

**COPY**  
SKT

---

*Structure Type Study*

**SR-823 Mainline over Fairground Road**

**SCI-823-0.00**  
**PID No. 19415**

Prepared for  
**Ohio Department of Transportation**

July 2005

**CH2MHILL**

---

*Structure Type Study*

**SR-823 Mainline over Fairground Road**

**SCI-823-0.00**  
**PID No. 19415**

Prepared for  
**Ohio Department of Transportation**

July 2005

**CH2MHILL**

# TABLE OF CONTENTS

<u>Table of Contents</u>	<u>Page No.</u>
1. Introduction.....	2
2. Design Criteria.....	2
3. Bridge Transverse Section and Alignment.....	3
4. Proposed Maintenance of Traffic Solution.....	3
5. Evaluation of Structure Alternatives.....	3
6. Recommended Alternative.....	6
7. Subsurface Conditions and Foundation Recommendation.....	6

## APPENDIX A

- Cost Comparison Summary (7 Alternatives)

## APPENDIX B

- Preliminary Structure Site Plan – Alternative 3 (Sheet 1 of 3)
- Structural Details – Alternative 3 (Sheets 2 to 3 of 3)

## APPENDIX C

- Preliminary Vertical Clearance Calculations (7 Alternatives)

## APPENDIX D

- Preliminary Structure Site Plan – Alternative 1 (Sheet 1 of 1)
- Preliminary Structure Site Plan – Alternative 2 (Sheet 1 of 1)
- Preliminary Structure Site Plan – Alternative 4 (Sheet 1 of 1)
- Preliminary Structure Site Plan – Alternative 5 (Sheet 1 of 1)
- Preliminary Structure Site Plan – Alternative 6 (Sheet 1 of 1)
- Preliminary Structure Site Plan – Alternative 7 (Sheet 1 of 1)

## APPENDIX E

- Preliminary Structural Foundation Recommendations (DLZ)

## 1. Introduction

Seven (7) alternatives for construction of the proposed SR-823 Mainline bridge over Fairground Road have been evaluated in this Structure Type Study, and are designated (in no particular order) Alternatives 1 through 7. All seven alternatives involve construction of the proposed bridge on either a single-span or a three-span layout. As part of the SCI-823-0.00 project, three roadway alignments, SR-823 Mainline, Ramp B, and Ramp C, pass over the existing Fairground Road. Due to the close proximity of the three roadway alignments at the proposed grade separations over Fairground Road, it is important from a construction, maintenance, and overall aesthetic standpoint to use similar structure types for the three bridges. Because the existing Fairground Road is a lightly-traveled, two-lane rural road, the required clear span is relatively short, and single-span alternatives are assumed to provide the most cost-effective structure. This assumption was verified in this document by analyzing three-span alternatives behind spill-through slopes for the SR-823 Mainline bridge over Fairground Road. The results show that a three-span alternative is excessive in both initial construction and life-cycle maintenance costs.

Alternatives 1 and 2 consist of a long span bridge deck supported by semi-integral stub abutments on spill through slopes constructed in fill. Alternatives 3 and 4 consist of a short, single-span bridge with tall Mechanically Stabilized Earth (MSE) abutments located outside of the horizontal clear zone. These MSE walls would be continuous and serve as the rear and forward abutment breastwalls for the SR-823 Mainline bridge over Fairground Road, as well as for both the adjacent Ramp B and Ramp C bridges over Fairground Road.

Alternatives 5, 6, and 7 consist of a three-span bridge deck supported by semi-integral stub abutments on spill through slopes constructed in fill; span lengths are controlled by both horizontal clear zone requirements and end span to intermediate span ratios to minimize structure costs. The long spans of Alternatives 1 and 2 allow for the use of a straight prestressed concrete I-beam superstructure and a tangent steel plate girder superstructure, respectively, while the short spans of Alternatives 3 and 4 allow for the use of a straight prestressed concrete I-beam superstructure and a tangent structural steel rolled beam superstructure, respectively. The three short spans of Alternatives 5, 6, and 7 allow for the use of a straight prestressed concrete I-beam superstructure, a tangent structural steel rolled beam superstructure, and a continuous concrete slab superstructure, respectively.

