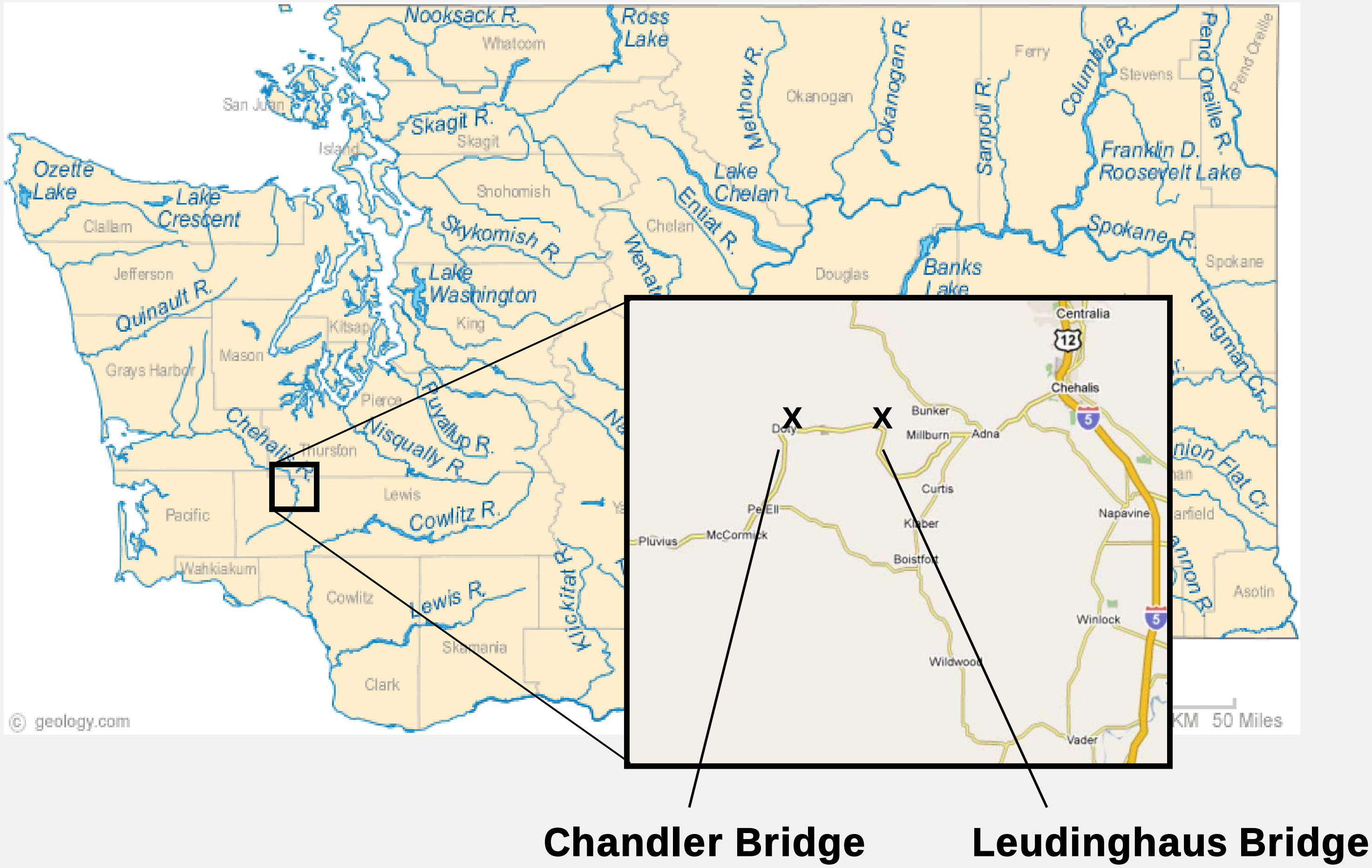
Chandler Road Bridge Prestressed Spliced Girder

Presented By: **Douglas Sarkkinen, P.E., SE.**
Principal
Kramer Gehlen and Associates, Inc.
Vancouver, WA

Overview

- Project Background
- Bridge Selection
- Sequence
- P.T. Profile
- Deflection
- Conclusions

