



**June 25, 2015**

Scott Benjamin, P.E.  
Walsh/Granite JV  
4 Penn Center Blvd., Suite 100  
Pittsburgh, PA 15276

**Re: S.R. 2001, Section A16  
JV421 Bridge Replacement  
S.R. 2001 (Monongahela Road) over Bunola Run  
Forward Township, Allegheny County  
Streamlined Type, Size and Location Submission**

Gentlemen:

HDR Engineering, Inc. is pleased to submit 1 copy of the Streamlined Type, Size and Location (TS&L) Submission for the proposed S.R. 2001 (Monongahela Road) over Bunola Run structure. The Streamlined TS&L Submission is in accordance with RBRP Modified Design Manual, Part 4, PP1.9.3.3. Type, Size and Location approval is requested for this structure. Enclosed for your review and approval are the following items:

- Type, Size and Location Drawings (2 sheets)
- Design Calculations

The following information for the proposed structure TS&L is provided in accordance with RBRP Modified Design Manual, Part 4, Section PP 1.9.3.3:

**1) Location:**

S.R. 2001, Section A16  
Segment 0080 Offset 0335  
Station 16+22.00  
S.R. 2001 (Bunola River or Monongahela Road) over Bunola Run  
Forward Township, Allegheny County

**2) Recommended Structure:**

Single cell precast concrete box culvert with a 10'-0" x 4'-6" opening and post-tensioned longitudinally.  
Independent wingwalls at the upstream end and independent wingwalls at the downstream end.  
Culvert is at-grade with a variable depth bituminous overlay.

- 3) **Span Lengths:**  
One (1), 10'-0" clear span (14'-1 3/4" along centerline or roadway)
- 4) **Roadway Width:**  
Out-to-out: 56'-2 1/2", includes two 1'-6" wide concrete curbs.  
Curb-to-curb 28'-0", includes two 10'-0" lanes and two 4'-0" shoulders.
- 5) **Skew Angles:**  
45° 00' 00" (Left Ahead)
- 6) **Vertical and Horizontal Clearance:**
  - Minimum Required Effective Opening Height: 3'-0" (BD-632M)
  - Existing Opening Height: Not Available
  - Provided Effective Opening Height Under Bridge: 3'-3 3/8"
- 7) **Type of Substructure Recommended:** N/A
- 8) **Deck Joints:** None
- 9) **Bearing Type and Location:** N/A
- 10) **Deck and Off Structure Drainage:**
  - On Structure: None
  - Off Structure: None
- 11) **Design Methodology for Superstructure:**  
Load and Resistance Factor Design in accordance with AASHTO LRFD Bridge Design Specifications, 5th Edition, 2010, as Supplemented by RBRP Modified Design Manual Part 4. Live load distribution is based on AASHTO live load distribution methods as modified by RBRP Modified Design Manual Part 4.

Additional information from QA Form D-512:

**1. Project Information**

S-Number: Pending  
Design ADT: 932  
Design ADTT: 65  
Design Year: 2037

**2. Culvert Type and Geometry**

Fill Height: 0.42' Min – 1.02' Max  
Length: 56'-2 1/2" (along centerline of culvert)  
Fish Passage: Yes

**3. General**

Backfill Unit Density: 120 pcf  
Railroad Live Load: No  
pH Foundation Material: N/A  
pH Water: 6.2  
Method of Corrosion Protection: Epoxy Coated Rebar and Type II Cement  
Anticipated Removal of Unsuitable Material: No  
Anticipated Settlement: <1.0"  
Inlet End Wall Provided: Soldier pile walls.  
Inlet Scour Protection Provided: R-6 min. Grouted Rock Protection 5'-0"  
Outlet End Wall Provided: Soldier pile walls.  
Outlet Scour Protection Provided: R-6 min. Grouted Rock Protection 5'-0"

**4. Design Requirements**

Design Life: Greater than 100 years  
Box Culvert Type: Precast  
Why C.I.P: N/A  
Computer Program Used: BXLRFD 2.6.0.0  
Method of Abrasion Protection: None

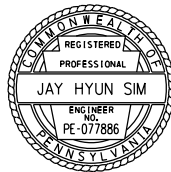
If you have any questions regarding this submission, please contact me, at (484) 612-1129. Thank you.

