AD: July 2012 (right of way dependent) (IF Design/Bid/Build)
- Now through August will be setting the bridge footprint with BNSF (30% design)

4. Planned Projects/Improvements

Andy Amparan

- No planned projects for BNSF as of right now
- BNSF is like CDOT though, that if funding is to become available there could be

Scott Waterman:

- Have had one meeting with Denver, and they have no future projects planned for this area
- There is high potential this bridge will be added to the Bridge Enterprise US 6 Corridor Projects west of I-25

5. Easements

Scott Waterman:

- Legal description has been pulled for the flyover
- Still looking for the legal description of this existing bridge

Andy Amparan:

- BNSF Real Estate contact for Colorado has moved on
- Andy will check back with the BNSF real estate office for new contact to research

Pam Fischhaber:

- Will also check PUC records for the legal description of the existing bridge

6. Geometric Requirements for Proposed Improvements

Gene Eliassen:

- BNSF ROW is approx. 65' from the original mainline
 - o Original/mainline is 2nd from the east
 - o ROW most likely dimensioned from here in the legal description
- See attached ROW exhibit provided by Gene

Andy Amparan:

- PDF submittals are good for BNSF review

Scott Waterman:

- Surveyors have permit, resubmitted and waiting to get flaggers
- Need to survey from 8th Ave. to the I-25 crossing on the south
 - o Need the 1000' on each side of the structure to verify there are no sags in the tracks

Andy Amparan:

- Will check when the last maintenance was performed on the tracks
- Will check to see how often maintenance is performed on the tracks

Andy Leifheit:

- Minimum 25' horizontal pier clearance without crash wall per Grade Separation Guidelines
- Absolute minimum 18' horizontal pier clearance with crash wall per Grade Separation Guidelines
- Minimum vertical clearance 23'-4" per Grade Separate Guidelines
- Looking to move pier back on the east side to get 25'
- West side depends on the ROW, but will most likely have a wall with tall abutment
 - o NO MSE walls on BNSF ROW
 - o NO drainage onto BNSF ROW
- 6th Ave will likely have to be raised as existing vertical clearance may be below 23'4"

Gene Eliassen:

- BNSF is supposed to have a maintenance road on both side of a triple track, but physical constraints on either side make it difficult
- Gene will check with BNSF maintenance to see how many they want/need since there isn't one there currently

Scott Leiker:

- A drainage report will be needed for the project and the report should include a specific section discussing impacts to BNSF
 - o This will need to be presented to BNSF
- Historic drainage patterns must be maintained
- The drainage system should be designed for the ultimate lane configuration of 6th Ave
- Based on an ultimate design, it is assumed that to meet increased impervious area and current drainage criteria, that the outfall may need to be upsized or detention pond may be required
- There is no water quality banking policy in place, therefore we will need to treat our impacted drainage while not precluding future WQ improvements for the Valley Highway EIS
- This project will need to provide 100% Water Quality Capture Volume or 80% TSS removal for the impervious areas within the limits of disturbance
- Susie Smith should be contacted early in the design process to discuss the water quality concept
- We should anticipate future improvements to 6th Ave, both east and west of this project, and design our drainage system accordingly (let's look at the big picture)
- At or before FIR, the water quality basin map (34" x 22") with proposed BMP's should be discussed with Susie Smith or CDOT Hydraulics so that concept going forward meets requirements with CDPHE and right of way needs can be addressed

7. Utilities

Ron Dickey:

- Overhead high voltage electric
- We need to check if fiber is present along railroad
- Try not to impact these

8. Construction Time Constraints

Andy Amparan:

- No work Oct. – Dec. that will affect train operations

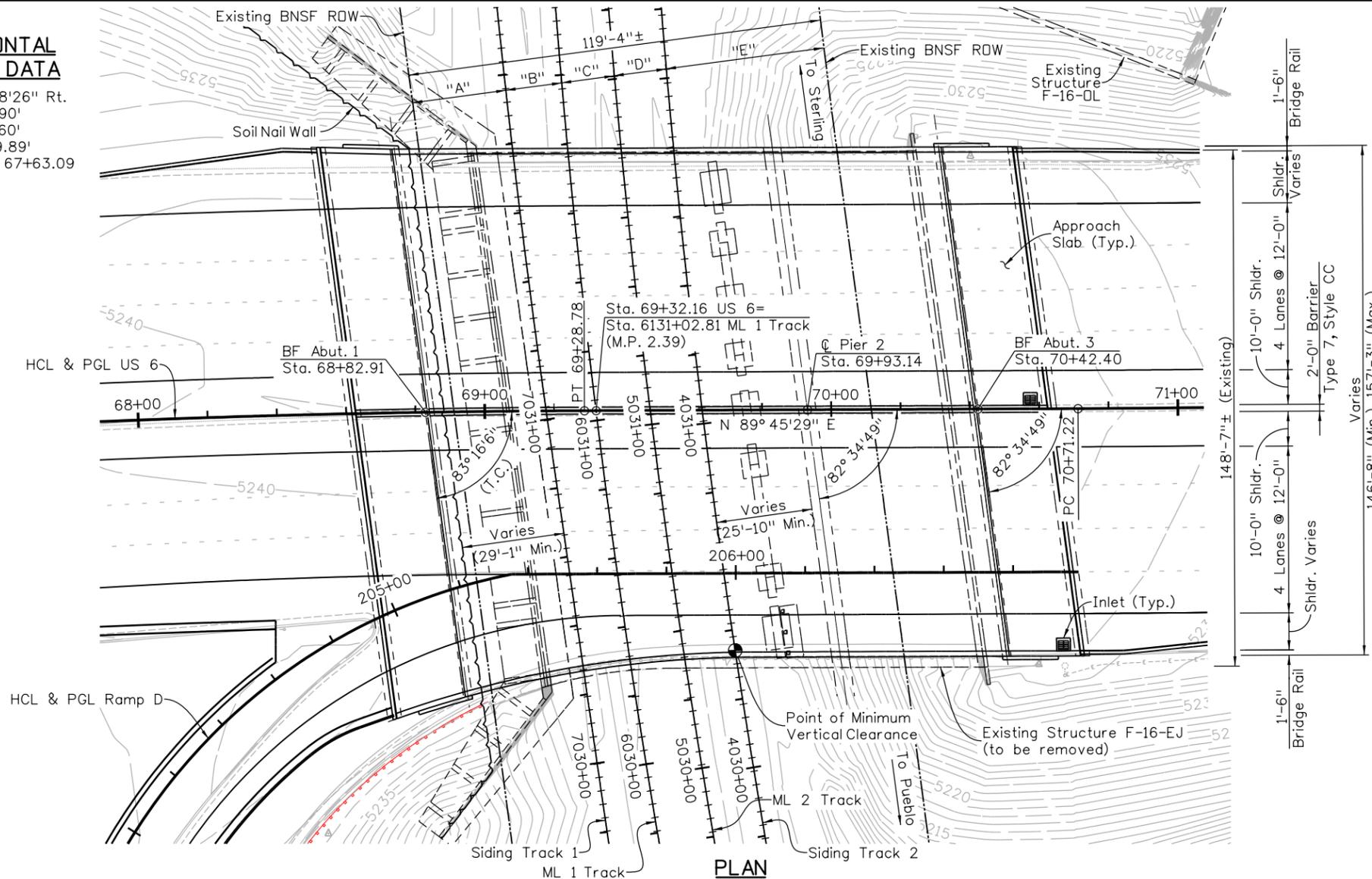
- Procurement process – need to know sooner than later – will know July 1st
- C&M agreement will be affected if this project changes from DBB to DB
- Bill Snowden to research Design Build (DB) language for BNSF and UPRR
- DBB or DB could also affect the PUC application
- Pam Fischhaber says to have PUC application in early to mid April to maintain July 2012 AD date