Map of Washington, Lewis County



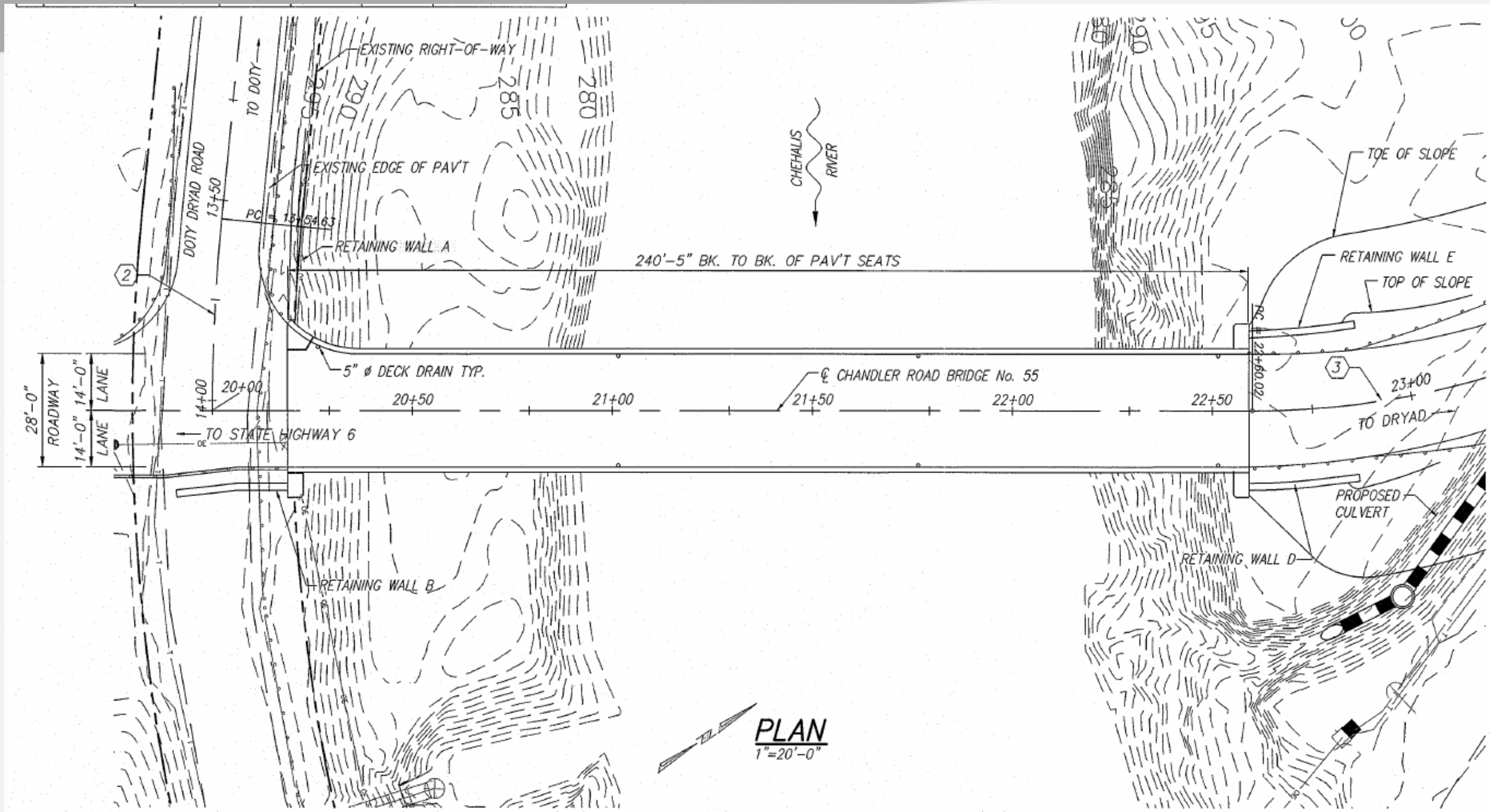
December 2007 Storm

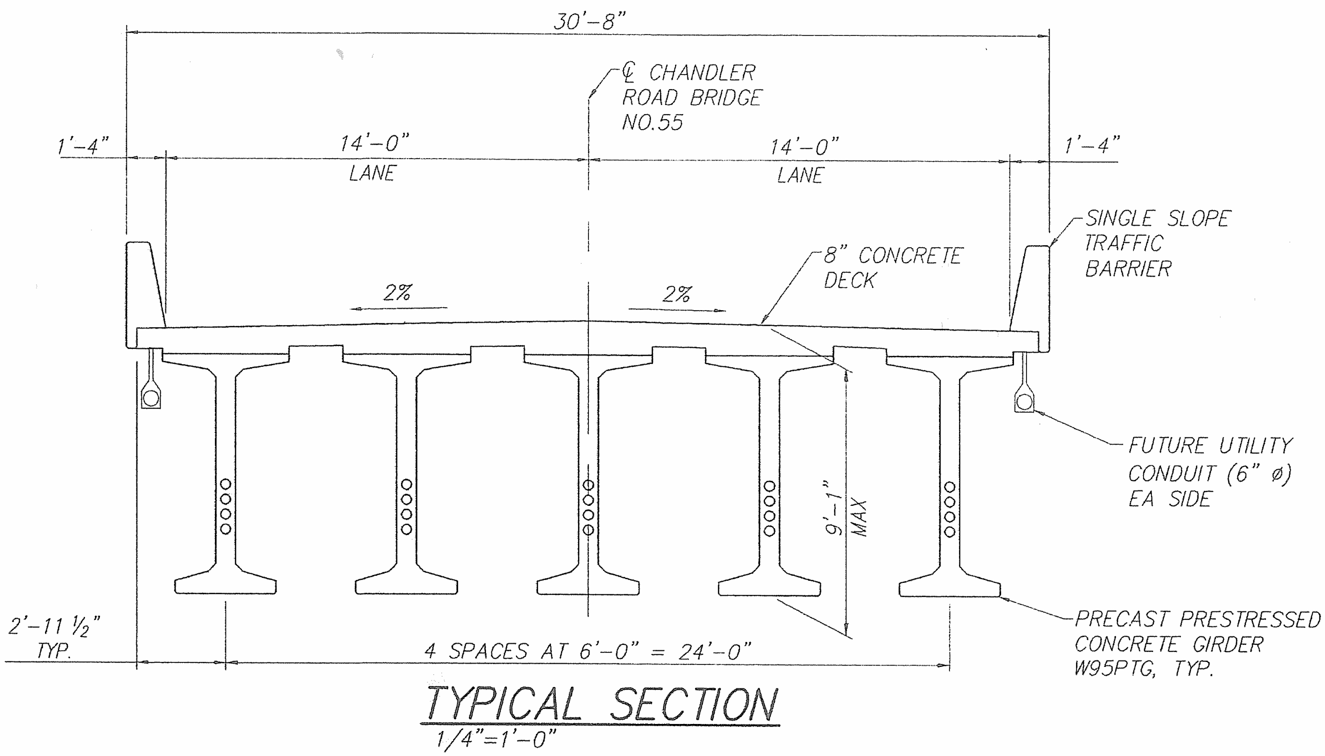
Bridge Selection Criteria

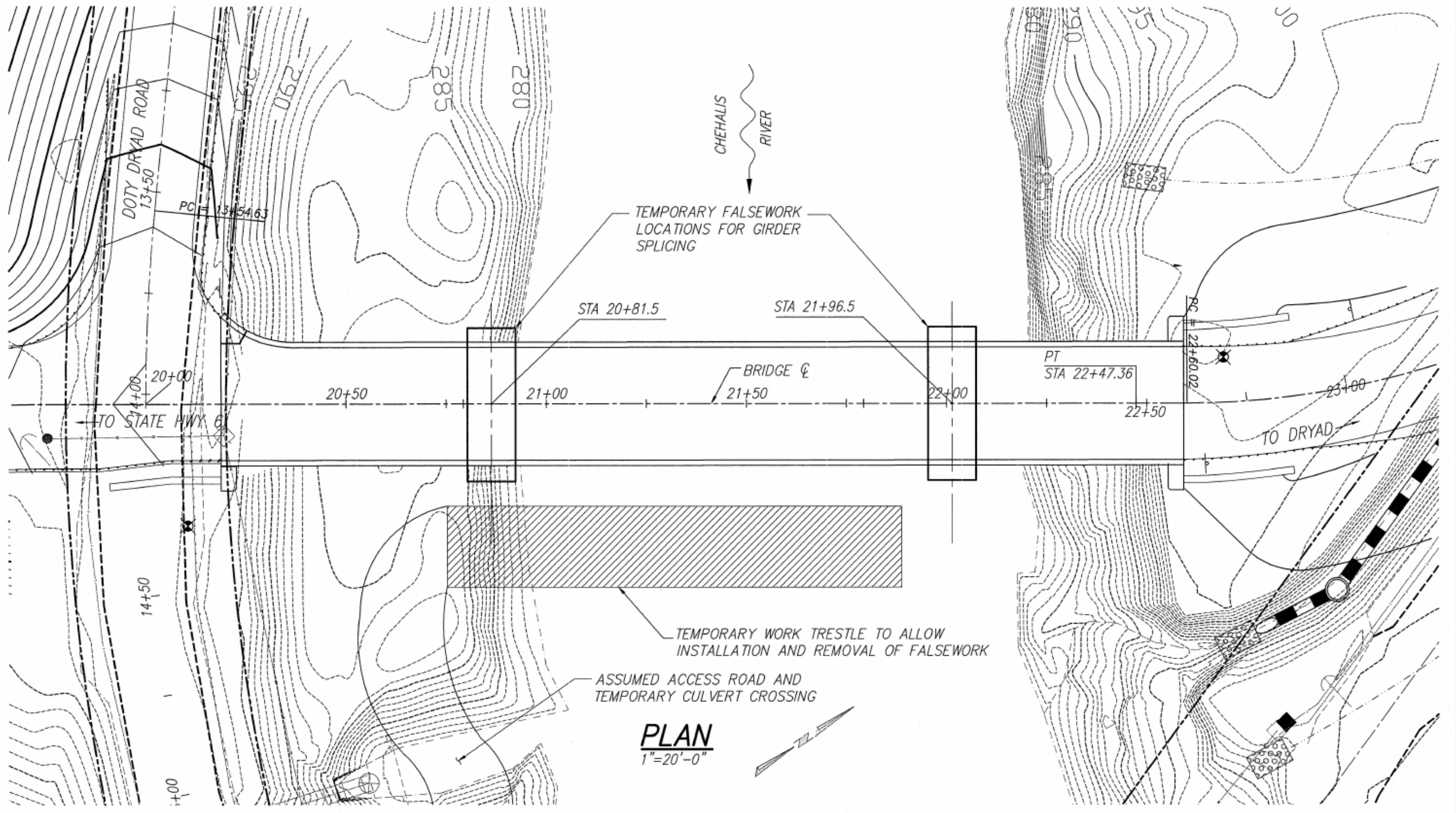
- New Hydraulic study raised the expected flood elevation
- Maintaining 4ft of clearance above flood elevation for debris
- Robust Structure – needs to withstand debris impact
- Clear Span – did not want scour issues or areas for debris to build up on

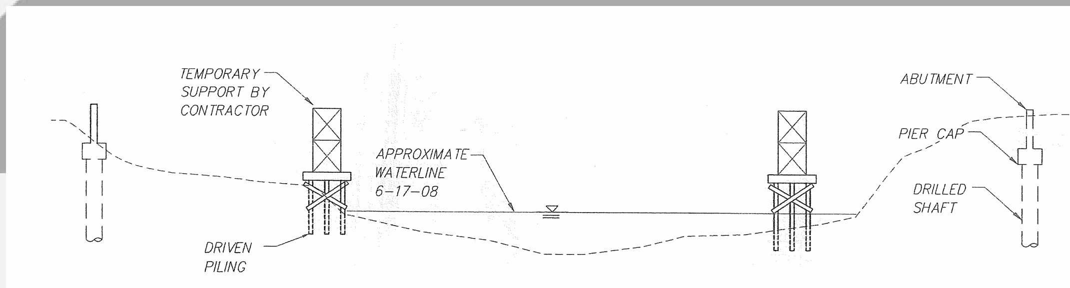
Bridge Options Considered

- Cast-in-place post-tensioned box
- Steel Girders
- Steel Tied Arch
- Steel Truss
- Post-tensioned Spliced Precast Girders

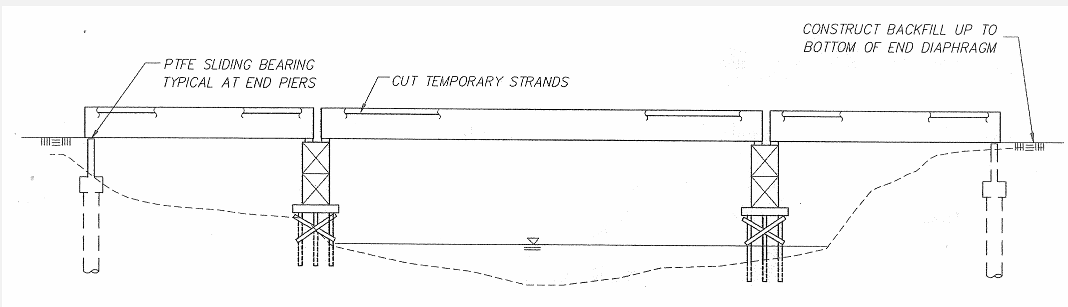

EXISTING RIGHT-OF-WAY
EXISTING EDGE OF PAV'T
PC = 13+54.63
RETAINING WALL A
240'-5" BK. TO BK. OF PAV'T SEATS
CHEHALIS RIVER
TOE OF SLOPE
RETAINING WALL E
TOP OF SLOPE
DOTY DRYAD ROAD
TO DOTY
13+50
14+00
20+00
20+50
21+00
21+50
22+00
22+50
23+00
PC = 22+60.02
5" ø DECK DRAIN TYP.
℄ CHANDLER ROAD BRIDGE No. 55
TO STATE HIGHWAY 6
TO DRYAD
28'-0" ROADWAY
14'-0" LANE
14'-0" LANE
PROPOSED CULVERT
RETAINING WALL D
RETAINING WALL B
PLAN
1"=20'-0"
295
290
285
280