Sincerely yours,

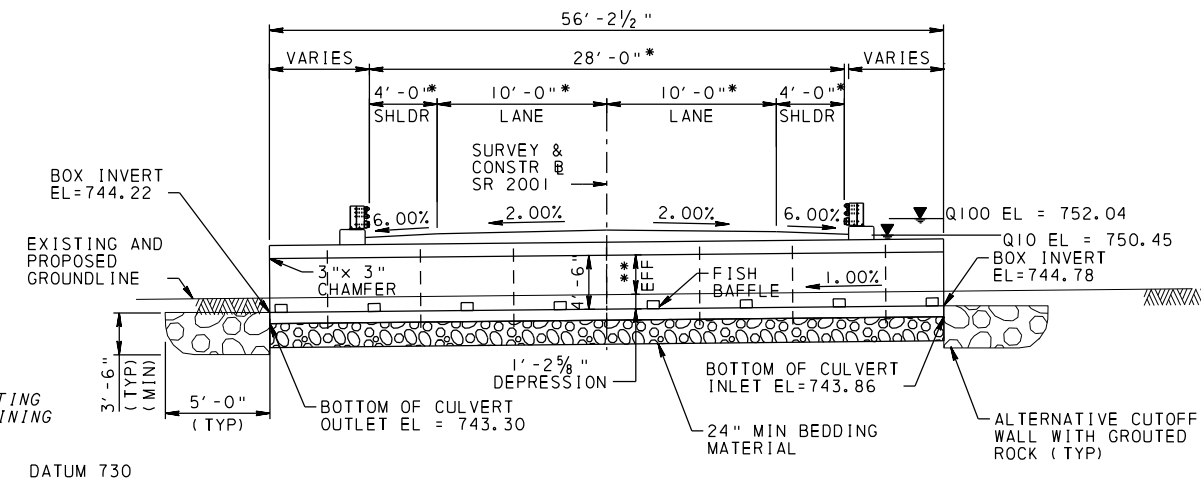
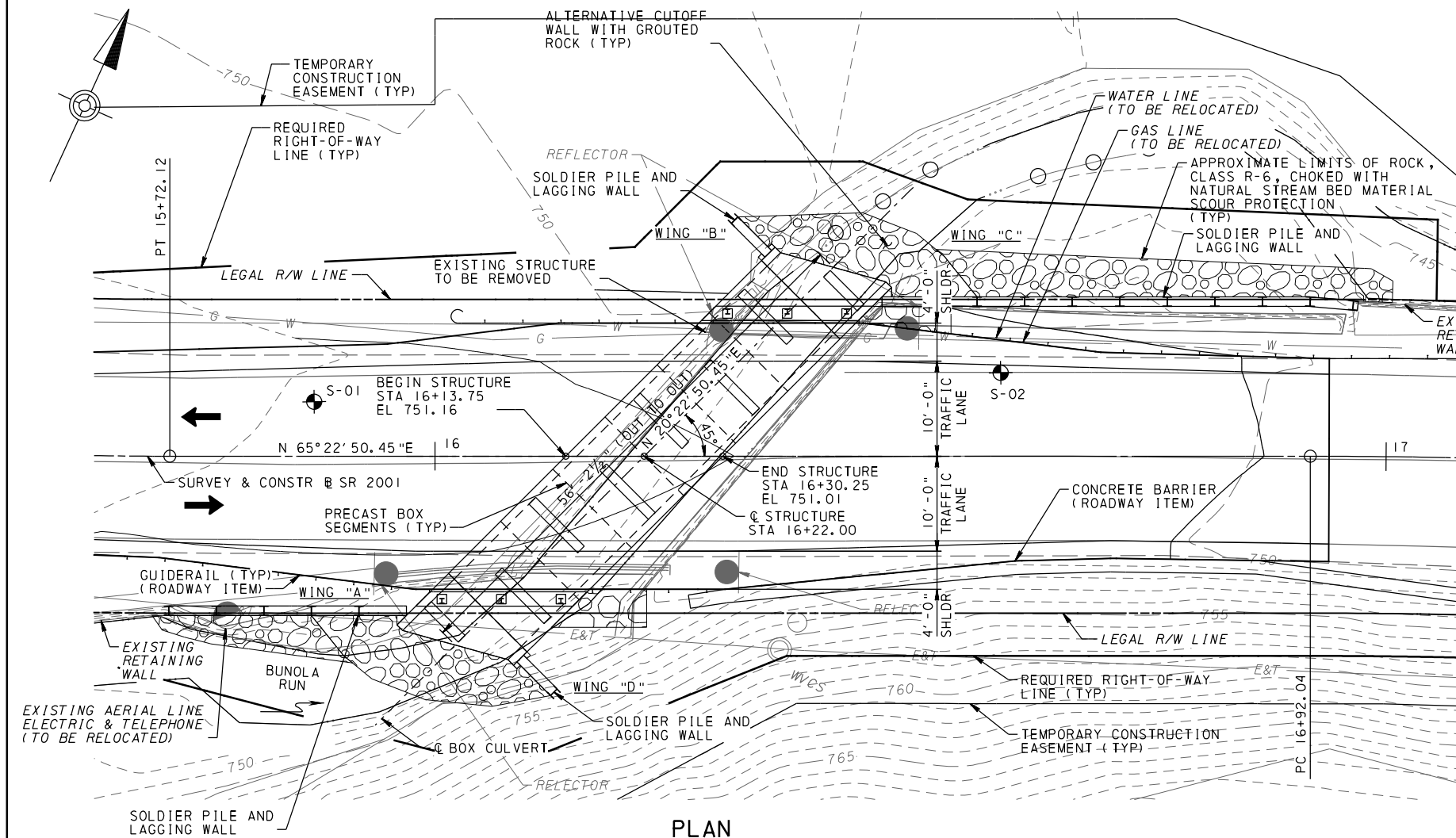
**HDR ENGINEERING, INC.**



Jay H Sim, P.E.  
Structures Engineer



Enclosures



SECTION ALONG C OF CULVERT

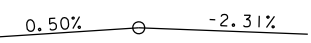
\* MEASURED NORMAL TO SURVEY & CONSTR SR 2001  
 \*\* VERTICAL CLEARANCE PROVIDED = 3'-3 3/8"  
 MIN VERTICAL CLEARANCE REQUIRED = 3'-0"

**HORIZONTAL CURVE DATA**

SURVEY & CONSTR SR 2001  
 PI STA 18+20.54  
 Δ = 20°15'44" RT.  
 T = 128.50'  
 L = 254.32'  
 R = 719.15'  
 E = 11.39'  
 PC STA 16+92.04  
 PT STA 19+46.35  
 SUPERELEVATE N/A  
 DESIGN SPEED 35 MPH