Appendix D

Preliminary Bridge Plans

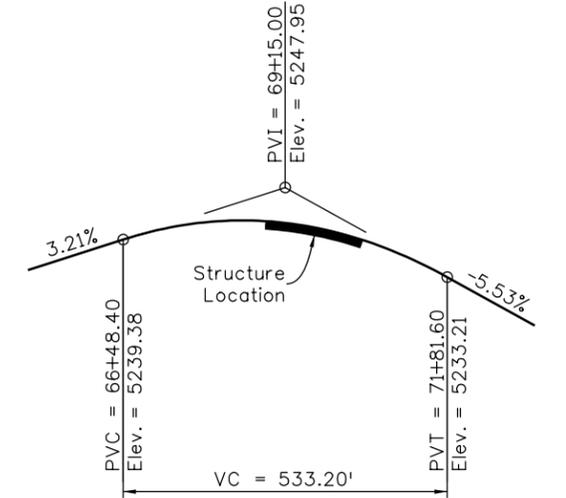
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 Lc = 331.60'
 Rc = 3819.89'
 PI = Sta. 67+63.09

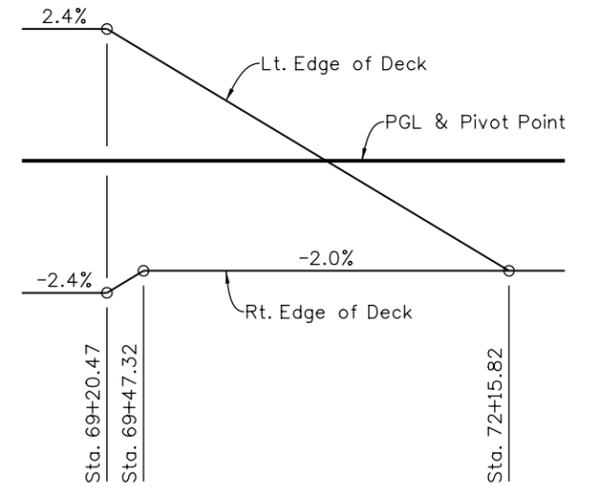


TRACK CLEARANCE TABLE

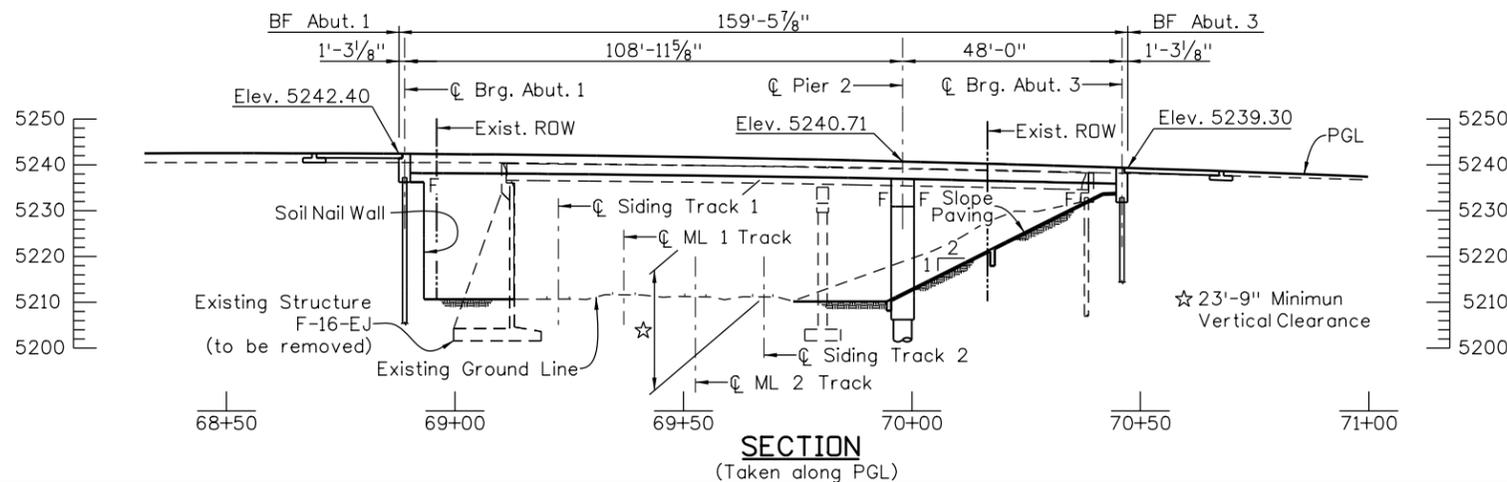
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US 6 PROFILE GRADE