Each alternative was evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, aesthetics, constructability, and maintenance of traffic. Based on these evaluations, one alternative is recommended for further design development in the Bridge Preliminary Design Report stage.

## 2. Design Criteria

All proposed structure types are in accordance with the most current version of the Ohio Department of Transportation Bridge Design Manual and the 2002 AASHTO Standard Specifications for Highway Bridges, 17<sup>th</sup> edition.

### **3. Bridge Transverse Section and Alignment**

At the proposed bridge location, the SR-823 Mainline follows a tangent horizontal alignment. The proposed eastbound section consists of one 16-foot lane, a 6'-1 1/8" left shoulder, and an 8-foot right shoulder. The proposed westbound section also consists of one 16-foot lane, a 6'-1 1/8" left shoulder, and an 8-foot right shoulder. With two 1'-6" wide single slope outside deflector parapets and a 2'-9 3/4" wide single slope Type B1 median barrier, the out-to-out deck width is a constant 66'-0" for all alternatives. In addition, the SR-823 Mainline bridge deck will consist of a 1.6% deck cross slope.

The proposed SR-823 Mainline vertical alignment over Fairground Road consists of a -3.00 percent slope for the entire length of the proposed bridge structure.

The existing Fairground Road will remain on the existing horizontal alignment and vertical grade under the bridge, and will not be constructed as part of the project except as required for restoration after construction of the new bridge.

### **4. Proposed Maintenance of Traffic Solution**

The proposed SR-823 Mainline alignment will carry traffic both exiting southbound US-23 onto eastbound SR-823 and exiting westbound SR-823 onto southbound US-23. Because the SR-823 Mainline alignment is new construction, maintenance of traffic during construction of the SR-823 Mainline bridge over Fairground Road will be limited. With the exception of limited Fairground Road closure for superstructure beam setting, as well as traffic safety precautions throughout bridge construction, no additional maintenance of traffic solutions will need to be investigated.

### **5. Evaluation of Structure Alternatives**

#### **Common Considerations**

Construction costs for each alternative have been developed for an identical length of improvement, equal to the length of the longest alternative. Estimated construction costs for each alternative include all proposed work between these limits. The vertical profile of the SR-823 Mainline is controlled by the crossing over the Norfolk Southern Railway to the west of the proposed structure over Fairground Road. As a result, vertical clearance over Fairground Road greatly exceeds the 17'-0" minimum, and no additional costs associated with profile adjustments are necessary. Other estimated construction costs not included in the cost estimate include provisions for the reconstruction of Fairground Road (if required due to construction impacts) and maintenance of traffic cost differentials.

The existing Fairground Road section is an uncurbed roadway, with an edge of pavement to edge of pavement width of approximately 21'-0" and a design speed of 40 mph. Substructures along Fairground Road for alternatives consisting of spill-through slopes are located outside the minimum preferred horizontal clear zone of 8'-0". Substructures consisting of either abutments behind MSE walls or piers are located outside the minimum preferred horizontal clear zone width of 10'-0" to the face of MSE wall or pier.

### **Alternative 1**

Alternative 1 consists of a 124.00 foot single-span bridge with rear and forward abutments on steel H-piles behind spill-through 2:1 slopes. Both semi-integral stub abutment faces will be tangent and parallel to the Fairground Road centerline. For Alternative 1, the superstructure will consist of seven straight 72"-deep Modified AASHTO Type 4 prestressed concrete beams spaced at 9'-10" on center.

The initial bridge construction cost for Alternative 1 is estimated to be \$1,183,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$442,000, resulting in a total estimated ownership cost of \$1,625,000 in year 2008 dollars.

### **Alternative 2**

Alternative 2 also consists of a 124.00 foot single-span bridge with rear and forward abutments on steel H-piles behind spill-through 2:1 slopes. Both semi-integral stub abutment faces will be tangent and parallel to the Fairground Road centerline. For Alternative 2, however, the superstructure will consist of seven tangent steel plate girders, using Grade 50 steel members spaced at 9'-10" and having a web depth of 52".

The initial bridge construction cost for Alternative 2 is estimated to be \$1,293,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$660,000, resulting in a total estimated ownership cost of \$1,953,000 in year 2008 dollars.