**VERTICAL CURVE DATA**

PVI STA 16+23.00  
 EL = 751.43'  
 Vc = 98.00'  
 MO = -0.34%  
 SSD = 434.11  
 DESIGN SPEED = 35 MPH



**HYDRAULIC DATA  
 BUNOLA RUN**

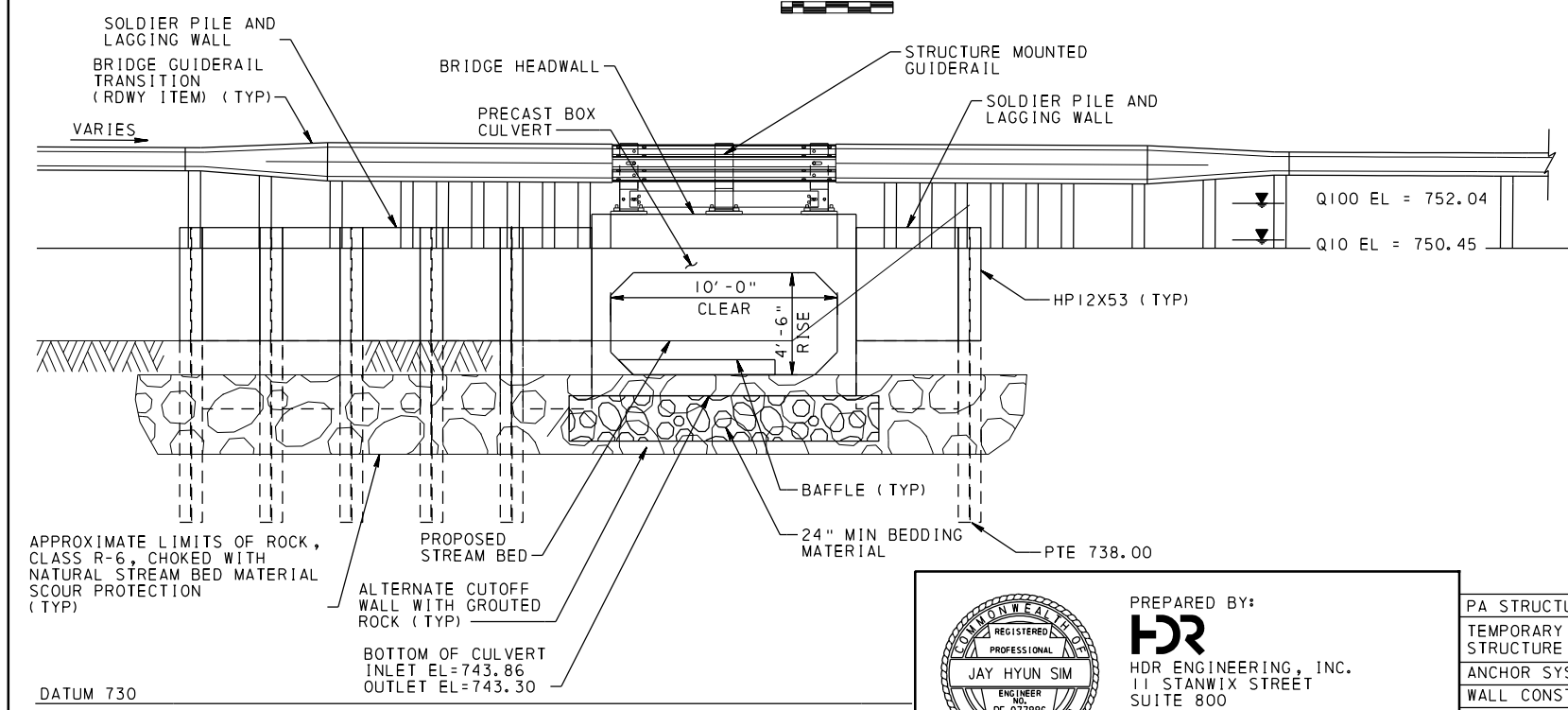
RETURN PERIOD - 10 YR FLOOD  
 WATER SURFACE EL = 750.45  
 Q = 154 CFS  
 V = 3.9 FPS

RETURN PERIOD - 100 YR FLOOD  
 WATER SURFACE EL = 752.04  
 Q = 350 CFS  
 V = 2.4 FPS

DRAINAGE AREA 0.86 SQ. MILES  
 WATERWAY OPENING 33.3 SQ. FEET

FLOOD OF RECORD - UNKNOWN  
 WATER SURFACE ELEVATION (FLOOD) - UNKNOWN

BORING TABLE		
BORING	STATION	OFFSET
S-01	15+87.29	5.73' LT
S-02	16+59.47	8.77' LT



**LEGEND:**

- SOIL BORING
- INDICATES TRAFFIC DIRECTION
- EXISTING CONTOURS
- PROPOSED CONTOURS

JV 421 | BRIDGE KEY 1479 | BMS 02200100800335 | MPMS 28607

**COMMONWEALTH OF PENNSYLVANIA**  
 DEPARTMENT OF TRANSPORTATION

**ALLEGHENY COUNTY**  
 S.R. 2001 SECTION A16  
 SEG. 0080 OFF. 0335  
 S.R. 2001 STA. 16+22.00  
 OVER BUNOLA RUN

**10'-0" x 4'-6" PRECAST CONCRETE BOX CULVERT  
 TYPE, SIZE AND LOCATION**

RECOMMENDED \_\_\_\_\_

SHEET 1 OF 2

S-XXXX

PREPARED BY:  
**HDR**  
 HDR ENGINEERING, INC.  
 11 STANWIX STREET  
 SUITE 800  
 PITTSBURGH, PA 15222

**JAY HYUN SIM**  
 ENGINEER  
 PE-077886

SIGNATURE & DATE \_\_\_\_\_ **07/23/2015**

DESCRIPTION	DWG. NO.	APP. DATE
PA STRUCTURE MOUNTED GUIDE RAIL BARRIER	BC-706M	11-26-13
TEMPORARY CONCRETE BARRIER, STRUCTURE MOUNTED	BC-719M	10-26-10
ANCHOR SYSTEMS	BC-734M	10-26-10
WALL CONSTR & EXP JOINT DETAILS	BC-735M	10-26-10
REINFORCEMENT BAR FABRICATION DETAILS	BC-736M	5-18-12
BRIDGE DRAINAGE	BC-751M	11-26-13
TYPICAL WATERPROOFING AND EXPANSION DETAILS	BC-788M	5-18-12
MECHANICAL CONNECTION DETAILS	BC-798M	11-26-13

SUPPLEMENTAL DRAWINGS

USER: jsm | PLOT: DRIVER: P:\proj\DOT\_PDF\_Memo.plt | PLOT DATE: 07-15-2015 11:08:10 AM  
 PATH: O:\0000\CON094634\00000000245776\6\_0\_CAD\_BLM\6\_2\_Wrk\in\_Progress\6\_2\_2\_Constr\01-F\files\1\_2\_2\_1\_Sheet\_1-Files\Brdge MODEL: BRG GPE Sheet 1  
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**GENERAL NOTES**

PROVIDE MATERIALS AND PERFORM WORK IN ACCORDANCE WITH SPECIFICATIONS, RBRP MODIFIED PUB NO 408, AND THE CONTRACT SPECIAL PROVISIONS.

**DESIGN SPECIFICATIONS:**

AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS 2010, AND AS SUPPLEMENTED BY RBRP MODIFIED DM4.

LIVE LOAD DISTRIBUTION TO THE CULVERT IS BASED UPON RBRP MODIFIED DM-4 DISTRIBUTION FACTOR METHOD.

DESIGN IN ACCORDANCE WITH THE LRFD METHOD.

DEAD LOAD INCLUDES AN ADDITIONAL 30 LB/SF FOR FUTURE WEARING SURFACE.