SUPERELEVATION DIAGRAM

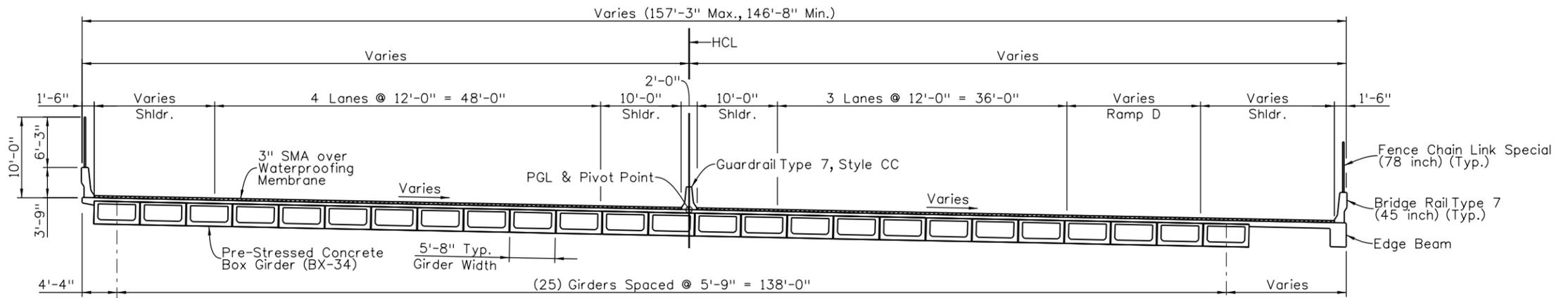


SECTION
(Taken along PGL)

PRELIMINARY PLANS
 12/15/2011

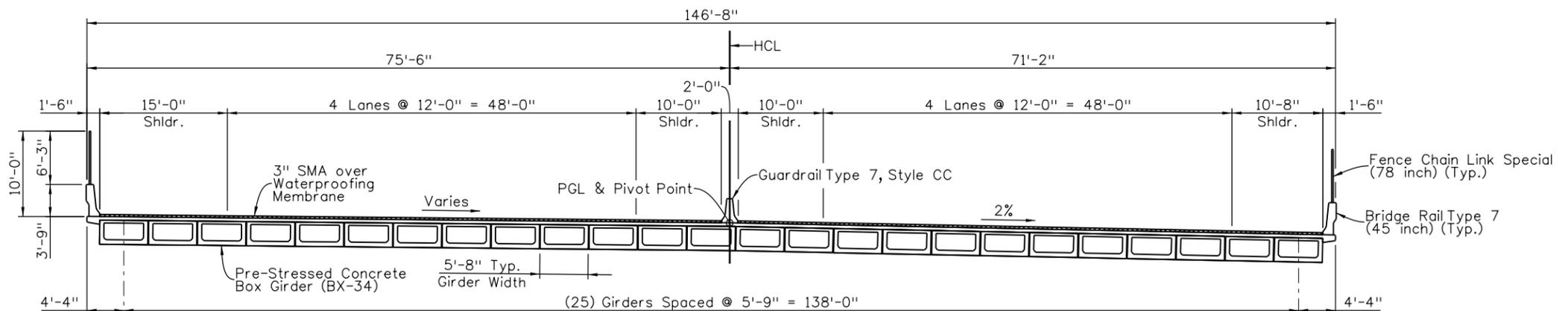
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Designed By	12/11	Detailed By	12/11	Quantities By	12/11
Checked By	JAR	Checked By	BJA	Checked By	BJA

Print Date: 12/15/2011	Sheet Revisions			Colorado Department of Transportation		As Constructed		US 6 OVER BNSF GENERAL LAYOUT		Project No./Code	
File Name: 18202BRDG_GeneralLayout.dgn	Date:	Comments	Init.	425 B Corporate Circle Golden, CO 80401 Phone: 303-972-9112 FAX: 720-497-6951		No Revisions:		Designer: B. Allen		FBR 0062-026	
Horiz. Scale: 1:1				Region 6		Revised:		Detailer: D. Anderson		18202	
Staff Bridge Branch - Unit 022X Unit Leader Initials				KRS		Void:		Sheet Subset: BRIDGE		Sheet Number	
WILSON & COMPANY								Structure Numbers: F-17-YJ			
								Subset Sheets: B1 of BX			



TYPICAL SECTION

Abut. 1 to Sta. 69+76.53



TYPICAL SECTION

Sta. 69+76.53 to Abut. 3

**PRELIMINARY
PLANS**
12/15/2011

Design		Detail		Quantities	
INITIAL	DATE	INITIAL	DATE	INITIAL	DATE
Designed By	12/11	Detailed By	12/11	Quantities By	12/11
Checked By	JAR	Checked By	JAR	Checked By	BJA

Print Date: 12/15/2011
 File Name: 18202BRDG_TypSection_01.dgn
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 Staff Bridge Branch - Unit 022X Unit Leader Initials

Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation

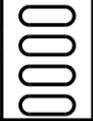
 2000 S. Holly Street
 Denver, Co 80222
 Phone: 303-757-9350 FAX: 303-757-9004
Region 6

As Constructed
 No Revisions:
 Revised:
 Void:

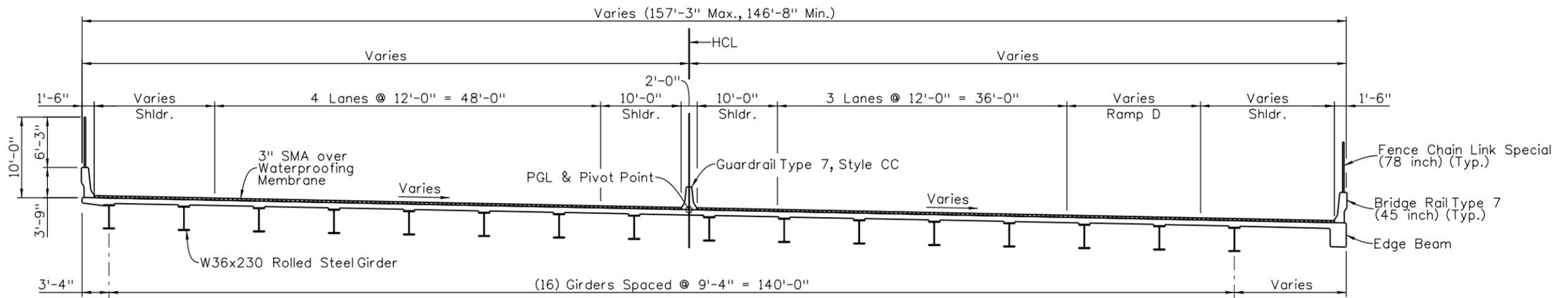
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TYPICAL SECTION
CONCRETE ALTERNATE**

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Detailer:	B. Allen	Subset Sheets:	B2 of BX
Sheet Subset:	BRIDGE		