30'-8"
℄ CHANDLER ROAD BRIDGE NO.55
1'-4"
14'-0"
LANE
14'-0"
LANE
1'-4"
SINGLE SLOPE TRAFFIC BARRIER
8" CONCRETE DECK
2%
2%
FUTURE UTILITY CONDUIT (6" ø) EA SIDE
9'-1" MAX
PRECAST PRESTRESSED CONCRETE GIRDER W95PTG, TYP.
2'-11 ½" TYP.
4 SPACES AT 6'-0" = 24'-0"
TYPICAL SECTION
1/4"=1'-0"

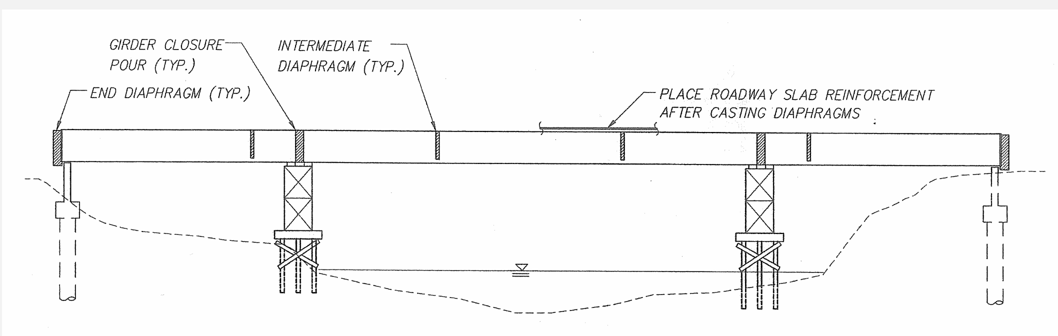

CHEHALIS RIVER
TEMPORARY FALSEWORK LOCATIONS FOR GIRDER SPLICING
STA 20+81.5
STA 21+96.5
DOTY DRYAD ROAD
BRIDGE ℄
PT
STA 22+47.36
TO STATE HWY 6
TO DRYAD
TEMPORARY WORK TRESTLE TO ALLOW INSTALLATION AND REMOVAL OF FALSEWORK
ASSUMED ACCESS ROAD AND TEMPORARY CULVERT CROSSING
PLAN
1"=20'-0"



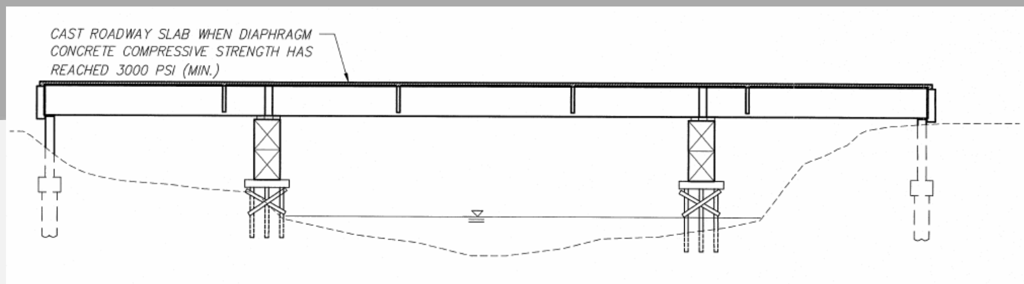
STAGE 1
FALSEWORK, DRILLED SHAFTS, PILE CAPS, AND ABUTMENT WALLS



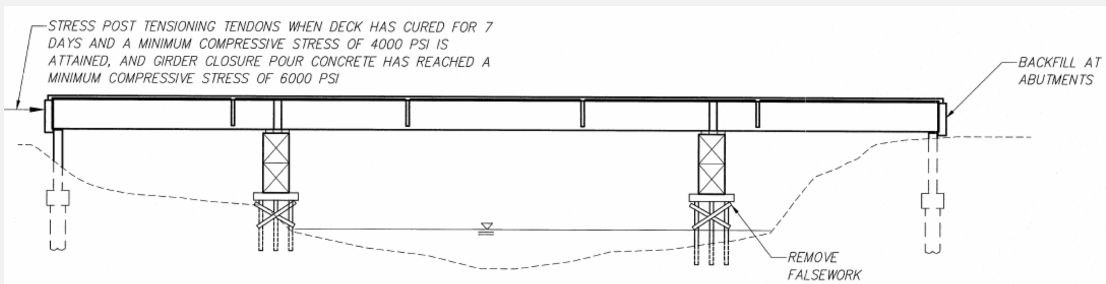
STAGE 2
SET GIRDERS IN PLACE



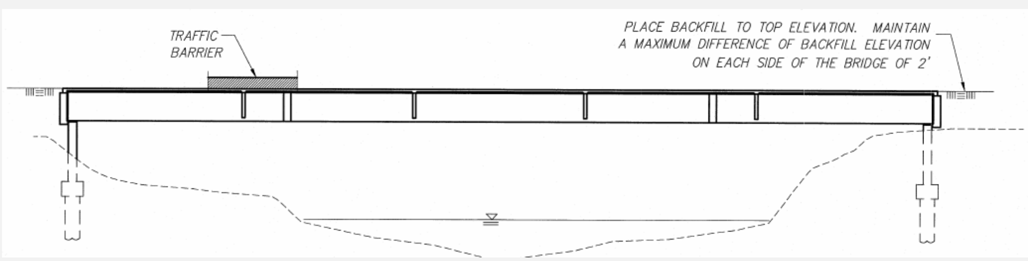
STAGE 3
CONSTRUCT GIRDER CLOSURE POURS, CAST DIAPHRAGMS, PLACE SLAB REINFORCEMENT



STAGE 4
CAST ROADWAY SLAB



STAGE 5
POST TENSION SPLICED GIRDERS AND REMOVE TEMPORARY SUPPORTS



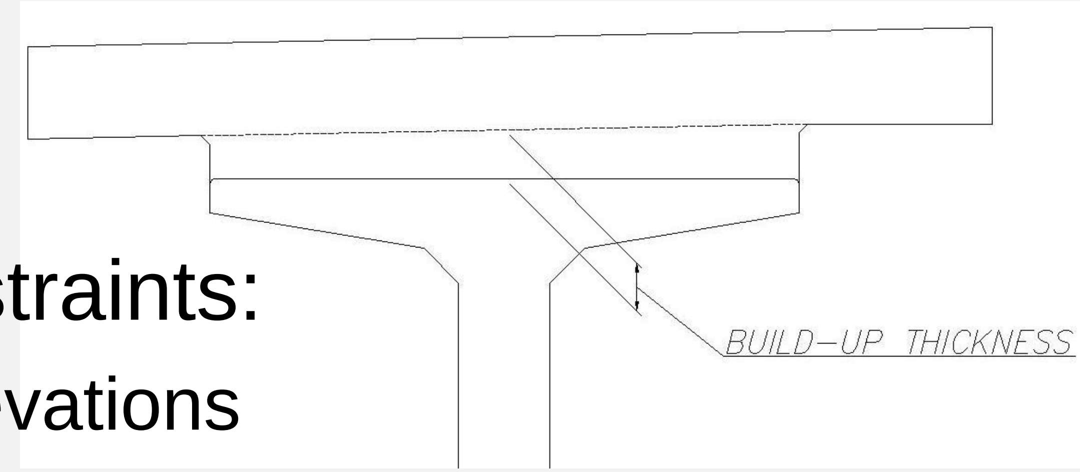
STAGE 6
CAST TRAFFIC BARRIERS

Girder Deflections

- Given: Final Road Profile
- Determined various deflections at different stages
- Adjusted Falsework Points and Elevation of Deck Forms to Produce Desired Final Profile