**DESIGN LIVE LOADS:**

PHL-93 OR P-82 (204 KIP PERMIT LOAD)

USE A CONCRETE STRENGTH ( $f'c$ ) OF 5000 PSI MINIMUM AT 28 DAYS FOR PRECAST BOX AND PRECAST WING SECTIONS. REINFORCEMENT BAR  $F_y$  = 60000 PSI

USE CLASS A CEMENT CONCRETE FOR BAFFLES.

USE CLASS AA CEMENT CONCRETE FOR CAST-IN-PLACE CURB/HEADWALL.

USE TYPE II SULFATE RESISTANT CEMENT AND WATER/CEMENT RATIO OF 0.45 FOR ALL PRECAST AND CAST-IN-PLACE ELEMENTS.

COORDINATE, LOCATE AND CONDUCT ALL WORK RELATED TO PUBLIC AND PRIVATE UTILITIES IN ACCORDANCE WITH RBRP MODIFIED PUB NO 408, SECTIONS 105.06 AND 107.12.

FOR CAST-IN-PLACE CONCRETE, PROVIDE GRADE 60 REINFORCING STEEL THAT MEETS THE REQUIREMENTS OF ASTM A 615/A 615M, A 996/A 996M OR A 706/A 706M. DO NOT WELD GRADE 60 REINFORCING STEEL BARS UNLESS SPECIFIED. DO NOT USE RAIL STEEL A 996/A 996M REINFORCEMENT BARS IN CURBS, BAFFLES OR CUT-OFF WALLS, OR WHERE BENDING OR WELDING OF THE REINFORCEMENT BARS IS INDICATED.

DO NOT EXCEED A 2 FT. DIFFERENCE IN FILL ELEVATION ON THE SIDES OF THE BOX CULVERT DURING PLACEMENT OF A BACKFILL. DO NOT ALLOW THE WHEELS OF ROLLERS TO COME CLOSER THAN 1 FT. TO THE FACES OF THE STRUCTURE DURING COMPACTION OF THE BACKFILL.

PROVIDE MINIMUM LAP AND EMBEDMENT LENGTH OF REINFORCEMENT IN ACCORDANCE WITH STANDARD DRAWING BC-736M, UNLESS NOTED OTHERWISE.

PROVIDE 2" CONCRETE COVER ON REINFORCEMENT BARS EXCEPT AS NOTED.

CHAMFER EXPOSED CONCRETE EDGES 1"X1" EXCEPT AS NOTED.

USE OF CONCRETE ADDITIVES CONTAINING CHLORIDES IS PROHIBITED.

USE EPOXY-COATED REINFORCEMENT BARS IN ALL CAST-IN-PLACE CONCRETE AND PRECAST CONCRETE.

REFER TO THE WATERWAY PERMIT FOR TIME PERIODS IN WHICH WORK IS PROHIBITED.

VERIFY THAT THE EXISTING STRUCTURAL MEMBERS DO NOT CONTAIN LEAD OR OTHER TOXIC MATERIAL.

NOTIFY THE REGIONAL HEADQUARTERS OF THE PA FISH AND BOAT COMMISSION PRIOR TO CONSTRUCTION AND COOPERATE WITH THE FISH COMMISSION DURING CONSTRUCTION.

**FOUNDATION NOTES**

PRIOR TO FOUNDATION CONSTRUCTION, THE DEVELOPMENT ENTITY'S ENGINEER OF RECORD WILL EVALUATE THE BEARING MATERIAL. REPLACE ALL SOFT, WEATHERED OR OTHERWISE INCOMPETENT SOIL WITH NO. 8 COARSE AGGREGATE, 12" MINIMUM THICKNESS. REPLACE ALL SOFT OR OTHERWISE INCOMPETENT BEDROCK WITH CLASS C CEMENT CONCRETE.

THE DEVELOPMENT ENTITY'S ENGINEER OF RECORD MAY CHANGE THE FOOTING ELEVATION OR ANY DIMENSIONS NECESSARY TO PROVIDE A PROPER FOUNDATION.

DEWATER EXCAVATIONS EXTENDING BELOW GROUNDWATER LEVEL.

REMOVE THE EXISTING FOUNDATION ELEMENTS IN THEIR ENTIRETY IN THE LOCATIONS WHERE THE EXISTING FOUNDATION ELEMENTS INTERFERE WITH THE PROPOSED STRUCTURE AND TO A MINIMUM OF TWO (2) FEET BELOW BEDDING.

DESIGN TEMPORARY EXCAVATIONS IN ACCORDANCE WITH THE SOIL AND ROCK PARAMETERS PROVIDED IN THE STRUCTURE FOUNDATION REPORT, INCLUDING ISSUED ADDENDUMS TO THE REPORT, AND IN ACCORDANCE WITH CURRENT OSHA REQUIREMENTS (29 CFR PART 1926.650.652, SUBPART P). IF THE CONTRACTOR ELECTS TO NOT USE THE SOIL AND ROCK PARAMETERS PROVIDED IN THE STRUCTURE FOUNDATION REPORT FOR DESIGN OF THE TEMPORARY EXCAVATION SUPPORT SYSTEM, ASSUME TYPE C SOILS (UNLESS SOIL TYPE IS CONFIRMED BY DEVELOPMENT ENTITY'S ENGINEER OF RECORD).

SOLDIER PILE EXCAVATIONS WILL EXTEND INTO MATERIAL THAT DETERIORATES WHEN EXPOSED TO THE ELEMENTS. INSTALL PILE AND PLACE CONCRETE IMMEDIATELY AFTER EACH EXCAVATION IS COMPLETED.