### **Alternative 3**

Alternative 3 consists of a 53.25 foot single-span bridge with rear and forward semi-integral stub abutments behind tall MSE abutment breastwalls constructed outside the minimum preferred Fairground Road lateral clearance. The rear and forward abutment breastwalls will be parallel to the Fairground Road centerline. While it is possible to construct an MSE retaining wall with semi-integral stub abutments on steel H-piles, both the rear and the forward abutments are assumed to be founded on spread footings for this analysis. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. For Alternative 3, the superstructure will consist of eight 36"-deep AASHTO Type 2 prestressed concrete beams spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 3 is estimated to be \$1,001,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$203,000, resulting in a total estimated ownership cost of \$1,204,000 in year 2008 dollars.

### **Alternative 4**

Alternative 4 also consists of a 53.25 foot single-span bridge with rear and forward semi-integral stub abutments behind tall MSE abutment breastwalls constructed outside the minimum preferred Fairground Road lateral clearance. The rear and forward abutment breastwalls will be parallel to the Fairground Road centerline. While it is possible to

construct an MSE retaining wall with semi-integral stub abutments on steel H-piles, both the rear and the forward abutments are assumed to be founded on spread footings for this analysis. In the Preliminary Design Report submission, the footing width will need to be sized accordingly to satisfy the maximum bearing pressure of 4,000 psf, as required by the AASHTO specifications and ODOT Bridge Design Manual. For Alternative 4, the superstructure will consist of eight tangent W24 steel rolled beams, using Grade 50 steel members spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 4 is estimated to be \$990,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$268,000, resulting in a total estimated ownership cost of \$1,258,000 in year 2008 dollars.

### **Alternative 5**

Alternative 5 consists of a 41.50-55.00-41.50 foot three-span bridge (75% end span-to-middle span ratio) with rear and forward abutments on steel H-piles behind spill-through 2:1 slopes. Both semi-integral stub abutment faces will be tangent and parallel to the Fairground Road centerline. Two cap and column shoulder piers set outside of the minimum preferred lateral clearance zone will also be tangent and parallel to the Fairground Road centerline. Both piers will be on pedestal footings founded on steel H-piles. For Alternative 5, the superstructure will consist of eight 36"-deep AASHTO Type 2 prestressed concrete beams spaced at 8'-6" on center; the beams will be constructed as simple spans, requiring 24 total concrete beams.

The initial bridge construction cost for Alternative 5 is estimated to be \$1,326,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$468,000, resulting in a total estimated ownership cost of \$1,794,000 in year 2008 dollars.

### **Alternative 6**

Alternative 6 also consists of a 41.50-55.00-41.50 foot three-span bridge (75% end span-to-middle span ratio) with rear and forward abutments on steel H-piles behind spill-through 2:1 slopes. Both semi-integral stub abutment faces will be tangent and parallel to the Fairground Road centerline. Two cap and column shoulder piers set outside of the minimum preferred lateral clearance zone will also be tangent and parallel to the Fairground Road centerline. Both piers will be on pedestal footings founded on steel H-piles. For Alternative 6, the superstructure will consist of eight continuous W21 steel rolled beams, using Grade 50 steel members spaced at 8'-6" on center.

The initial bridge construction cost for Alternative 6 is estimated to be \$1,254,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$616,000, resulting in a total estimated ownership cost of \$1,870,000 in year 2008 dollars.

### **Alternative 7**

Alternative 7 also consists of a 41.50-55.00-41.50 foot three-span bridge (75% end span-to-middle span ratio) with rear and forward abutments on a single row of steel H-piles behind spill-through 2:1 slopes. Both integral abutment faces will be tangent and parallel to the Fairground Road centerline. Two cap and column shoulder piers set outside the minimum

preferred lateral clearance zone will also be tangent and parallel to the Fairground Road centerline. Both piers will be on pedestal footings founded on steel H-piles. For Alternative 7, the superstructure will consist of a 25 ½" thick continuous cast-in-place concrete slab deck, designed and constructed following both the ODOT Bridge Design Manual and ODOT Standard Bridge Drawings.

The initial bridge construction cost for Alternative 7 is estimated to be \$1,310,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be \$778,000, resulting in a total estimated ownership cost of \$2,088,000 in year 2008 dollars.