Project No./Code
 FBR 0062-026
 18202
 Sheet Number

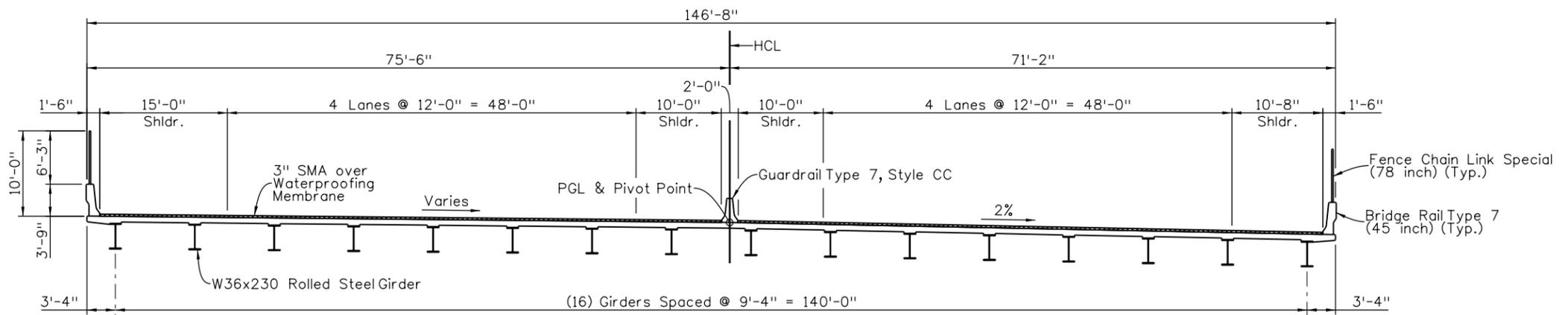


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TYPICAL SECTION

Abut. 1 to Sta. 69+76.53



TYPICAL SECTION

Sta. 69+76.53 to Abut. 3

**PRELIMINARY
PLANS**
12/15/2011

Design		Detail		Quantities	
INITIAL	DATE	INITIAL	DATE	INITIAL	DATE
Designed By	12/11	Detailed By	12/11	Quantities By	12/11
Checked By	JAR	Checked By	JAR	Checked By	BJA

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 Staff Bridge Branch - Unit 022X Unit Leader Initials



Sheet Revisions		
Date:	Comments	Init.

Colorado Department of Transportation

 2000 South Holly Street
 Denver, CO 80222
 Phone: 303-512-4105 FAX: 303-757-9059
 Region 6 KRS

As Constructed
 No Revisions:
 Revised:
 Void:

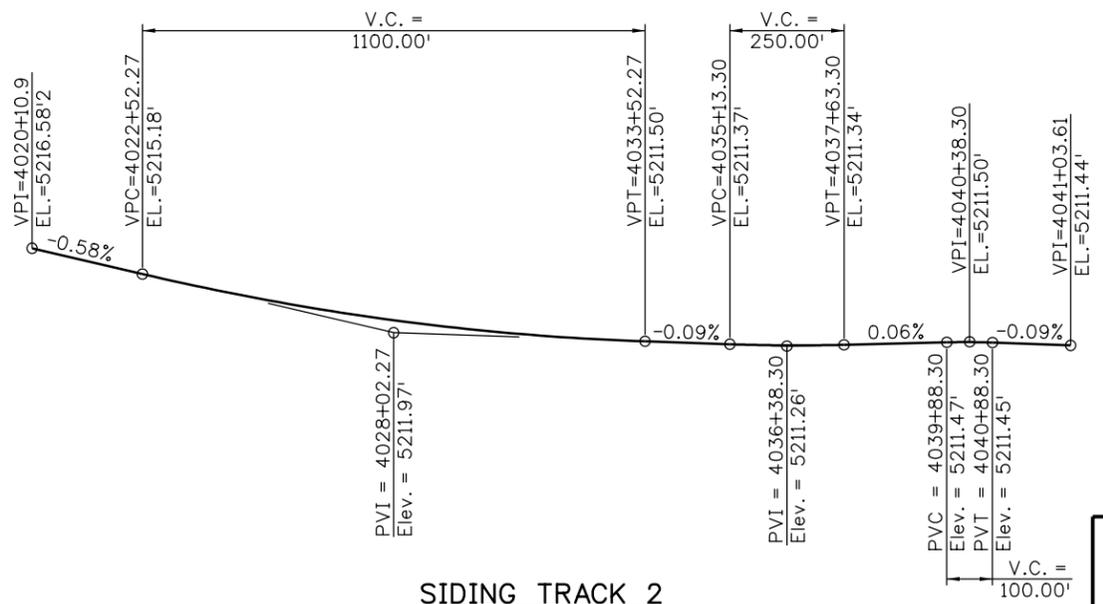
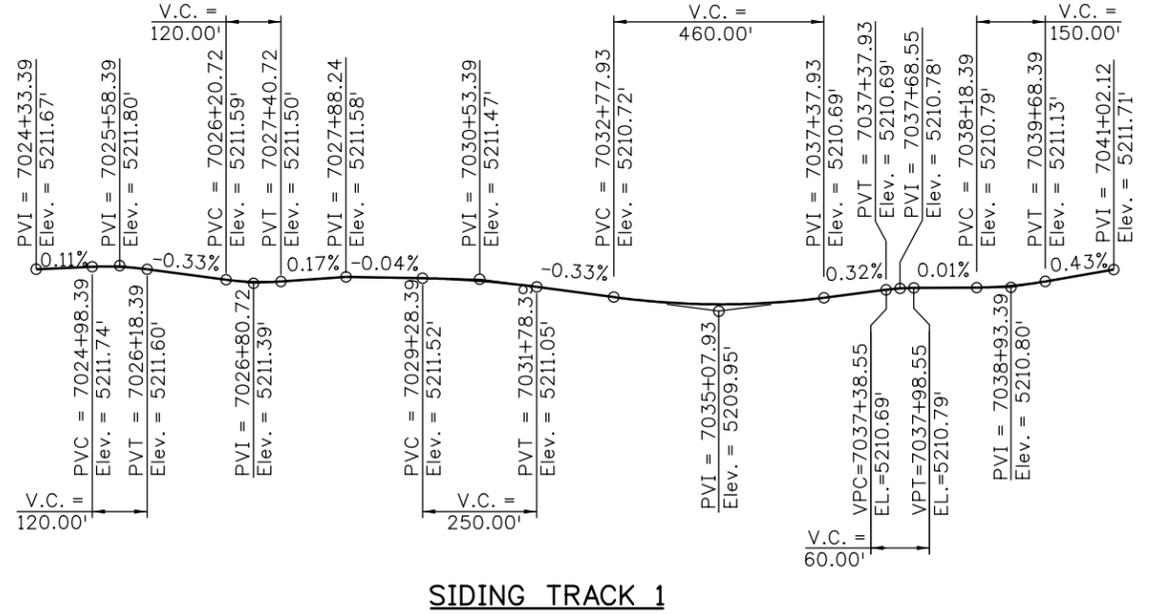
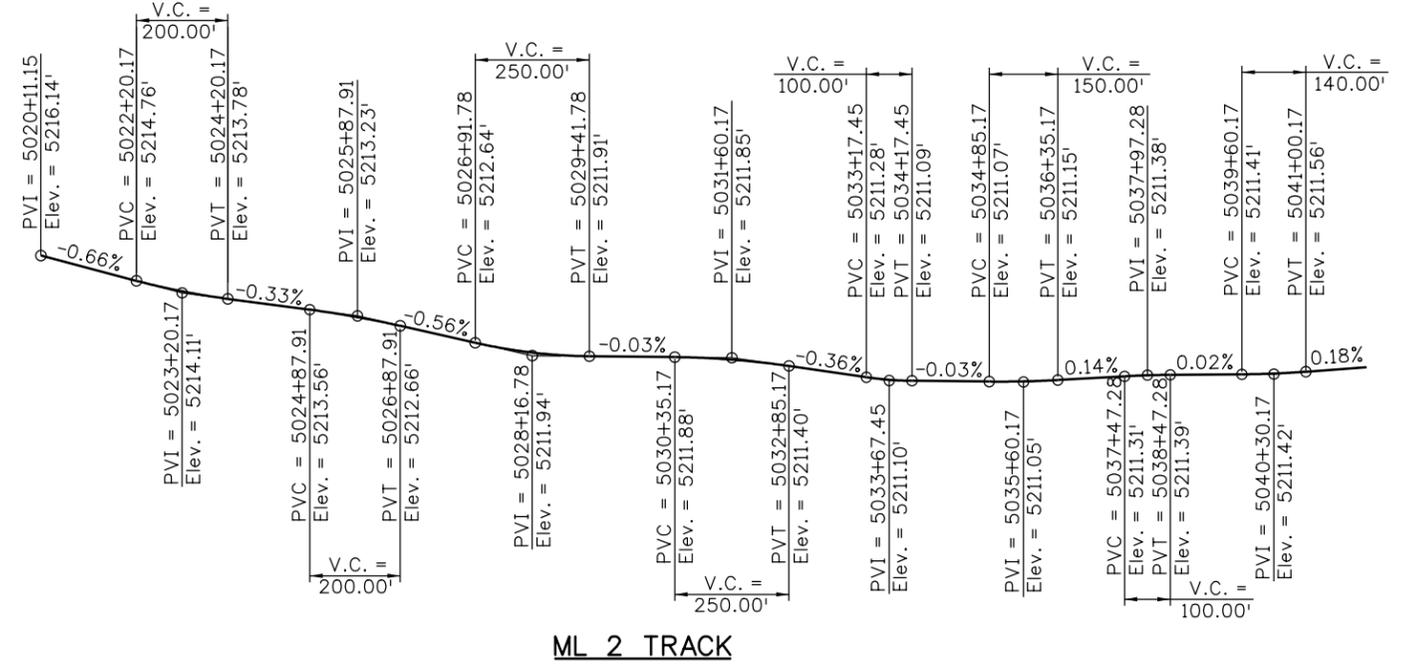
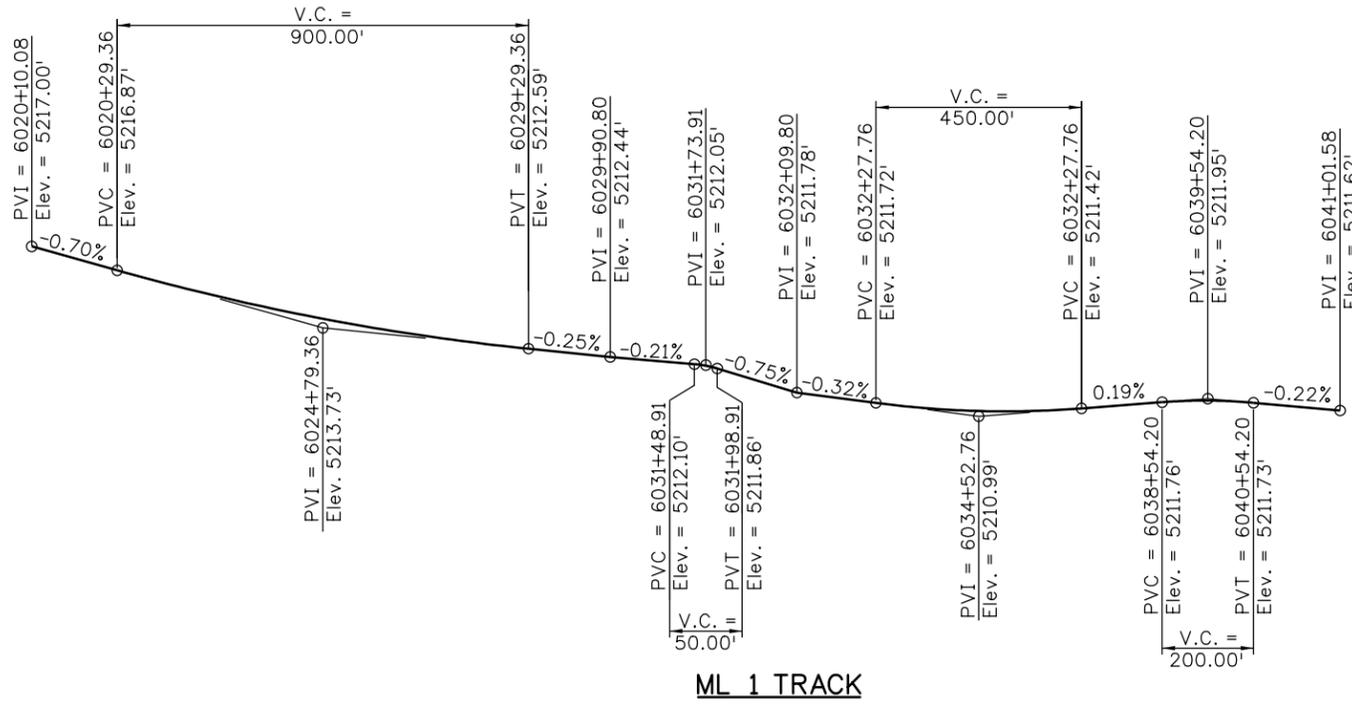
**US 6 OVER BNSF
TYPICAL SECTION
STEEL ALTERNATE**

Designer:	B. Allen	Structure Numbers	F-17-YJ
Detailer:	B. Allen	Subset Sheets:	B3 of BX
Sheet Subset:	BRIDGE		