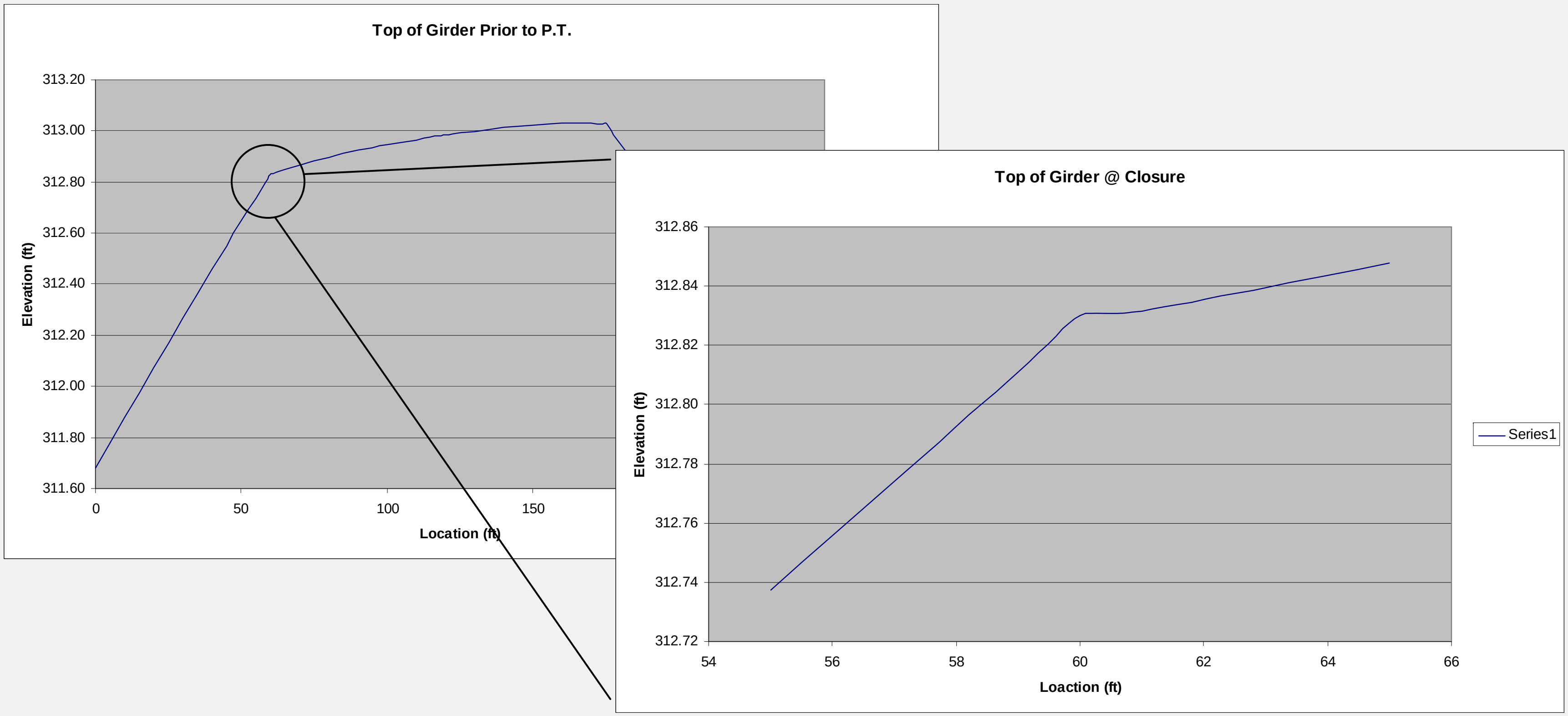
Constraints

- Fixed Constraints:
  - Final Grade
- Variable Constraints:
  - Abutment Elevations
  - Elevation of Temporary Piers
  - Depth of Girder Build-Up



Challenges

1) Variable Deflections and Rotations in Independent Segments



Challenges (Cont.)

- Had to Adjust Duct Profile Very Slightly in Region Around Splices to Ensure Smooth Variation
- Differential Rotations Corrected for in Variable Build-Up Thickness
- Try to Limit Rotation as Much as Possible by Varying amount of Prestressing

Challenges (Cont.)

2) Limited Capability to Vary Amount of Prestress
   - Adjusted Prestress as much as Possible to get “Flat” Girders Prior to Splicing
   - Due to High Stresses Had a Minimum Amount of Prestressing that had to be Maintained

Challenges (Cont.)

3) Non-Typical P.T. Profile

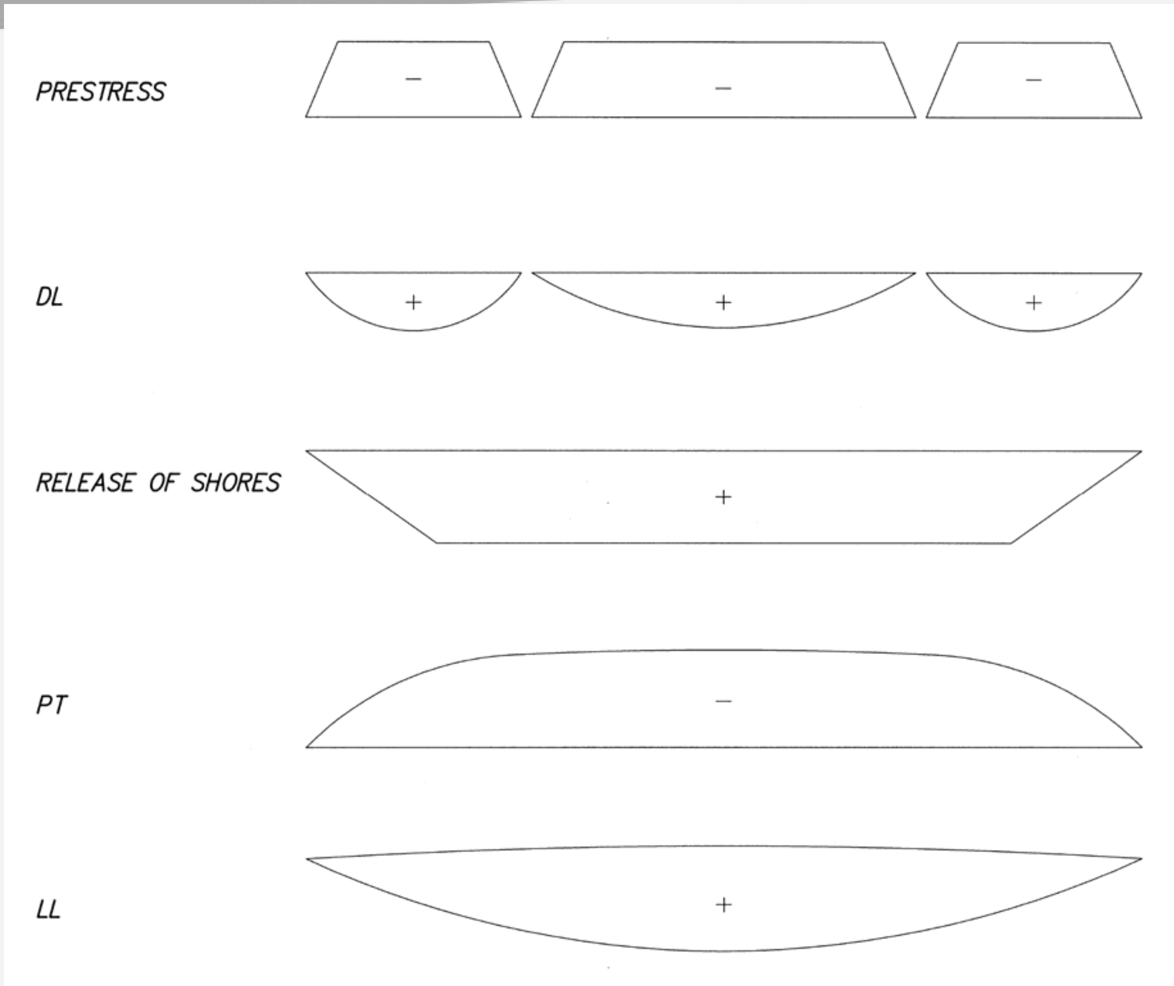
4) Variation of I, (3) Cases
   - Composite or Non-Composite
   - P.T. Ducts Grouted or Ungrouted

5) Account for Anticipated Future Deflections

Determination of P.T. Profile

- Set Splice Locations at 60’ +/- From Girder Ends
- No Prestress through Splice Locations
- Prestress has to Develop Coming out of Splices
- Maintain “0 Tension” at Service Loads