## **6. Recommended Alternative**

Seven (7) structural solutions for the construction of the proposed SR-823 Mainline alignment over Fairground Road have been evaluated in this structure type study. All alternatives provide comparable operational characteristics and meet minimum horizontal clearance requirements. Due to the fact that the proposed SR-823 Mainline grade separation structure over the Norfolk Southern Railway west of Fairground Road controls the vertical profile for vertical clearance, no differential costs associated with profile adjustments have been considered in the aforementioned alternatives. Based on lower estimated total ownership costs, **CH2M HILL recommends that the single-span bridge of ALTERNATIVE 3, using tall MSE walls and prestressed concrete I-beams, be constructed for the SR-823 Mainline bridge over Fairground Road.**

## **7. Subsurface Conditions and Foundation Recommendation**

Subsurface investigations for the SCI-823-0.00 project will be conducted in two, possibly three, phases. The first mobilization is complete, and included all of the proposed pavement and embankment borings, and a limited number of bridge borings. The second mobilization will include the remaining bridge borings (if necessary), and the majority of the proposed MSE retaining wall borings. If required, a third mobilization will target specific boring locations or in-situ testing recommended in the bridge and retaining wall Preliminary Design Report submissions.

Two borings at the SR-823 Mainline bridge over Fairground Road were taken during the first mobilization. Based on these initial borings, geotechnical subconsultant DLZ has made preliminary foundation recommendations for the SR-823 Mainline structure. Copies of the preliminary report are included with this submission.

The recommended alternative, Alternative 3, consists of semi-integral stub abutments supported behind MSE retaining walls for the single-span bridge. Both abutments are assumed to be supported on spread footings resting directly on the MSE select granular fill to avoid conflicts with the MSE reinforcing straps. If pile foundations are required and used, the piles are envisioned to be HP 14x73 H-pile sections driven to bedrock refusal. The pile spacing is assumed to be 7'-6" to allow for convenient staggering of the piles between MSE reinforcing in 5'-0" standard square wall panels. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock.

Final foundation size, capacity, and possible pile length recommendations will be made upon completion of the remaining bridge and retaining wall borings, and will be included with the bridge Preliminary Design Report submission.

**APPENDIX A**

**Cost Comparison Summary**

**SCI-823-0.00**  
**SCI-823 Over Fairground Road**  
**STRUCTURE TYPE STUDY**

Filename: \\Aries\Proj\TransSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\Structure Cost Comparison.xls\Substructure  
 By: SKT  
 Checked: Date: 07/05/2005  
 Date:

**COST COMPARISON SUMMARY**

Alternative No.	Span Arrangement No. Spans	Span Lengths	Framing Alternative	Proposed Stringer Section	Total Initial Superstructure Cost	Total Initial Substructure Cost	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	1	124.00	7 ~ P.S. Concrete I-Beams	AASHTO Type 4 Mod. (72")	\$581,000	\$263,000	\$1,183,000	\$442,000	\$1,625,000
2	1	124.00	7 ~ Steel Plate Girders	52" Web - Grade 50	\$660,000	\$263,000	\$1,293,000	\$660,000	\$1,953,000
3	1	53.25	8 ~ P.S. Concrete I-Beams	AASHTO Type 2	\$264,000	\$424,000	\$1,001,000	\$203,000	\$1,204,000
4	1	53.25	8 ~ Steel Rolled Beams	W24 - Grade 50	\$257,000	\$423,000	\$990,000	\$268,000	\$1,258,000
5	3	41.50 - 55.00 - 41.50	8 ~ P.S. Concrete I-Beams	AASHTO Type 2	\$615,000	\$338,000	\$1,326,000	\$468,000	\$1,794,000
6	3	41.50 - 55.00 - 41.50	8 ~ Steel Rolled Beams	W21 - Grade 50	\$561,000	\$340,000	\$1,254,000	\$616,000	\$1,870,000
7	3	41.50 - 55.00 - 41.50	Continuous Concrete Slab	-	\$701,000	\$240,000	\$1,310,000	\$778,000	\$2,088,000

**SCI-823-0.00**  
**SCI-823 Over Fairground Road**  
**STRUCTURE TYPE STUDY**

Filename: C:\Documents and Settings\brown3\Local Settings\Temporary Internet Files\OLK7\Structure Cost Comparison.xls\Alternative Summary  
 Date: 07/05/2005  
 By: SKT  
 Checked:

**ALTERNATIVE COST SUMMARY**

Alternative No.	Span Arrangement No. Spans	Span Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Approach Roadway Length (1)	Approach Roadway Cost (2, 3)	Structure Incidental Cost (16%)	Structure Contingency Cost (20%)	Roadway Incidental & Contingency Cost (30%)	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	1	124.00	124.00	7 ~ P.S. Concrete I-Beams	AASHTO Type 4 Mod. (72")	\$581,000	\$263,000	14.0	\$6,000	\$135,000	\$196,000	\$2,000	\$1,183,000	\$442,000	\$1,625,000
2	1	124.00	124.00	7 ~ Steel Plate Girders	52" Web - Grade 50	\$660,000	\$263,000	14.0	\$6,000	\$148,000	\$214,000	\$2,000	\$1,293,000	\$660,000	\$1,953,000
3	1	53.25	53.25	8 ~ P.S. Concrete I-Beams	AASHTO Type 2	\$264,000	\$424,000	84.8	\$33,000	\$110,000	\$160,000	\$10,000	\$1,001,000	\$203,000	\$1,204,000
4	1	53.25	53.25	8 ~ Steel Rolled Beams	W24 - Grade 50	\$257,000	\$423,000	84.8	\$33,000	\$109,000	\$158,000	\$10,000	\$990,000	\$268,000	\$1,258,000
5	3	41.50 - 55.00 - 41.50	138.00	8 ~ P.S. Concrete I-Beams	AASHTO Type 2	\$615,000	\$338,000	0.0	\$0	\$152,000	\$221,000	\$0	\$1,326,000	\$468,000	\$1,794,000
6	3	41.50 - 55.00 - 41.50	138.00	8 ~ Steel Rolled Beams	W21 - Grade 50	\$561,000	\$340,000	0.0	\$0	\$144,000	\$209,000	\$0	\$1,254,000	\$616,000	\$1,870,000
7	3	41.50 - 55.00 - 41.50	138.00	Continuous Concrete Slab	-	\$701,000	\$240,000	0.0	\$0	\$151,000	\$218,000	\$0	\$1,310,000	\$778,000	\$2,088,000

**NOTES:**

- Approach roadway length equals the difference between the maximum bridge length and the bridge length for the alternative being considered.
  - Use 2004 pavement cost = \$33.20 /sq. yd. Allow 3.5% escalation for years 2005 - 2008  
 2008 Unit Cost = \$38.10 /sq. yd.
- Pavement Widths:
- | Alternative | Average Rear Approach | Average Fwd. Approach | Combined Average |
|-------------|-----------------------|-----------------------|------------------|
| Alt. 1      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 2      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 3      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 4      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 5      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 6      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
| Alt. 7      | 66.00 ft.             | 66.00 ft.             | 66.00 ft.        |
- Use 2004 Concrete Barrier, Single Slope, Type B1 cost = \$50.30 /ft.  
 Allow 3.5% escalation for years 2005 - 2008 2008 Unit Cost = \$57.70 /ft.
  - Structure incidental cost allowance includes provision for structure excavation, porous backfill & drainage pipe, sealing of concrete surfaces, structural steel painting, bearings, (minor) temporary shoring, crushed aggregate slope protection, pile driving equipment mobilization, shear connectors, settlement platforms, expansion joints, joint sealers, and joint fillers costs.
  - Roadway incidental cost allowance includes provision for drainage, maintenance of traffic, and traffic control costs.
  - Estimated construction cost does not include existing structure removal, which should be quantified separately, if required.
  - No profile adjustment costs associated with raising the SCI-823 profiles have been considered, since all alternatives satisfy the minimum required vertical clearance of 17'-0" for steel structures and 17'-0" for concrete structures.

Alternative	Vertical Clearance Provided (ft.)	Profile Adjustment Required (ft.)
Alt. 1	19.95 ft.	0.00 ft.
Alt. 2	21.58 ft.	0.00 ft.
Alt. 3	23.03 ft.	0.00 ft.
Alt. 4	24.11 ft.	0.00 ft.
Alt. 5	23.03 ft.	0.00 ft.
Alt. 6	24.36 ft.	0.00 ft.
Alt. 7	24.78 ft.	0.00 ft.