Project No./Code
 FBR 0062-026
 18202
 Sheet Number

BJAllen 1:26:23 PM c:\pwworking\wilson\projects\18202BRDG_TypSection_02.dgn

Design		Detail		Quantities	
INITIAL	DATE	INITIAL	DATE	INITIAL	DATE
Designed By		Detailed By		Quantities By	
Checked By		Checked By		Checked By	



PRELIMINARY PLANS
12/15/2011

Print Date: 12/15/2011	0000	Sheet Revisions			Colorado Department of Transportation  425 B Corporate Circle Golden, CO 80401 Phone: 303-972-9112 FAX: 720-497-6951 Region 6	As Constructed		US 6 OVER BNSF EXISTING TRACK PROFILES		Project No./Code		
File Name: 18202BRDG_TrackProfiles_01.dgn		Date:	Comments:	Init.		No Revisions:			F-16-YJ		FBR 0062-026	
Horiz. Scale: 1:1 Vert. Scale: As Noted						Revised:	Designer: B. Allen	Structure Numbers:		18202		
Staff Bridge Branch - Unit 022X Unit Leader Initials				Void:	Detailer: D. Anderson	Subset Sheets:	B4 of BX	Sheet Number				
WILSON & COMPANY				KRS								

Appendix E

Preliminary Geotechnical Recommendations



April 1, 2011

Scott Waterman, P.E.
Wilson & Company, Inc., Engineers & Architects
999 18th Street
Denver, CO 80202

**RE: Preliminary Geotechnical Recommendations
Soil & Foundation Investigation
6th Avenue Bridge over BNSF, Denver, Colorado**

Dear Scott:

This letter provides preliminary recommendations for the referenced 6th Avenue bridge project over the BNSF Railroad in CDOT's Region 6, Denver, Colorado. The recommendations contained are based on subsurface information detailed in drawings provided by the Division of Highways, dated February 1988 and for investigations conducted for Ramp H planned to be constructed north of this bridge project. Our recommendations are subject to change once the site specific subsurface investigation is completed.

Subsurface Conditions

The subsoils graphically shown on the drawing indicate that a layer of fill consisting of clayey sands to sandy clays was over relatively clean natural sands with trace gravel. Claystone Bedrock was encountered at about elevation 5180 feet. Ground water was encountered at about elevation 5192 feet. Ground surface was at about 5210 feet.

Preliminary Foundation Recommendations

Based on the subsurface conditions described a drilled shaft or driven pile foundation may be used for support of the structure. The following design and construction recommendations should be observed.

Drilled Shafts

1. Drilled shafts should be designed for ultimate end bearing pressure and side shear values as shown below for that portion of the shaft in competent claystone bedrock.

Ultimate End Bearing (psf)
130,000

Ultimate Side Shear (psf)
13,000

Using LRFD methodology, a resistance factor of 0.50 should be applied to end bearing, 0.55 should be applied to side shear, and 0.45 should be applied to side shear for uplift resistance. The ultimate capacity recommendations assume that a weighted load factor of 1.6 is used.

The above ultimate strength parameters are intended to correspond to the following Allowable Stress Design (ASD) capacities.

<u>Allowable End Bearing (psf)</u>	<u>Allowable Side Shear (psf)</u>	<u>Allowable Side Shear Uplift (psf)</u>
40,000	4,400	3,600

2. Some variation in the bedrock surface should be anticipated. Drilled shafts should penetrate at least 20 feet into claystone bedrock and have a minimum length of at least 25 feet for the upper capacities to be valid. These are geotechnical parameters, greater penetration depths may be needed based on the structural requirements.
3. The minimum spacing requirements between drilled shafts should be 3 diameters from center to center. At this spacing, no reduction in axial design parameters is required. Drilled shafts grouped less than 3 diameters center to center should be studied on an individual basis to evaluate the appropriate reduction in axial capacity.
4. Drilled shaft holes should be properly cleaned prior to placement of reinforcing steel or concrete. A maximum length to diameter ratio of 25 is recommended to facilitate cleaning and observation of the shaft hole.
5. Concrete utilized in the drilled shafts should be a fluid mix with sufficient slump so it will fill the voids between reinforcing steel and the shaft hole. Concrete with a slump in the range of 5 to 7 inches is recommended.
6. Casing and mud slurry will be required to reduce water infiltration and to help control caving. If water cannot be removed prior to placement of concrete, then concrete should be placed with an approved tremie method. The drilling contractor should be aware that water may be encountered in the bedrock as well as overburden soils. Concrete placement should occur after the hole has been well cleaned and approved. Concrete should not be placed through more than 2-inches of water.
7. A sufficient head of concrete should be maintained inside the casing during casing extraction to prevent voids being formed in the concrete upon casing removal. The concrete level should not be allowed to rise during casing removal. If it becomes apparent that voids may have formed during shaft installation, the contractor should be required to perform non-destructive tests to evaluate the continuity and integrity of the shaft. Tests may include sonic echo tests or other tests.
8. Bedrock penetration should be measured down from the bottom of the casing or top of competent bedrock, whichever is the lower elevation.
9. Care should be taken to prevent forming mushroom shapes at the top of the drilled shafts.
10. Concrete should be placed in the holes the same day they are drilled. The presence of water will most likely require concrete to be placed immediately after the shaft hole is completed. Failure to place concrete the day of drilling will result in degradation of bedrock capacity and a requirement for additional bedrock

penetration. The amount of additional bedrock penetration will be a function of how long the hole is left open and whether or not water accumulates during the inactive period. If holes are left open over night, this office should be contacted for additional bedrock penetration requirements.

11. The drilling contractor should mobilize equipment of sufficient size and operating condition to penetrate the materials and to achieve the required bedrock penetration.
12. Installation of drilled shafts should be observed by a representative of Geocal, Inc.

Driven Pile Foundation

Recommendations presented in this section are based on the "AASHTO LRFD Bridge Design Specifications" manual, the subsurface data described, our experience, and local geotechnical engineering practice. Installation of driven piles should be in accordance with Section 502 of *Standard Specifications for Road and Bridge Construction (2011)*, by the Colorado Department of Transportation.