**LOAD RATING SUMMARY (ADTT = 64)**

		PRECAST BOX CULVERT (W/FWS)					
		H 20	HS 20	ML-80	TK527	PHL-93	P-82
INVENTORY RATING (IR)	DISTRIBUTION FACTOR	TOP SLAB	TOP SLAB	BOT. SLAB	TOP SLAB	TOP SLAB	- - -
	LOCATION	0.82L	0.82L	0.83L	0.82L	0.18L	- - -
	LIMIT STATE	STR-I	STR-I	STR-I	STR-I	STR-I	- - -
	RATING FACTOR	1.53 (V)	1.53 (V)	1.32 (V)	1.56 (V)	1.04 (V)	- - -
	ULTIMATE CAPACITY	16.25 K	16.25 K	-12.43 K	16.25 K	-16.25 K	- - -
OPERATING RATING (OR)	DISTRIBUTION FACTOR	TOP SLAB	TOP SLAB	BOT. SLAB	TOP SLAB	TOP SLAB	BOT. SLAB
	LOCATION	0.82L	0.82L	0.83L	0.82L	0.18L	0.83L
	LIMIT STATE	STR-II	STR-II	STR-II	STR-II	STR-IA	STR-II
	RATING FACTOR	1.98 (V)	1.98 (V)	1.71 (V)	2.03 (V)	1.65 (V)	1.46 (V)
	ULTIMATE CAPACITY	16.25 K	16.25 K	-12.43 K	16.25 K	-16.25 K	-12.43 K

**RATING NOTES:**

- RATINGS IN THIS TABLE ARE BASED ON LOAD AND RESISTANCE FACTOR DESIGN (LRFD).
- THE ULTIMATE CAPACITY RELATES TO THE GOVERNING RATING. SHEAR RATINGS PROVIDE CAPACITY IN KIPS. MOMENT RATINGS PROVIDE CAPACITY IN KIP-FEET.
- V INDICATES RATING CONTROLLED BY SHEAR. M INDICATES RATING CONTROLLED BY MOMENT.

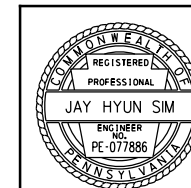
Mark	Description	By	Chk'd.	Recm'd.	Date
REVISIONS					

JV 421 | BRIDGE KEY 1479 | BMS 02200100800335 | MPMS 28607

**COMMONWEALTH OF PENNSYLVANIA**  
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ALLEGHENY COUNTY  
S.R. 2001 SECTION A16  
SEG. 0080 OFF. 0335  
S.R. 2001 STA. 16+22.00  
OVER BUNOLA RUN

10'-0" x 4'-6" PRECAST CONCRETE BOX CULVERT  
**GENERAL NOTES**



RECOMMENDED \_\_\_\_\_

SHEET 2 OF 2

S-XXXXX

USER: jsm | PATH: \\000001\COMMON\00000000024576\6.0.CAD.BIM\6.2.2.Contract.Files\6.2.2.LSheet.Files\Bridg | PLOT DATE: 07-10-2015 2:12:11 PM | MODEL: BRG\_DET\_Sheet1

# FINAL PRECAST BOX CULVERT DESIGN

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## CALCULATIONS & ANALYSIS RATINGS

CLEAR SPAN x CLEAR HEIGHT x FILL

10.000' x 4.500' x 1.000'

Designer: JS  
Date: 6/8/2015

Checker: SMK  
Date: 6/8/2015

## TABLE OF CONTENTS

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BXLRFD DATA SUMMARY .....	2
BXLRFD INPUT SUMMARY .....	3
BXLRFD BARRIER DEAD LOAD .....	6
STEEL REINFORCEMENT .....	7
LAP LENGTH CALCULATIONS .....	10
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BXLRFD OUTPUT FILE .....	16

# HDR Computation

Project: PENNDOT P3	Computed: JDD	Date: 6/8/2015
Subject: PRECAST BOX CULVERT DESIGN	Checked: JS	Date: 6/8/2015
Task: PRECAST CULVERT DESIGN ASSUMPTIONS	Sheet: 1	Of: 16

## **ASSUMPTIONS**

- Single cell precast box culvert.
- See Sheet 2/16 for details of precast culvert and roadway geometry.
- No shear reinforcement.
- Vertical wall barrier is used for all analyses.
- 12" x 12" Haunches.
- Material properties per BD-632M (Sheet 4 of 13) and per these calculations (Sheet 2 of 16).
- Concrete clear cover per BD-632M, Sheet 4 of 13:
  - Top bars in top slab: 2.5" clear cover (all cases considered).
  - Top bars in bottom slab: 2.0" clear cover.
  - All other bars: 1.5" clear cover.
- Additional 30 PSF included for future wearing surface per PennDOT DM-4, Section 12.11.2.1 and BD-632M, Sheet 4 of 13, Note #6.
- Refer to "BXLRFD Input" summary for additional assumptions.



# HDR Computation

Project: PENNDOT P3  
 Subject: PRECAST BOX CULVERT DESIGN  
 Task: BXLRFD DATA SUMMARY

Computed: JS  
 Checked: SMK  
 Sheet: 2

Date: 6/8/2015  
 Date: 6/8/2015  
 Of: 16

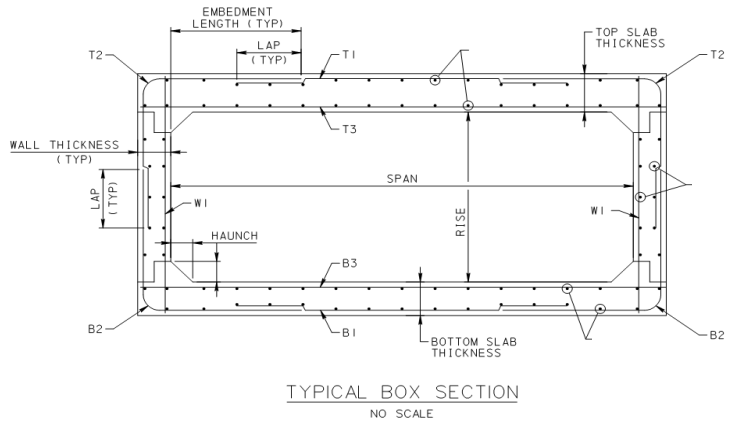
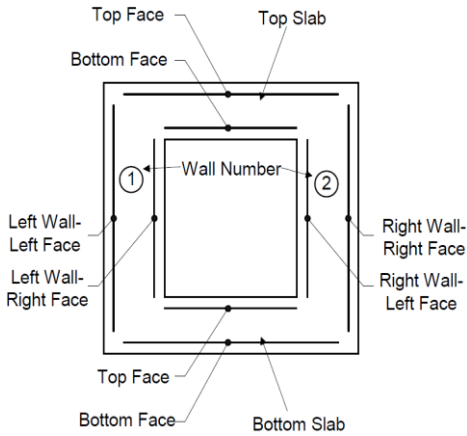
## 10' x 4.5' Opening