**SCI-823-0.00**  
**SCI-823 Over Fairground Road**  
**STRUCTURE TYPE STUDY**

Filename: C:\Documents and Settings\brown3\Local Settings\Temporary Internet Files\OLK7\Structure Cost Comparison.xls\Alternative Summary  
 Date: 07/05/2005  
 By: SKT  
 Checked:

**SUPERSTRUCTURE**

Alternative No.	Span Arrangement No. Spans	Span Lengths (ft.)	Total Span Length (ft.)	Deck Length (ft.)	Deck Area (sq. ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Framing Alternative	Annual Escalation	Year 2004	Year 2008	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Prestressed Girder Cost	Initial Superstructure Cost
1	1	124.00	124.00	126.00	8,300	323	\$193,900	\$81,000	\$72,600	7 ~ P.S. Concrete I-Beams	3.5%	\$26,000	\$29,840	AASHTO Type 4 Mod. (72")	0.0	\$0	\$233,700	\$581,000
2	1	124.00	124.00	126.00	8,300	337	\$202,300	\$84,600	\$72,600	7 ~ Steel Plate Girders	3.5%	\$1,800	\$2,070	52" Web - Grade 50	249000.0	\$300,000	\$0	\$660,000
3	1	53.25	53.25	55.25	3,600	142	\$85,000	\$35,500	\$60,500	8 ~ P.S. Concrete I-Beams	3.5%	\$1,200	\$1,380	AASHTO Type 2	0.0	\$0	\$83,100	\$264,000
4	1	53.25	53.25	55.25	3,600	142	\$85,000	\$35,500	\$60,500	8 ~ Steel Rolled Beams	3.5%	\$8,000	\$9,180	W24 - Grade 50	90000.0	\$76,400	\$0	\$257,000
5	3	41.50 - 55.00 - 41.50	138.00	140.00	9,200	359	\$215,400	\$90,000	\$60,500	8 ~ P.S. Concrete I-Beams	3.5%	\$1,800	\$2,070	AASHTO Type 2	0.0	\$0	\$249,300	\$615,000
6	3	41.50 - 55.00 - 41.50	138.00	140.00	9,200	359	\$215,400	\$90,000	\$60,500	8 ~ Steel Rolled Beams	3.5%	\$1,200	\$1,380	W21 - Grade 50	230000.0	\$195,300	\$0	\$561,000
7	3	41.50 - 55.00 - 41.50	138.00	140.00	9,200	820	\$474,500	\$165,900	\$60,500	Continuous Concrete Slab	3.5%	\$1,200	\$1,380	-	0.0	\$0	\$0	\$701,000

**Prestressed Concrete Girders**

**Unit Costs:**

Alt.	Type	Year 2004	Annual Escalation	Year 2008	No. Required
Alt. 1	AASHTO Type IV Modified Beams				
	Type 4 I-Beams (72")	\$26,000	3.5%	\$29,840	7
	Pier Diaphragms	\$1,800	3.5%	\$2,070	0
	Abutment Diaphragms	\$1,200	3.5%	\$1,380	0
	Intermediate Diaphragms	\$1,200	3.5%	\$1,380	18
Alt. 3	AASHTO Type 2 Beams				
	Type 2 I-Beams (36")	\$8,000	3.5%	\$9,180	8
	Pier Diaphragms	\$1,800	3.5%	\$2,070	0
	Abutment Diaphragms	\$1,200	3.5%	\$1,380	0
	Intermediate Diaphragms	\$1,200	3.5%	\$1,380	7

Note: Deck width measured as average width.  
 10% of deck area allowed for haunches and overhangs (excludes slab alternative).

**QC/QA Concrete, Class QSC2**

**Unit Cost (\$/cu. yd.):**

Year	Annual Escalation	Year 2008
2004		\$563.00
	3.5%	\$706.00
	3.5%	\$600.00
		\$579.00

Based on parapet and slab percentages of total concrete area

**Epoxy Coated Reinforcing Steel**

**Unit Cost (\$/lb.):**

Assume 285 lbs of reinforcing steel per cubic yard of deck concrete for concrete or steel girder bridges  
 230 lbs of reinforcing steel per cubic yard of deck concrete for slab bridges

Year	Annual Escalation	Year 2008
2004		\$0.88
	3.5%	\$0.88

**Reinforced Concrete Approach Slabs (T=15")**

**Unit Cost (\$/sq. yd.):**

Alt. 1 & 2  
 Length = 30 ft.  
 Area = 220 sq. yd.  
 Width = 66.00 ft.