1. Piles should consist of heavy steel H-sections driven into and supported by the underlying bedrock. A Pile Driving Analyzer (PDA) should be used to establish the pile driving refusal criteria. For preliminary design purposes, a combined side shear friction and end bearing ultimate capacity of 30,000 pounds per square inch (30 ksi) times the cross sectional area of the pile may be used for the Load and Resistance Factor Design (LRFD) method. The ultimate capacity assumes a weighted load factor of 1.6. A resistance factor of 0.45 should be applied. For the Allowable Stress Design (ASD) method, an allowable load equal to 9 ksi times the cross sectional area of the pile may be used for piles driven into the underlying bedrock. The above values are for $f_y = 36$ ksi steel H-piles.
2. For H-piles consisting of $f_y = 50$ ksi steel driven into bedrock, a combined side shear friction and end bearing ultimate capacity of 42,000 pounds per square inch (42 ksi) times the cross sectional area of the pile may be used for the Load and Resistance Factor Design (LRFD) method. The ultimate capacity assumes a weighted load factor of 1.6. A resistance factor of 0.45 should be applied. For the Allowable Stress Design (ASD) method, an allowable load equal to 12 ksi times the cross sectional area of the pile may be used.
3. Settlement of properly constructed driven piles is expected to be nominal, on the order of $\frac{1}{2}$ inch or less.
4. H-piles are expected to encounter refusal within about 2 feet to 5 feet of the bedrock surface, although some variation in the bedrock surface elevation and penetration should be expected.
5. Penetration into the bedrock may vary and could be nominal. Therefore, uplift resistance should be limited to the soil-pile side shear above bedrock. Side shear capacity should be assumed zero "0" in the upper three feet to account for frost activity and surface disturbance. At three feet the side shear can be assumed to be an ultimate value of 500 psf. The ultimate value of 500 psf may be assumed constant for the remaining depth. A Resistance Factor of 0.25 should be applied. Pile and pile cap weights may be included in dead weight resistance to uplift forces.
6. Pile groups will require appropriate reductions of the axial capacities based on the effective envelope of the pile group. For axial and uplift, this reduction can be avoided by spacing the piles no closer than 3

diameters from center to center. Piles spaced closer than 3 diameters should be evaluated on an individual basis to establish the appropriate reduction in the design parameters.

7. The pile hammer should be operated at the manufacturer's recommended stroke when measuring penetration resistance. The pile capacity should be verified during construction by using a Pile Driving Analyzer (PDA). A minimum of two piles per structure should be monitored using a PDA, each at a separate foundation element (abutment or pier foundation).
8. The pile driving operation should be observed by qualified personnel on a full-time basis. Piles should be observed and checked for buckling, crimping and alignment in addition to recording penetration resistance and general pile driving operations.

Retaining Structure Earth Pressures

For this preliminary report, we have assumed that walls will be cast-in-place concrete and cantilevered. Retaining structures which are laterally supported and can be expected to undergo only a slight amount of deflection should be designed for lateral earth pressures based on the "at-rest" earth pressure condition. Cantilevered or gravity retaining structures which rotate and/or deflect sufficiently to mobilize the internal soil strength of the wall backfill may be designed for the "active" earth pressure condition. The following ultimate earth pressure coefficients are recommended for imported Class 1 material. Fine grained soils (i.e. clays and silts) produce excessive earth pressures on walls and are not recommended for use as structure backfill.

The following values assume placement and compaction in accordance with the CDOT standard specifications.

Material or location	Active (K _a)	At-Rest (K _o)	Passive (K _p)	γ _T – Unit Weight (pcf)	Friction Angle (φ), degrees
Imported Class 1	0.28	0.44	3.54	135	34

For granular backfill, lateral wall movements or rotation equal to 1% of the wall height is typically required to develop the full active case, whereas lateral movement equal to at least 2% of the wall height is normally required to establish full passive resistance. Suitable factors of safety should be applied to the above ultimate values to limit strain needed to reach ultimate strength, particularly in the case of passive resistance where large strains are needed to mobilize resistance. Imported material should meet CDOT Class 1 structure backfill grading requirements.

Equivalent fluid unit weights may be taken as follows:

$$\begin{aligned}
 \text{Above ground water:} & \quad \gamma_{eq} = \gamma_T \times K_{a,o,p} \\
 \text{Below ground water:} & \quad \gamma_{eq} = (\gamma_T - 62.4) \times K_{a,o,p}
 \end{aligned}$$

where

$$\begin{aligned}
 \gamma_T & = \text{soil total unit weight} \\
 K_{a,o,p} & = \text{appropriate earth pressure coefficient}
 \end{aligned}$$

The above parameters are for a horizontal backfill and no surcharge load to the backfill. Retaining structures should be designed for appropriate surcharge pressures such as from traffic, etc. The buildup of water behind a wall or an upward sloping backfill surface will increase the lateral pressure imposed on retaining structures and should be accounted for. An under-drain should be provided to help reduce hydrostatic pressure buildup, unless the wall is designed to accommodate the additional pressure.

Limitations

This *preliminary* report has been prepared in accordance with generally accepted geotechnical engineering practices used in this area, and has been prepared for planning purposes. The conclusions and recommendations are based upon the data obtained from a review of previous information collected by others. The nature and extent of the variations adjacent to the borings may not become evident until our investigation is done or excavation is performed. If during construction, soil, bedrock, fill, or ground water conditions appear to be different from those described, this office should be advised so that re-evaluation of our recommendations may be made. Onsite observation of foundation bearing materials and testing of fill placement by a representative of this office is recommended.

If you have any questions, or if we can be of further service, please feel free to give me a call.

Sincerely,

GEOCAL, INC.

Ronald J. Vasquez, P.E.
Principal Engineer

RJV/G10.1354.002

Appendix F

Estimated Construction Costs

Option 1 - Prestressed Concrete Box Girder Two Span (109'-48')