Superposition of Moment Diagrams



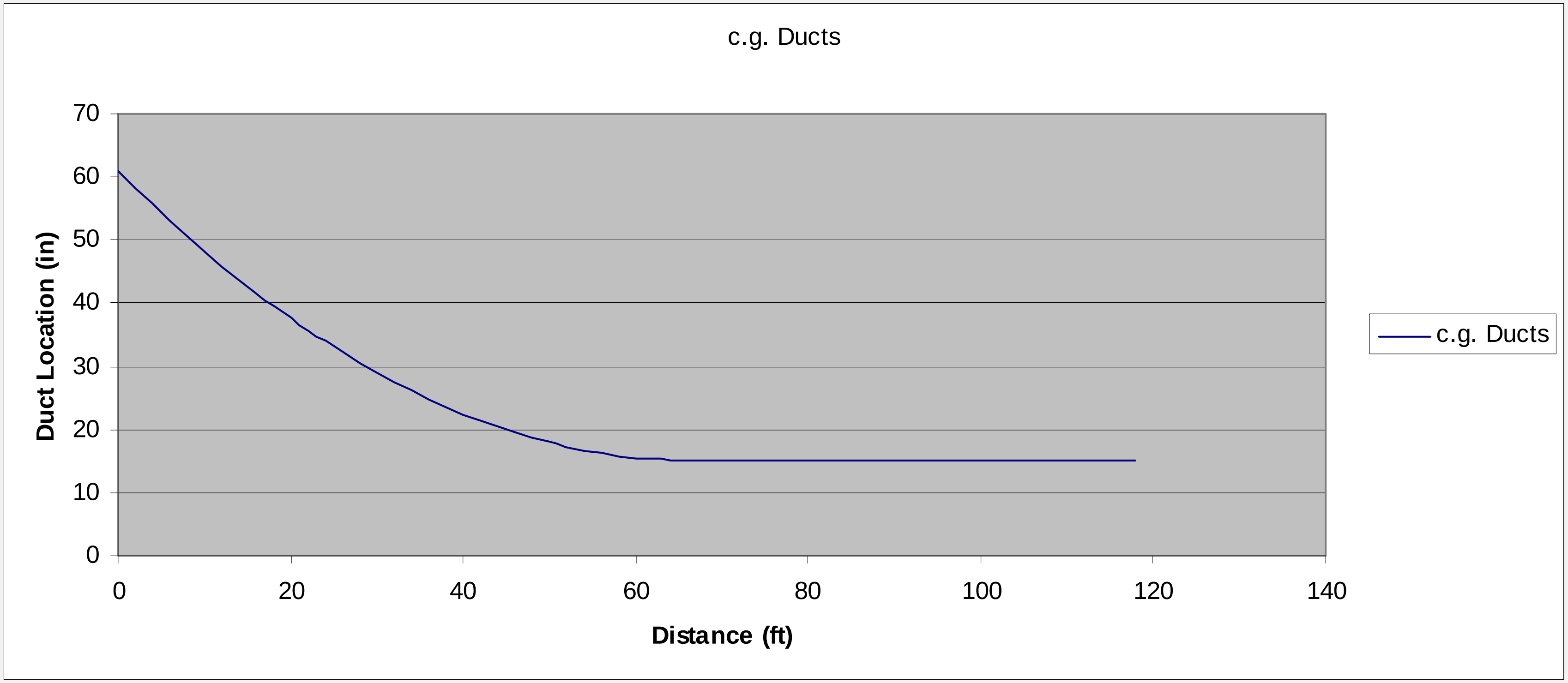
P.T. Profile (Cont.)

- Determined Amount of P.T. Required for Zero Tension at C.L.
- Determined Depth of P.T. Required at Critical Location
  - Calculated at 1’ Intervals for 4’ Past Splice in Either Direction

P.T. Profile (Cont.)

- Had c.g. of Tendons at End of Bridge, at Critical Location, and Knew c.g. Required at C.L.
  - Fit a Parabolic Curve through known points
  - Ran Tendons Flat Throughout most of Center Girder

P.T. Profile (Cont.)



P.T. Profile (Cont.)

- Concern: Bursting Stresses Due to Decreased Radius of Curvature and Amount of P.T.
  - Due to Girder Length Radius of Curvature Still well Within Code Limits

Approach

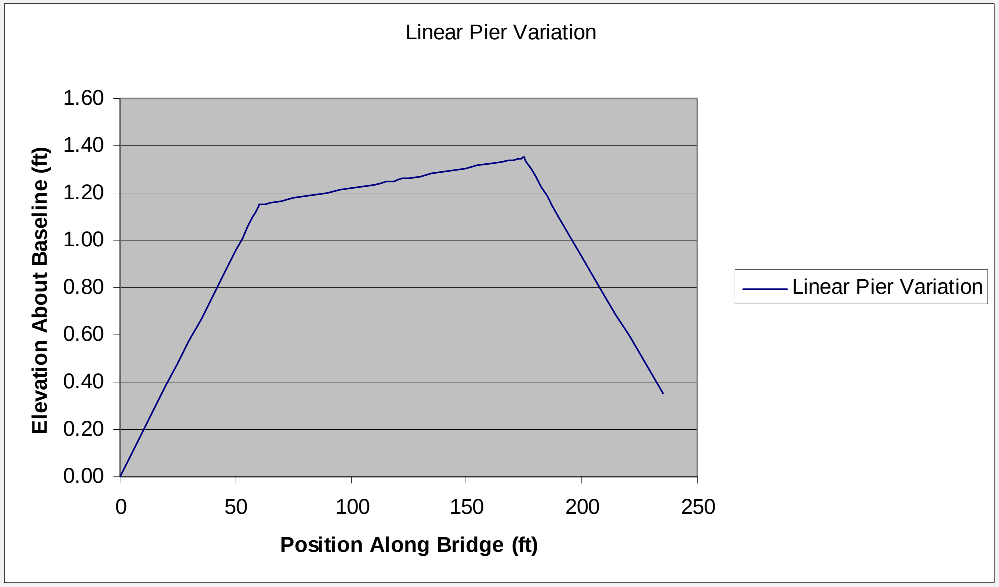
- Set Build-Up Thickness at Temp. Piers to Minimum Value
- Calculated Deflections at Each Time Step
  - Immediate Elastic Deformations
  - Prestress and P.T. Deflections Using Elastic Weight Method
  - Applied WSDOT Deflection Multipliers

WSDOT Creep Multipliers

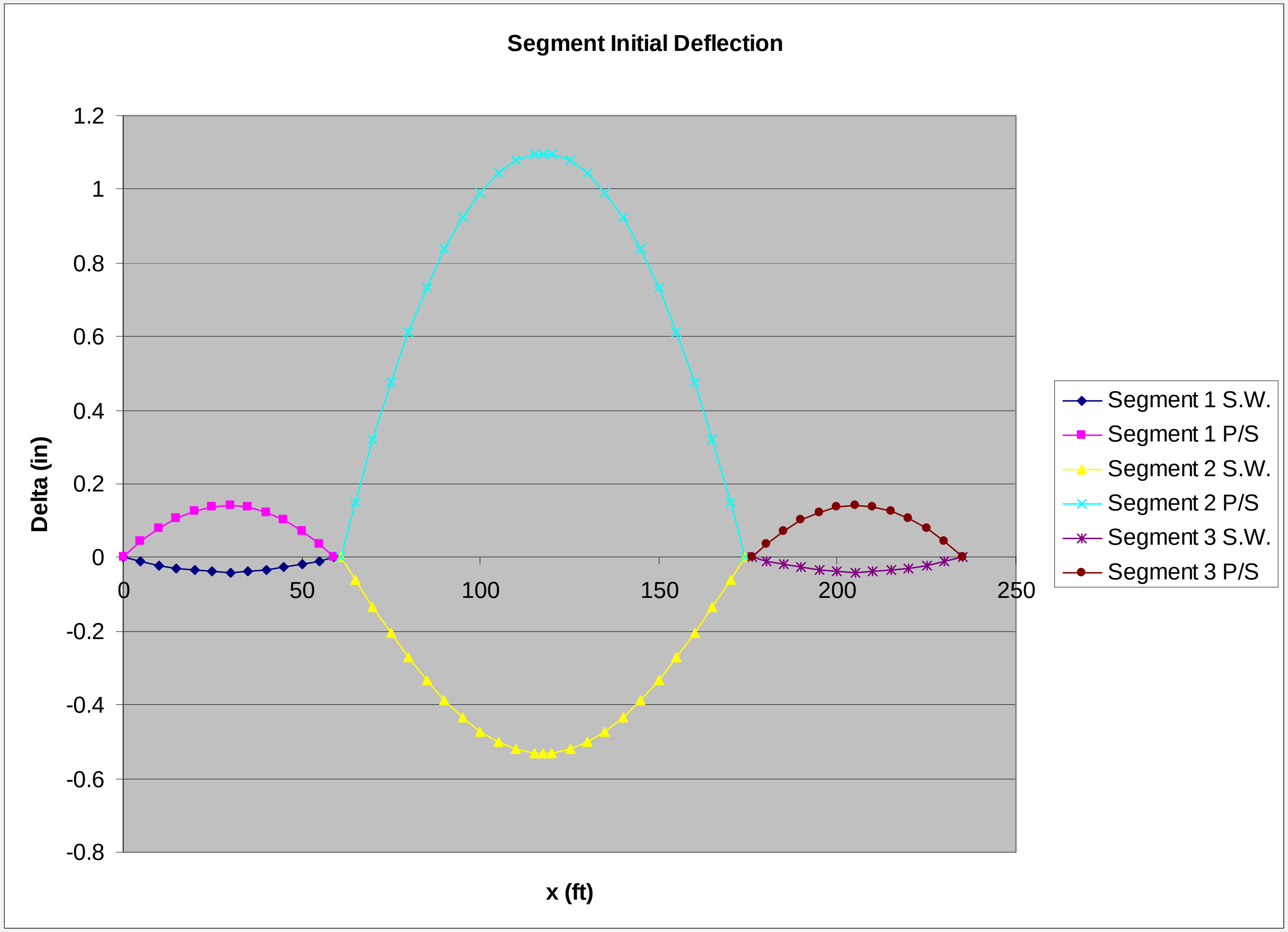
	Normal Strength Concrete $f'_c \le 7.0ksi$		High Strength Concrete $f'_c \succ 7.0ksi$	
	Non-Composite	Composite	Non-Composite	Composite
Deflection at Erection				
Apply to the elastic deflection due to the member weight at release of prestress	1.85	1.85	1.75	1.75
Apply to the elastic deflection due to prestressing at release of prestress	1.80	1.80	1.70	1.70
Deflection at Final				
Apply to the elastic deflection due to the member weight at release of prestress	2.70	2.40	2.50	2.20
Apply to the elastic deflection due to prestressing at release of prestress	2.45	2.20	2.25	2.10
Apply to the elastic deflection due to the Super Imposed Dead Loads	3.00	3.00	2.75	2.75
Apply to the elastic deflection due to weight of slab	----	2.30	----	2.15

Approach (Cont.)