Alt. 3 - 7  
 Length = 25 ft.  
 Area = 183 sq. yd.  
 Width = 66.00 ft.

Year	Annual Escalation	Year 2008
2004		\$144.00
	3.5%	\$165.00

Approach Slabs

Superstructure

**Structural Steel**

**Unit Costs (\$/lb.):**

Year	Cost Ratio	Year 2004	Annual Escalation	Year 2008
	n/a	\$0.74	3.5%	\$0.85
	n/a	\$1.05	3.5%	\$1.20
	1.10	\$1.16	3.5%	\$1.33

Roller Beams - Grade 50  
 Plate Girders - Grade 50  
 Hybrid Plate Girders - Grade 50/70W  
 Note - all structural steel weight will be estimated at 30 pounds per each square foot of bridge deck area for long span tangent girders.  
 25 pounds per each square foot of bridge deck area for short span tangent girders.



SCI-823-0.00  
STRUCTURE TYPE STUDY

Filename: C:\Documents and Settings\abrown\Local Settings\Temporary Internet Files\OLK7\Structure Cost Comparison.sbj\Alternative Summary  
Date: 07/09/2005  
By: SKT  
Checked:

LIFE CYCLE MAINTENANCE COST

Alt. No.	Span Arrangement	Span Lengths	Framing Alternative	Structural Steel Painting		Superstructure Sealing		Approach Pavement Resurfacing		
				Cost Per Cycle	Number of Cycles	Cost Per Cycle	Number of Cycles	Cost Per Cycle	Number of Cycles	
1	1	124.00	7 - P-S, Concrete I-Beams	\$0	0	\$19,400	2	\$38,800	7	\$31,500
2	1	124.00	7 - Steel Plate Girders	\$122,400	2	\$244,800	0	\$0	7	\$31,500
3	1	53.25	8 - P-S, Concrete I-Beams	\$0	0	\$4,700	2	\$9,400	7	\$19,600
4	1	53.25	8 - Steel Rolled Beams	\$37,100	2	\$74,200	0	\$0	7	\$19,600
5	3	41.50 - 55.00 - 41.50	8 - P-S, Concrete I-Beams	\$0	0	\$12,200	2	\$24,400	0	\$0
6	3	41.50 - 55.00 - 41.50	8 - Steel Rolled Beams	\$86,300	2	\$172,600	0	\$0	0	\$0
7	3	41.50 - 55.00 - 41.50	Continuous Concrete Slab	\$0	0	\$0	0	\$0	0	\$0

Alt. No.	Span Arrangement	Span Lengths	Framing Alternative	Bridge Deck Overlay (5)		Bridge Decking (5)		Total Relative Ownership Cost
				Cost	Number of Cycles	Cost	Number of Cycles	
1	1	124.00	7 - P-S, Concrete I-Beams	\$25,200	1	\$25,200	1	\$1,625,000
2	1	124.00	7 - Steel Plate Girders	\$25,200	1	\$25,200	1	\$1,953,000
3	1	53.25	8 - P-S, Concrete I-Beams	\$10,900	1	\$10,900	1	\$1,204,000
4	1	53.25	8 - Steel Rolled Beams	\$10,900	1	\$10,900	1	\$1,258,000
5	3	41.50 - 55.00 - 41.50	8 - P-S, Concrete I-Beams	\$27,900	1	\$27,900	1	\$1,794,000
6	3	41.50 - 55.00 - 41.50	8 - Steel Rolled Beams	\$27,900	1	\$27,900	1	\$1,870,000
7	3	41.50 - 55.00 - 41.50	Continuous Concrete Slab	\$27,900	1	\$27,900	1	\$2,088,000

Structural Steel Painting:

Structural Steel Area:	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (ft.)	Nominal Exposed Area (sq. ft.)	Secondary Member Allowance	Total Exposed Area (sq. ft.)	Year 2004 Escalation	Year 2008 Escalation
Alt. 2	52	7	124.0	12.00	10,127	20%	12,200	3.5%	3.5%
Alt. 4	24	8	53.3	13.00	3,089	20%	3,700	3.5%	3.5%
Alt. 6	21	8	138.0	12.00	7,176	20%	8,600	3.5%	3.5%