Bridge Length: 157 ft
 Bridge Width: Varies ft
 Bridge Deck Area: 23564 ft



CONTRACT ITEM NO.	CONTRACT ITEM	UNIT	BRIDGE TOTALS	2007 AVE UNIT COST	2008 AVE UNIT COST	2010 AVE UNIT COST	2011 AVE UNIT COST	ENGINEER'S UNIT COST	ENGINEER'S TOTAL COST
202-00400	Removal of Bridge	EACH	1	\$ 104,005.30	\$ 75,509.02	\$ 57,452.50	\$ 181,565.99	\$ 250,000.00	\$ 250,000
206-00000	Structure Excavation	CY	1,648	\$ 17.33	\$ 7.96	\$ 7.79	\$ 7.00	\$ 7.00	\$ 11,536
206-00100	Structure Backfill (Class 1)	CY	1,420	\$ 35.66	\$ 28.20	\$ 16.68	\$ 13.08	\$ 15.00	\$ 21,300
206-00360	Mechanical Reinforcement of Soil	CY	1,014	\$ 17.58	\$ 25.20	\$ 17.57	\$ 19.64	\$ 20.00	\$ 20,280
403-09210	Stone Matrix Asphalt	TON	528	\$ 71.70	\$ 71.32	\$ 81.73	#N/A	\$ 80.00	\$ 42,240
502-11274	Steel Piling (HP 12x74)	LF	1,947	\$ 51.99	\$ 77.73	\$ 48.44	#N/A	\$ 65.00	\$ 126,555
503-00048	Drilled Caisson (48 Inch)	LF	322	\$ 492.27	\$ 295.24	\$ 295.27	\$ 211.01	\$ 215.00	\$ 69,230
504-06100	Ground Nailed Wall	SF	5,750	\$ 85.00	#N/A	\$ 17.95	#N/A	\$ 40.00	\$ 230,000
513-00600	Bridge Drain	EACH	2	\$ 3,714.29	\$ 10,893.33	\$ 3,000.00	\$ 10,500.00	\$ 2,500.00	\$ 5,000
515-00120	Waterproofing (Membrane)	SY	3,260	\$ 10.20	\$ 15.41	\$ 13.71	\$ 12.84	\$ 13.00	\$ 42,380
518-01004	Bridge Expansion Device (0-4 Inch)	LF	314	\$ 186.87	\$ 267.88	\$ 154.74	\$ 210.33	\$ 250.00	\$ 78,500
601-03040	Concrete Class D (Bridge)	CY	1,446	\$ 473.70	\$ 432.91	\$ 396.97	\$ 366.72	\$ 375.00	\$ 542,250
602-00020	Reinforcing Steel (Epoxy Coated)	LB	302,550	\$ 1.02	\$ 0.99	\$ 0.79	\$ 0.75	\$ 1.00	\$ 302,550
606-00720	Guardrail Type 7 (Style CC)	LF	200	\$ 66.00	\$ 47.84	\$ 32.49	#N/A	\$ 70.00	\$ 14,000
606-10700	Bridge Rail Type 7	LF	399	\$ 83.69	\$ 95.69	\$ 74.52	\$ 68.15	\$ 70.00	\$ 27,930
607-53173	Fence Chain Link (Special) (72 Inch)	LF	238	#N/A	\$ 12.20	#N/A	#N/A	\$ 90.00	\$ 21,420
618-01994	Prestressed Concrete Box (Depth 32" Through 48")	SF	21,971	\$ 49.89	\$ 62.72	\$ 51.29	#N/A	\$ 60.00	\$ 1,318,260
Subtotal:								\$	3,123,431
626-00000	Mobilization (10%)	LS	1					\$ 312,343	\$ 312,343
Contingency (20%)								\$	624,686
Total Cost:								\$	4,060,460
Cost per SF:									\$172

Option 2 - Composite Steel W36 Girders Two Span (109'-48')

Bridge Length: 157 ft
 Bridge Width: Varies ft
 Bridge Deck Area: 23564 ft



CONTRACT ITEM NO.	CONTRACT ITEM	UNIT	TOTAL	2007 AVE UNIT COST	2008 AVE UNIT COST	2010 AVE UNIT COST	2011 AVE UNIT COST	ENGINEER'S UNIT COST	ENGINEER'S TOTAL COST
202-00400	Removal of Bridge	EACH	1	\$ 104,005.30	\$ 75,509.02	\$ 57,452.50	\$ 181,565.99	\$ 250,000.00	\$ 250,000
206-00000	Structure Excavation	CY	1,648	\$ 17.33	\$ 7.96	\$ 7.79	\$ 7.00	\$ 7.00	\$ 11,536
206-00100	Structure Backfill (Class 1)	CY	1,420	\$ 35.66	\$ 28.20	\$ 16.68	\$ 13.08	\$ 15.00	\$ 21,300
206-00360	Mechanical Reinforcement of Soil	CY	1,014	\$ 17.58	\$ 25.20	\$ 17.57	\$ 19.64	\$ 20.00	\$ 20,280
403-09210	Stone Matrix Asphalt	TON	528	\$ 71.70	\$ 71.32	\$ 81.73	#N/A	\$ 80.00	\$ 42,240
502-11274	Steel Piling (HP 12x74)	LF	1,593	\$ 51.99	\$ 77.73	\$ 48.44	#N/A	\$ 65.00	\$ 103,545
503-00048	Drilled Caisson (48 Inch)	LF	322	\$ 492.27	\$ 295.24	\$ 295.27	\$ 211.01	\$ 215.00	\$ 69,230
504-06100	Ground Nailed Wall	SF	5,750	\$ 85.00	#N/A	\$ 17.95	#N/A	\$ 40.00	\$ 230,000
509-00000	Structural Steel	LB	839,296	\$ 1.49	\$ 1.65	\$ 2.27	\$ 1.55	\$ 1.75	\$ 1,468,768
509-90003	Paint Structural Steel	L S	1	\$ 8,150.00	#N/A	\$ 36,926.73	#N/A	\$ 25,000.00	\$ 25,000
513-00600	Bridge Drain	EACH	2	\$ 3,714.29	\$ 10,893.33	\$ 3,000.00	\$ 10,500.00	\$ 2,500.00	\$ 5,000
515-00120	Waterproofing (Membrane)	SY	3,260	\$ 10.20	\$ 15.41	\$ 13.71	\$ 12.84	\$ 13.00	\$ 42,380
518-01004	Bridge Expansion Device (0-4 Inch)	LF	314	\$ 186.87	\$ 267.88	\$ 154.74	\$ 210.33	\$ 250.00	\$ 78,500
601-03040	Concrete Class D (Bridge)	CY	1,591	\$ 473.70	\$ 432.91	\$ 396.97	\$ 366.72	\$ 375.00	\$ 596,625
602-00020	Reinforcing Steel (Epoxy Coated)	LB	328,789	\$ 1.02	\$ 0.99	\$ 0.79	\$ 0.75	\$ 1.00	\$ 328,789
606-00720	Guardrail Type 7 (Style CC)	LF	200	\$ 66.00	\$ 47.84	\$ 32.49	#N/A	\$ 70.00	\$ 14,000
606-10700	Bridge Rail Type 7	LF	399	\$ 83.69	\$ 95.69	\$ 74.52	\$ 68.15	\$ 70.00	\$ 27,930
607-53173	Fence Chain Link (Special) (72 Inch)	LF	238	#N/A	\$ 12.20	#N/A	#N/A	\$ 90.00	\$ 21,420
Subtotal:									\$ 3,356,543
626-00000	Mobilization (10%)	LS	1					\$ 335,654	\$ 335,654
Contingency (20%)									\$ 671,309
Total Cost:									\$ 4,363,506
Cost per SF:									\$185