ROADWAY DATA	
STRUCTURE OUT-TO-OUT DISTANCE =	56.208 FT
CURB-TO-CURB DISTANCE =	28.000 FT
PA TYPE 10M BARRIER WIDTH =	18.0 IN
NUMBER OF SEGMENTS =	8.0
CONTINUITY SLAB THICKNESS =	5.00 IN
UPSTREAM INVERT EL =	--
DOWNSTREAM INVERT EL =	--
SLOPE OF CULVERT FLOOR =	-- FT/FT
MINIMUM PAVEMENT EL =	--
MIN PAVE EL HORIZ OFFSET FROM U.S. INVERT =	-- FT
MAXIMUM PAVEMENT EL =	--
MAX PAVE EL HORIZ OFFSET FROM U.S. INVERT =	-- FT
MAXIMUM PAVEMENT EL AT CURB =	--
MINIMUM PAVEMENT THICKNESS =	7.00 IN
MAXIMUM PAVEMENT THICKNESS =	7.00 IN
TOTAL THEORETICAL FILL =	12.00 IN

Total depth of asphalt above the top of the continuity slab.  
 Max. pavement thickness = Min. pavement thickness = Constant pavement thickness  
 Theoretical total fill (continuity slab thickness + pavement thickness)

STRUCTURE DATA																
f <sub>c</sub> (ksi)	Clear Span (ft)	Clear Height (ft)	Segment Width (ft)	Top Slab			Bottom Slab			Wall Thickness (in)	Walls				Haunches	
				Top Slab Thick (in.)	-	Bot. Steel Area (T3) (in <sup>2</sup> /ft)	Bot. Slab Thick (in.)	Top Steel Area (B3) (in <sup>2</sup> /ft)	-		Wall 1 Left Face Steel Area (in <sup>2</sup> /ft)	Wall 1 Right Face Steel Area (in <sup>2</sup> /ft)	Wall 2 Left Face Steel Area (in <sup>2</sup> /ft)	Wall 2 Right Face Steel Area (in <sup>2</sup> /ft)	Horizontal Dimension (in)	Vertical Dimension (in)
5.0	10.00	4.50	7.026	13.00	-	0.812 #6 @ 6.5"	11.00	0.812 #6 @ 6.5"	-	10.00	0.572 #5 @ 6.5"	0.369 #4 @ 6.5"	0.369 #4 @ 6.5"	0.572 #5 @ 6.5"	12.00	12.00
				Top Steel Area			Bottom Steel Area									
				Left	T2 Reinf 1 = 0.572 in <sup>2</sup> /ft T2 Reinf 1 = #5 @ 6.5" T2 Range 1 = 3.00 ft		B2 Reinf 1 = 0.572 in <sup>2</sup> /ft B2 Reinf 1 = #5 @ 6.5" B2 Rang 1 = 3.00 ft									
				Middle	T1 Reinf 2 = 0.369 in <sup>2</sup> /ft T1 Reinf 2 = #4 @ 6.5" T1 Range 2 = 7.00 ft		B1 Reinf 2 = 0.369 in <sup>2</sup> /ft B1 Reinf 2 = #4 @ 6.5" B1 Rang 2 = 7.00 ft									
				Right	T2 Reinf 3 = 0.572 in <sup>2</sup> /ft T2 Reinf 3 = #5 @ 6.5" T2 Range 3 = 10.00 ft		B2 Reinf 3 = 0.572 in <sup>2</sup> /ft B2 Reinf 3 = #5 @ 6.5" B2 Rang 3 = 10.00 ft									

Note: Transverse reinforcement for slabs and walls are defined in the "Rebar Checks" sheet.



# HDR Computation

Project:	PENNDOT P3
Subject:	PRECAST BOX CULVERT DESIGN
Task:	BXLRFD INPUT SUMMARY