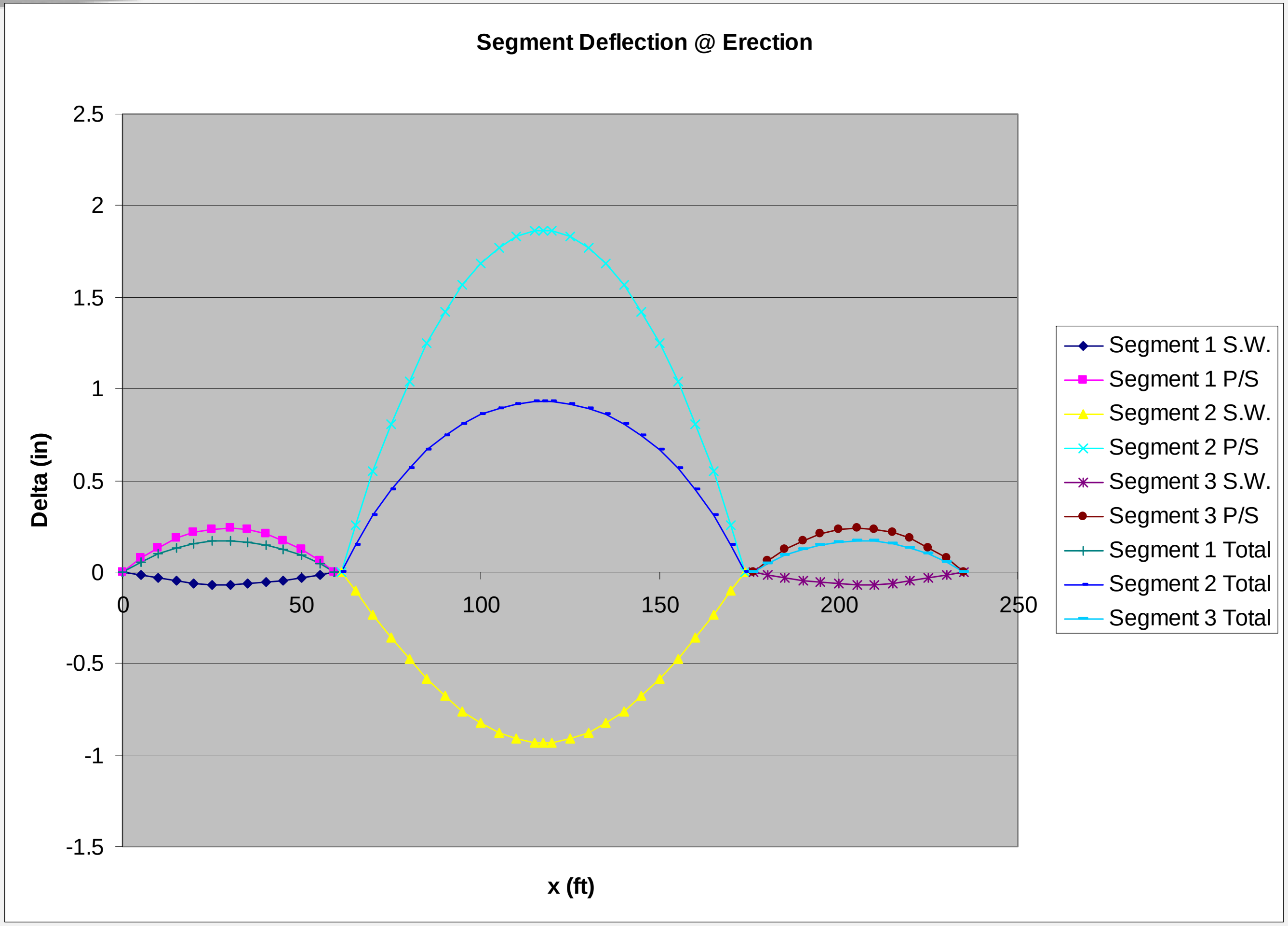
- Assumed Initial Value for Abutment Elevation
- Varied Elevation Linearly between Abutments and Piers
  - Set Top of Abutment 1 as Baseline