Computed:	JDD
Checked:	JS
Sheet:	3

Date:	6/8/2015
Date:	6/8/2015
Of:	16

FILE: C-STR_P3-10.000x4.500x1.000.dat				
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS
<b>TTL</b>	Line 1 Line 2 Line 3	See right See right See right		<b>JV 421 - Precast Concrete Box Culvert</b> <b>Culvert Size: 10.000' x 4.500' x 1.000' (Clear Span x Clear Height x Fill)</b> <b>Computed: JS (Date: 06/08/2015); Checked: SMK (Date:06/08/2015)</b>
<b>CTL</b>	System of Units Structure Type Type of Run Precast or Cast-in-place Bottom Slab Top Slab Support Frame Support	<b>1</b> <b>AR</b> <b>P</b> <b>Y</b>		Default: US Customary Units Box culvert has 1 cell Analyze, spec.check, and rate members. Geometry and reinforcement are known. Precast structure Bottom slab is present Leave blank for precast culverts. Leave Blank for culverts with bottom slabs.
<b>MAT</b>	f'c for All Members f'c for Top Slab Reinforcement Grade Reinforcement Type Alpha Rebar Size or Wire Diam. Epoxy Coated Bars Concrete Unit Weight for DL  Concrete Unit Weight for E	  <b>B</b>     150.0  145.0	ksi ksi ksi degrees # lb/ft <sup>3</sup> lb/ft <sup>3</sup>	Default = 5.0 ksi (in accordance with BD-632M, Sheet 4 of 13). Leave blank for precast culverts. Default = 60 ksi (in accordance with BD-632M, Sht. 4 of 13). Reinforcement bars used. Leave blank for designs that exclude shear reinf. (per D-10 preferences) Leave blank for analysis runs. N/A (Not used for precast culverts). See AASHTO LRFD Table 3.5.1-1 & C3.5.1. • For f'c ≤ 5.0 ksi, Unit Weight = 0.145 + 0.005 k/ft <sup>3</sup> = 0.150 k/ft <sup>3</sup> = 150 lb/ft <sup>3</sup> • For 5.0 < f'c ≤ 15.0 ksi, Unit Weight = 0.140 + (0.001)(f'c) + 0.005 k/ft <sup>3</sup> = 145 + (1.0)(f'c) lb/ft <sup>3</sup> . See AASHTO LRFD Table 3.5.1-1. • For f'c ≤ 5.0 ksi, Unit Weight = 0.145 k/ft <sup>3</sup> = 145 lb/ft <sup>3</sup> • For 5.0 < f'c ≤ 15.0 ksi, Unit Weight = 0.140 + (0.001)(f'c) k/ft <sup>3</sup> = 140 + (1.0)(f'c) lb/ft <sup>3</sup> .
<b>DIM</b>	Clear Span Clear Height Top Slab Thickness  Bottom Slab Thickness  Left Wall Thickness  Right Wall Thickness  Interior Wall Thickness Fill Grade Top Slab Grade U-channel Left Wall Height U-channel Right Wall Height	10.00 4.50 13.00  11.00  10.00  10.00   %	ft ft in.  in.  in.  in.  in.  in. %	Based on hydraulic requirements. Based on hydraulic requirements. As required by design. Minimum thickness for precast culverts (S ≥ 8 ft): • Min. = 10 in for 8' <= S <= 12' (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 10 in for 8' <= S <= 12' (per BD-632M, Sheet 4 of 13). • Controlling Min. = 10 in As required by design. Minimum thickness for precast culverts (S ≥ 8 ft): • Min. = 10.5 in for 8' <= S <= 12' (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 10 in for 8' <= S <= 12' (per BD-632M, Sheet 4 of 13). • Controlling Min. = 10.5 in As required by design. Minimum thickness for precast culverts (S ≥ 8 ft): • Min. = 10 in for 8' <= S <= 12' (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 10 in for 8' <= S <= 12' (per BD-632M, Sheet 4 of 13). • Controlling Min. = 10 in As required by design. Minimum thickness for precast culverts (S ≥ 8 ft): • Min. = 10 in for 8' <= S <= 12' (per BXLRFD Users's Manual, Table 5.8-1). • Min. = 10 in for 8' <= S <= 12' (per BD-632M, Sheet 4 of 13). • Controlling Min. = 10 in Leave blank for a one cell culvert. Leave blank for a culverts at grade. Default = 0.0%. Top slab thickness does not vary. Leave blank for a box culvert. Leave blank for a box culvert.
<b>LDC</b>	Earth Weight/Density Height of Fill Number of Lanes Live Load Surcharge Live Load Overlay Weight/Density Overlay Thickness Future Wearing Surface Max LL Distr Length Segment Length Mult Presence Reduction PA Traffic Factor Fatigue Dynamic Load Allow Ductility Factor Redundancy Factor Importance Factor P-82 Max Dynamic Load Allow Live Load Override Min Equiv. Fluid Press Max Equiv Fluid Press Barrier Dead Load Approach Slab DL Left Wall Approach Slab LL Left Wall Approach Slab DL Right Wall Approach Slab LL Right Wall Ratings without FWS Backfill Type	144.167 1.000 2 <b>3.0</b> <b>A</b> <b>0.00</b> <b>0.00</b> <b>30.00</b> 28 7.026                     0.68	lb/ft <sup>3</sup> ft  ft  lb/ft <sup>3</sup> in lb/ft <sup>2</sup> ft ft              lb/ft <sup>3</sup> lb/ft <sup>3</sup> kips/ft	Wt. avg. of 5" continuity slab (150 pcf) & 7" constant overlay thickness (140 pcf). Theoretical fill = continuity slab thickness + minimum pavement thickness 28' curb-to-curb / 12' per lane = 2.33 lanes --> use 2 lanes Per DM-4, Section 3.11.6.4, 3.0 for box culverts PHL-93,P-82, ML-80, TK527, HS20 and H20 Set = 0.00 since fill is defined in Parameters #1 & #2 Set = 0.00 since fill is defined in Parameters #1 & #2 PennDOT DM-4, Section 12.11.2.1; BD-632M, Note #6. Curb-to-curb distance. Refer to BXLRFD User's Manual - Fig. 5.10-1 8 Segments at 7.026' = 56.208' Default = 1.0 (only value allowed by BXLRFD) This parameter is no longer used and should be left blank. This parameter is no longer used and should be left blank. Default = 1.0 (DM-4, Section 1.3.3) Default = 1.0 (DM-4, Section 1.3.4) Default = 1.0 (DM-4, Section 1.3.5) Default = 1.2 (DM-4, Section 3.6.2.1) Default = 0 (the program determines when live load is applicable) Default = 45 lb/ft <sup>3</sup> (the min. specified in DM-4 Table 3.11.5.5-2) Default = 70 lb/ft <sup>3</sup> (the max. specified in DM-4 Table 3.11.5.5-2) See separate calcs: 0.3 klf per PennDOT BD-617M, Sht. 1 of 17 + extra barrier No approach slab per D-10. No approach slab per D-10. No approach slab per D-10. No approach slab per D-10. Default = N Default = 0 (Conservative assumption for LL through fill, BXLRFD Manual 3.3.17.2)

# HDR Computation

Project: PENNDOT P3  
 Subject: PRECAST BOX CULVERT DESIGN  
 Task: BXLRFD INPUT SUMMARY