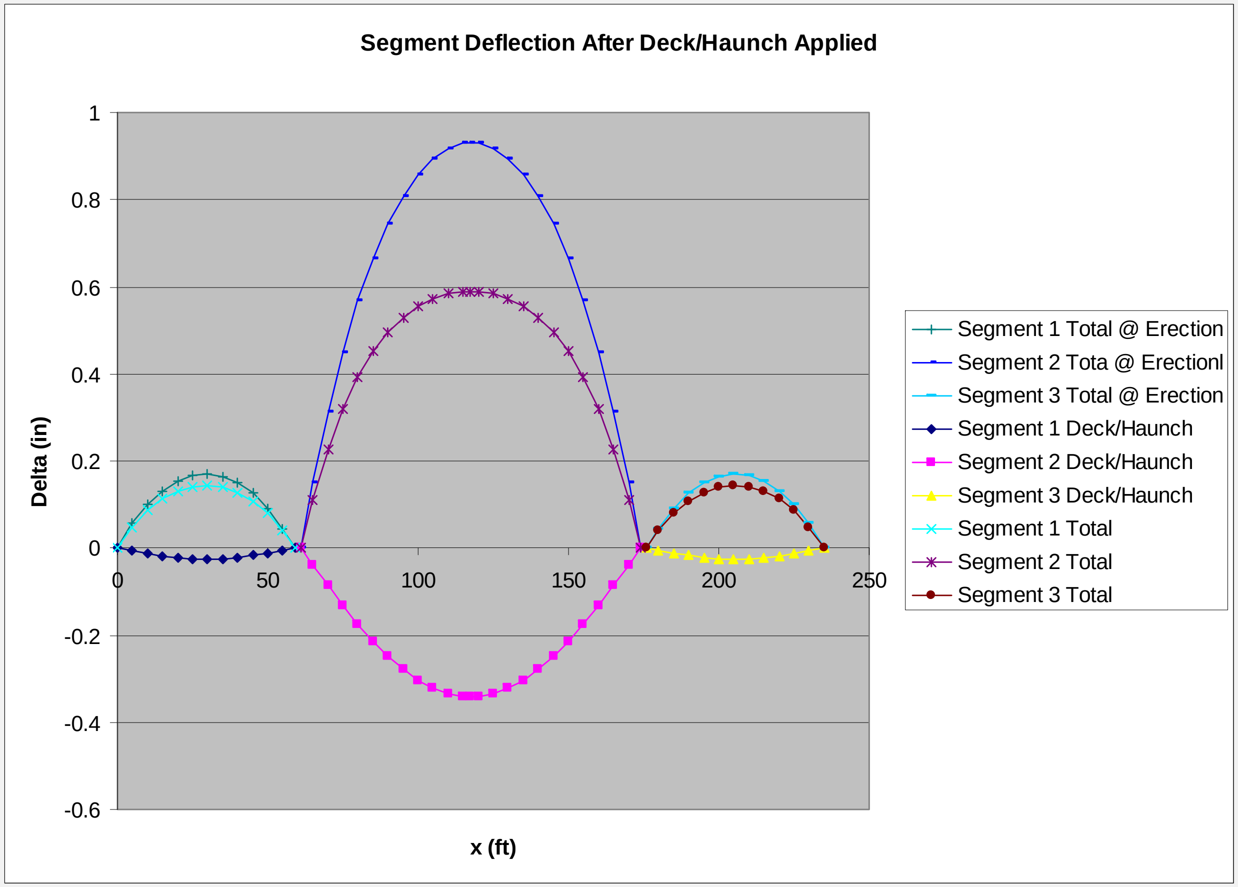
Deflection Results



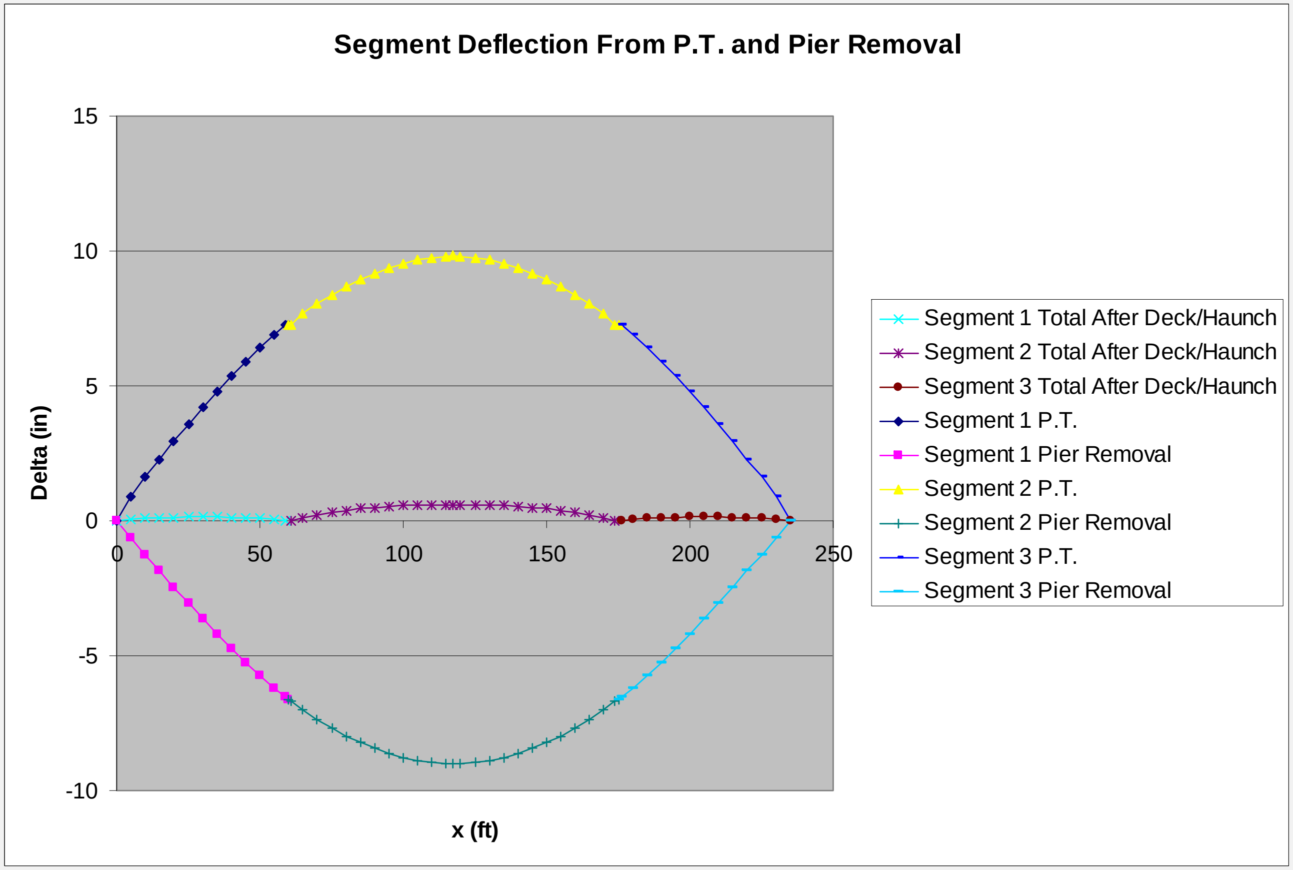
Deflection Results



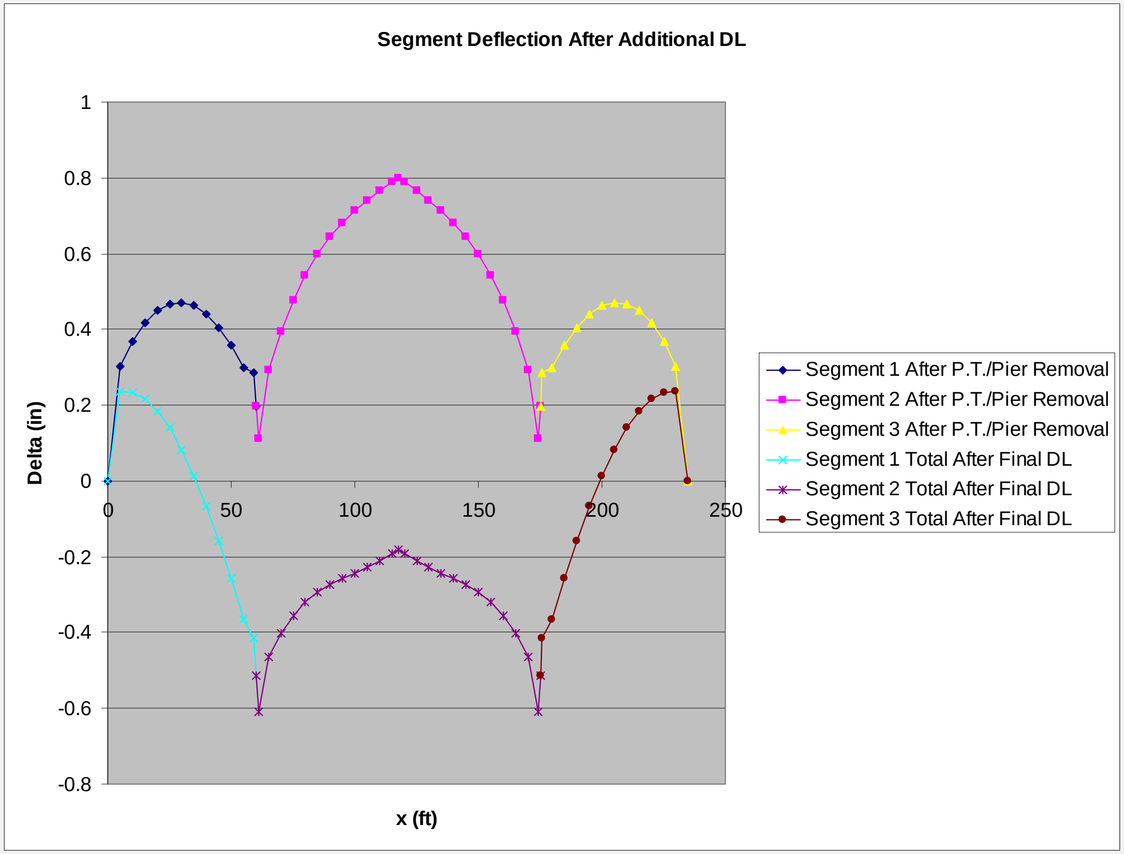
Deflection Results



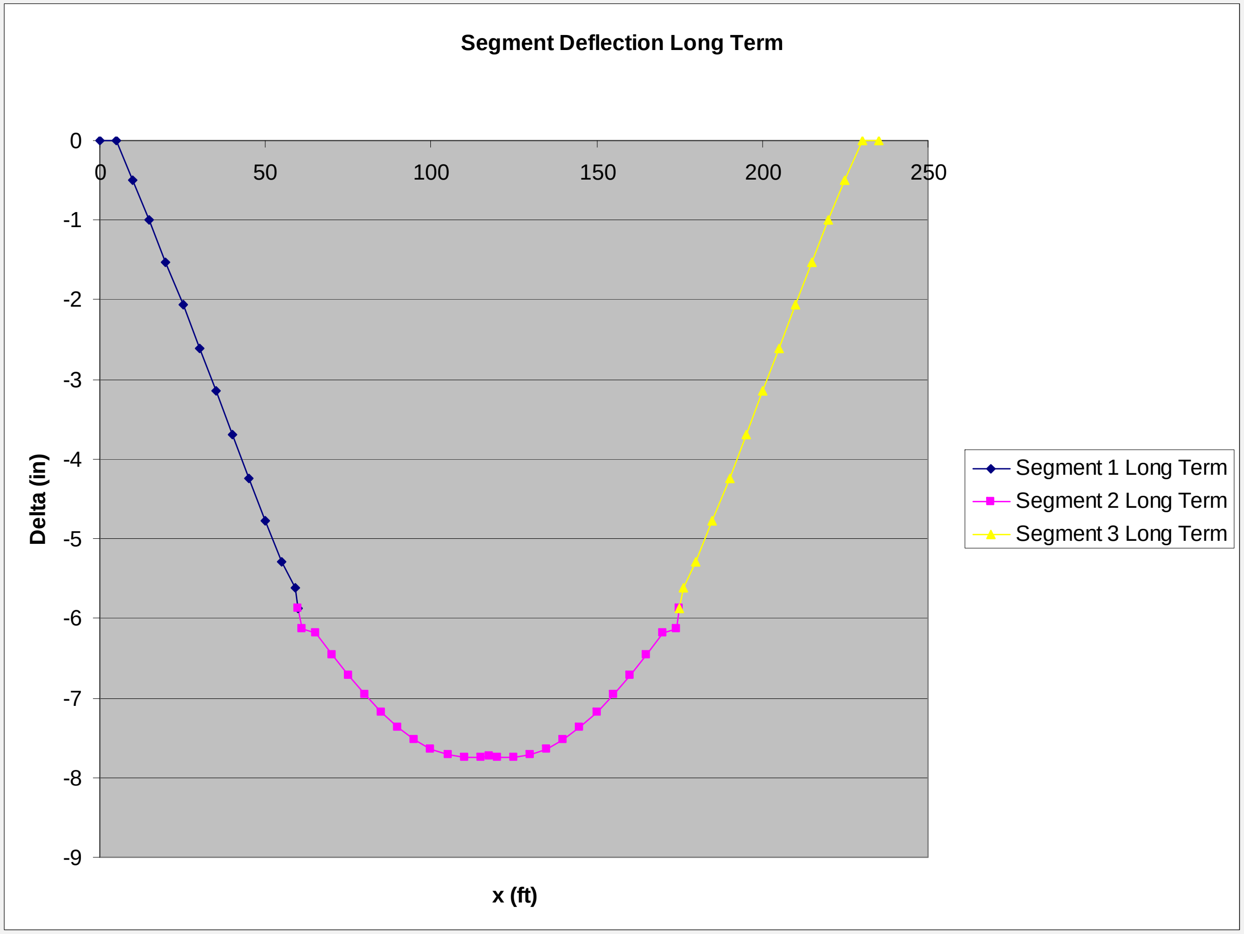
Deflection Results



Deflection Results

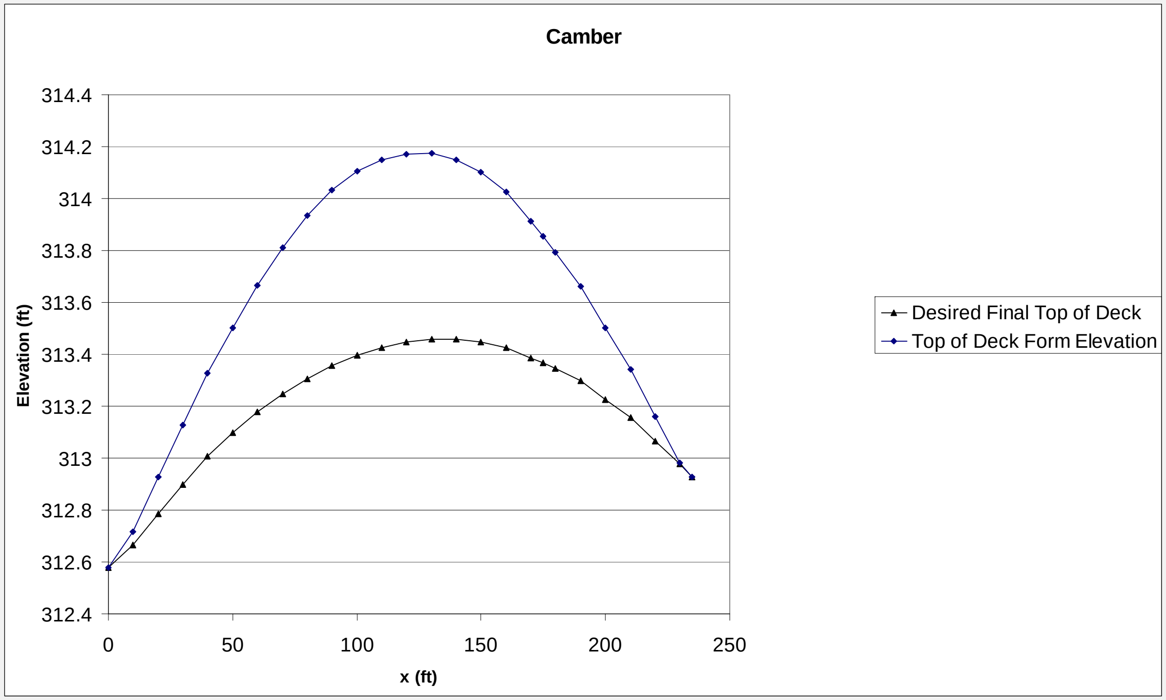


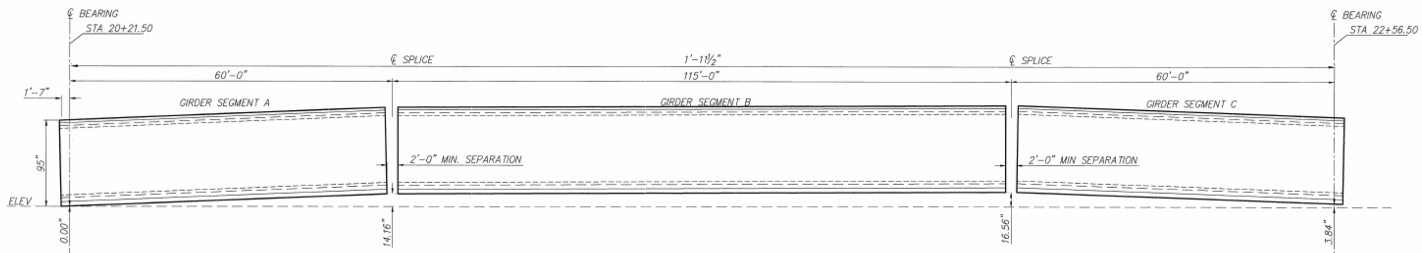
Deflection Results



Final Result

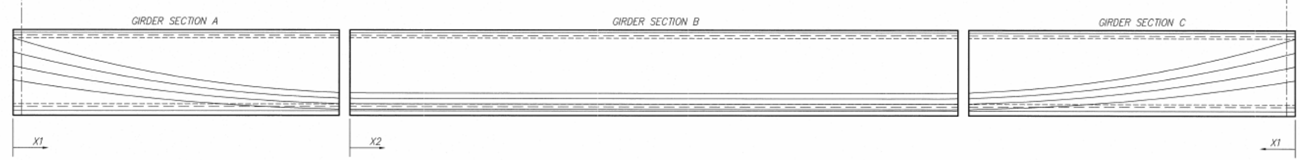
- Top of Deck That Arrives at Desired Grade





SPLICED GIRDER GEOMETRY

SCALE 1:10 HORIZ 1:2 VERTICAL



SPLICED GIRDER TENDON PROFILES

SCALE 1:10 HORIZ 1:2 VERTICAL

GIRDER A AND GIRDER C DUCT LOCATION

DISTANCE FROM END OF BEAM, X1 (FT)	BOTTOM OF BEAM TO C.G. DUCT 1 (IN)	BOTTOM OF BEAM TO C.G. DUCT 2 (IN)	BOTTOM OF BEAM TO C.G. DUCT 3 (IN)	BOTTOM OF BEAM TO C.G. DUCT 4 (IN)
0	77.42	62.91	48.40	33.89
1.58	75.01	60.60	46.76	32.63
2.58	73.51	59.62	45.73	31.85
7.58	66.34	53.59	40.85	28.10
13.58	58.47	46.98	35.49	24.00
19.58	51.42	41.05	30.68	20.32
25.58	45.17	35.80	26.43	17.05
31.58	39.73	31.22	22.72	14.21
37.58	35.09	27.33	19.56	11.79
43.58	31.27	24.11	16.95	9.79
49.58	28.24	21.57	14.89	8.22
55.58	26.03	19.71	13.38	7.06
59.58	25.00	18.84	12.68	6.52
60.58	24.62	18.49	12.37	6.29

GIRDER B DUCT LOCATION

DISTANCE FROM END OF BEAM, X2 (FT)	BOTTOM OF BEAM TO C.G. DUCT 1 (IN)	BOTTOM OF BEAM TO C.G. DUCT 2 (IN)	BOTTOM OF BEAM TO C.G. DUCT 3 (IN)	BOTTOM OF BEAM TO C.G. DUCT 4 (IN)
0.00	24.45	18.37	12.30	6.22
1.00	24.33	18.28	12.23	6.17
4.00	24.07	18.06	12.05	6.04
7.00	24.00	18.00	12.00	6.00
106.00	24.00	18.00	12.00	6.00
109.00	24.07	18.06	12.05	6.04
112.00	24.33	18.28	12.23	6.17
113.00	24.45	18.37	12.30	6.22

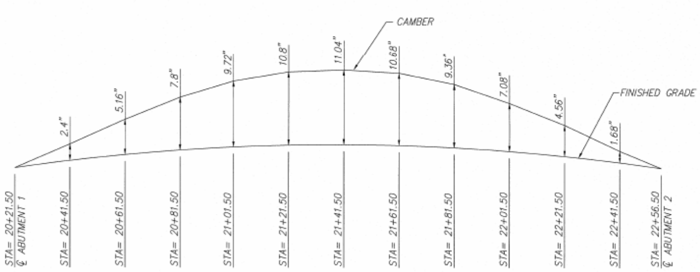
NOTES:

1. PROVIDE VENTS FOR P.T. DUCTS AT ANCHORING LOCATION, JACKING LOCATION, AND ALL HIGH POINTS.
2. PROVIDE DRAINS FOR P.T. DUCTS AT DUCT LOW POINTS.

"A" DIMENSION	
LOCATION	"A" INCHES
℄ ABUTMENT 1	10
℄ TEMP PIER 1	10
℄ TEMP PIER 2	10
℄ ABUTMENT 2	10

* SEE END DIAPHRAGM GEOMETRY SHEET B1.19

NOTE:
CAMBER DIAGRAM INDICATES LOCATION OF TOP OF DECK RELATIVE TO DESIRED FINAL GRADE PRIOR TO PLACEMENT OF DECK CONCRETE



CAMBER DIAGRAM

NTS

KGA KRAMER GEHLEN ASSOCIATES
Consulting Engineers Structural/Civil
400 COLUMBIA ST. SUITE 240 VANC. WA. 98660-3117
360-693-1621 503-289-2661

90% PLAN SET - FOR REVIEW ONLY

Conclusion

- Summarized Project Background
- Addressed Issues Pertaining to Deflections
  - Segment Rotations
  - Balance Prestress and P.T.
  - P.T. Profile
- Accounted For Various Creep Coefficients
- Monitor Future Deflections of the Bridge