Computed: JDD  
 Checked: JS  
 Sheet: 4

Date: 6/8/2015  
 Date: 6/8/2015  
 Of: 16

FILE: C-STR_P3-10.000x4.500x1.000.dat				
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS
HCH	Top Left x	12.00	in.	Minimum allowed per PennDOT District 10-0 = 12" Minimum allowed per DM-4, Section 12.11.1 = 6". Use 12" as the standard for all culverts.
	Top Left y	12.00	in.	Minimum allowed per PennDOT District 10-0 = 12" Minimum allowed per DM-4, Section 12.11.1 = 6". Use 12" as the standard for all culverts.
	Top Right x		in.	Leave Blank. Uses "Top Left x" value by default.
	Top Right y		in.	Leave Blank. Uses "Top Left y" value by default.
	Bottom Left x		in.	Leave Blank. Uses "Top Left x" value by default.
	Bottom Left y		in.	Leave Blank. Uses "Top Left y" value by default.
	Bottom Right x		in.	Leave Blank. Uses "Top Left x" value by default.
	Bottom Right y		in.	Leave Blank. Uses "Top Left y" value by default.
	Top Interior x		in.	Leave blank. No interior wall.
	Top Interior y		in.	Leave blank. No interior wall.
	Bottom Interior x		in.	Leave blank. No interior wall.
	Bottom Interior y		in.	Leave blank. No interior wall.
CVR	Top Slab Top Cover	2.50	in.	Default: 2.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
	Top Slab Bottom Cover	1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
	Bottom Slab Top Cover	2.00	in.	Default: 2.00 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
	Bottom Slab Bot Cover	1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
	All Wall Covers	1.50	in.	Default: 1.50 in. (See BD-632M, Sheet 4 of 13 or BXLRFD User's Manual Table 5.15-1)
	Footing Top Cover		in.	Leave blank (no footing).
	Footing Bottom Cover		in.	Leave blank (no footing).
TSR	Slab Number	1		Single cell culvert.
	Face	T		Top slab, top reinforcement.
	Range Distance 1	3.000	ft	Over full width.
	Reinforcement Size 1	5		Range 1 Reinforcement: #5 @ 6.5"
	Spacing 1	6.5	in.	
	Range Distance 2	7.000		
	Reinforcement Size 2	4		Range 2 Reinforcement: #4 @ 6.5"
	Spacing 2	6.5		
	Range Distance 3	10.000		
	Reinforcement Size 3	5		Range 3 Reinforcement: #5 @ 6.5"
Spacing 3	6.5			
TSR	Slab Number	1		Single cell culvert.
	Face	B		Top slab, bottom reinforcement.
	Range Distance	10	ft	Over full width.
	Reinforcement Size	6		Reinforcement: #6 @ 6.5"
	Spacing	6.5	in.	
BSR	Slab Number	1		Single cell culvert.
	Face	T		Bottom slab, top reinforcement.
	Range Distance	10	ft	Over full width.
	Reinforcement Size	6		Reinforcement: #6 @ 6.5"
	Spacing	6.5	in.	
BSR	Slab Number	1		Single cell culvert.
	Face	B		Bottom slab, bottom reinforcement.
	Range Distance 1	3.000	ft	Over full width.
	Reinforcement Size 1	5		Range 1 Reinforcement: #5 @ 6.5"
	Spacing 1	6.5	in.	
	Range Distance 2	7.000	ft	
	Reinforcement Size 2	4		Range 2 Reinforcement: #4 @ 6.5"
	Spacing 2	6.5	in.	
	Range Distance 3	10.000	ft	
	Reinforcement Size 3	5		Range 3 Reinforcement: #5 @ 6.5"
Spacing 3	6.5	in.		
WLR	Wall Number	1		Left wall.
	Face	L		Left face of wall.
	Range Distance	4.500	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	5		Reinforcement: #5 @ 6.5"
	Spacing	6.5	in.	
WLR	Wall Number	1		Left wall.
	Face	R		Right face of wall.
	Range Distance	4.500	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	4		Reinforcement: #4 @ 6.5"
	Spacing	6.5	in.	
WLR	Wall Number	2		Right wall.
	Face	L		Left face of wall.
	Range Distance	4.500	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	4		Reinforcement: #4 @ 6.5"
	Spacing	6.5	in.	

# HDR Computation

Project: PENNDOT P3  
 Subject: PRECAST BOX CULVERT DESIGN  
 Task: BXLFRD INPUT SUMMARY

Computed: JDD  
 Checked: JS  
 Sheet: 5

Date: 6/8/2015  
 Date: 6/8/2015  
 Of: 16

FILE: C-STR_P3-10.000x4.500x1.000.dat				
COMMAND	PARAMETER	INPUT	UNITS	CODE / COMMENTS
WLR	Wall Number	2		Right wall.
	Face	R		Right face of wall.
	Range Distance	4.500	ft	Over full height. Should equal clear height in "DIM" parameters.
	Reinforcement Size	5		Reinforcement: #5 @ 6.5"
	Spacing	6.5	in.	
OIN	Input File Echo	1		Print echo of input file.
	Input Commands	1		Print the input commands.
	Input Summary			Leave Blank. Default: 1. See BXLFRD User's Manual Table 6.26-1
OUR	Section Properties			Leave blank. Default: 0 (BXLFRD Table 6.27-1). Do not print section properties
	Live Load Rating	1		Use "1" to print capacities in the output file
	Rating Summary			Leave blank. Default: 1 (BXLFRD Table 6.27-1). Print Rating Summary
	DL Effects and Capacities			Leave blank. Default: 1 (BXLFRD Table 6.27-1). Print DL effects and capacities
	Flexural Reinforcement			Leave blank. Default: N/A for Analysis Run (BXLFRD Table 6.27-1).
	Shear Design			Leave blank. Default: N/A for Analysis Run (BXLFRD Table 6.27-1).
	Foundation Pressure			Leave blank. Default: 0 (BXLFRD Table 6.27-1). Do not print foundation pressure
	Quantities			Leave blank. Default: 1 (BXLFRD Table 6.27-1). Print Quantities
	Serviceability Table	1		Print serviceability table
	Serviceability Summary			Leave blank. Default: 1 (BXLFRD Table 6.27-1). Print serviceability summary table.
Foundation Pressure Summary			Leave blank. Default: 1 (BXLFRD Table 6.27-1). Print foundation pressure summary table	

## INPUT FILE (Analysis)

TTL JV 421 - Precast Concrete Box Culvert  
 TTL Culvert Size: 10.000' x 4.500' x 1.000' (Clear Span x Clear Height x Fill)  
 TTL Computed: JS (Date: 06/08/2015); Checked: SMK (Date:06/08/2015)  
 CTL ,1,AR,P,Y,,  
 MAT ,,B,,,,150,145  
 DIM 10,4.5,13,11,10,10,,,,  
 LDC 144.167,1,2,3,A,0,0,30,28,7.026,,,,,,,,,0.68,,,,,  
 HCH 12,12,,,,,  
 CVR 2.5,1.5,2,1.5,1.5,  
 TSR 1,T,3,5,6,5,7,4,6.5,10,5,6.5  
 TSR 1,B,10,6,6.5  
 BSR 1,T,10,6,6.5  
 BSR 1,B,3,5,6,5,7,4,6.5,10,5,6.5  
 WLR 1,L,4,5,5,6.5  
 WLR 1,R,4,5,4,6.5  
 WLR 2,L,4,5,4,6.5  
 WLR 2,R,4,5,5,6.5  
 OIN 1,1,  
 OUR ,1,,,,,1,,