Superstructure Sealing:

PS Concrete I-Beam Area	72" Modified AASHTO Type 4	Diag.	No.	Total Length (ft.)	Year 2004 Escalation	Year 2008 Escalation
Bot. Flange	26	8	1	26.00	3.5%	3.5%
Lower Fillets	9	9	2	18.00	3.5%	3.5%
Web	46	2	2	92.00	3.5%	3.5%
Upper Fillets	3	3	2	6.00	3.5%	3.5%
Top Flange	11	2	2	22.00	3.5%	3.5%
Total Exposed Perimeter	4	2	2	198.31	3.5%	3.5%

36" AASHTO Type 2

Diag.	No.	Total Length (ft.)	Year 2004 Escalation	Year 2008 Escalation
Bot. Flange	18	1	18.00	3.5%
Lower Fillets	6	6	18.00	3.5%
Web	15	2	30.00	3.5%
Upper Fillets	3	3	9.00	3.5%
Top Flange	6	2	12.00	3.5%
Total Exposed Perimeter	6	2	97.47	3.5%

PS Concrete Area:

Alt. No.	Span Length (ft.)	Total Exposed Area (sq. ft.)	Year 2004 Escalation	Year 2008 Escalation
Alt. 1	7	14,344	3.5%	3.5%
Alt. 3	8	3,460	3.5%	3.5%
Alt. 5	8	8,967	3.5%	3.5%

Sealing Cost per sq. ft.:

Year 2004	Year 2008
\$9.08	\$11.11

Epoxy-Urethane Sealer

Year 2004	Year 2008
\$59.50	\$68.28

Bridge Decking:

Year 2004 Escalation	Year 2008 Escalation
\$238.00	\$273.11

Bridge Deck Removal Cost:

Year 2004 Escalation	Year 2008 Escalation
\$28.28	\$36.22

Bridge Deck Overlay (Item 848):

Year 2004 Escalation	Year 2008 Escalation
\$29.59	\$42.54

Hand Chipping (10% of deck area):

Year 2004 Escalation	Year 2008 Escalation
\$37.07	\$48.24

Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only

Year 2004 Escalation	Year 2008 Escalation
\$144.00	\$165.24

NOTES:

- Life cycle maintenance costs assume a 75 -year structure life, and are expressed in present value (2008 construction year) dollars.
- Bridges are assumed to have semi-integral abutments, therefore no strip seal deck joints will be required.
- See Superstructure Cost sheet.
- See Alternative Cost Summary sheet.
- Assume bridge deck overlay at Year 25 and bridge deck replacement at Year 50. Assume superstructures are painted or sealed on a 25-year recurrence interval. Assume complete bridge replacement at Year 75.
- Life cycle maintenance cost differences are assumed to be predominantly a function of superstructure maintenance costs. Consequently, substructure lifecycle maintenance costs are not included in this analysis.

Approach Pavement Resurfacing:

Year 2004 Escalation	Year 2008 Escalation
\$0.98	\$1.12

Approach Resurfacing Costs:

Year 2004 Escalation	Year 2008 Escalation
\$72.00	\$82.62



**BENCHMARKS**

**TRAFFIC DATA**  
CURRENT ADT (2010) = 8900  
DESIGN ADT (2030) = 13000  
DESIGN ADTT = 1820

**LEGEND**  
⊕ INDICATES BORING LOCATION

**NOTE**  
EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

**PROPOSED STRUCTURE**

**TYPE:** SINGLE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK AND SEMI-INTEGRAL ABUTMENTS ON MSE WALLS

**LENGTH OF SPAN:** 53'-3", MEASURED ALONG Ⓢ CONSTRUCTION

**ROADWAY:** 30'-1 1/8" TOE/TOE PARAPETS (RB)  
30'-1 1/8" TOE/TOE PARAPETS (LB)

**SIDEWALK:** NONE

**DESIGN LOADING:** HS25 AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT

**SKEW:** 16°50'19" RIGHT FORWARD

**WEARING SURFACE:** MONOLITHIC CONCRETE

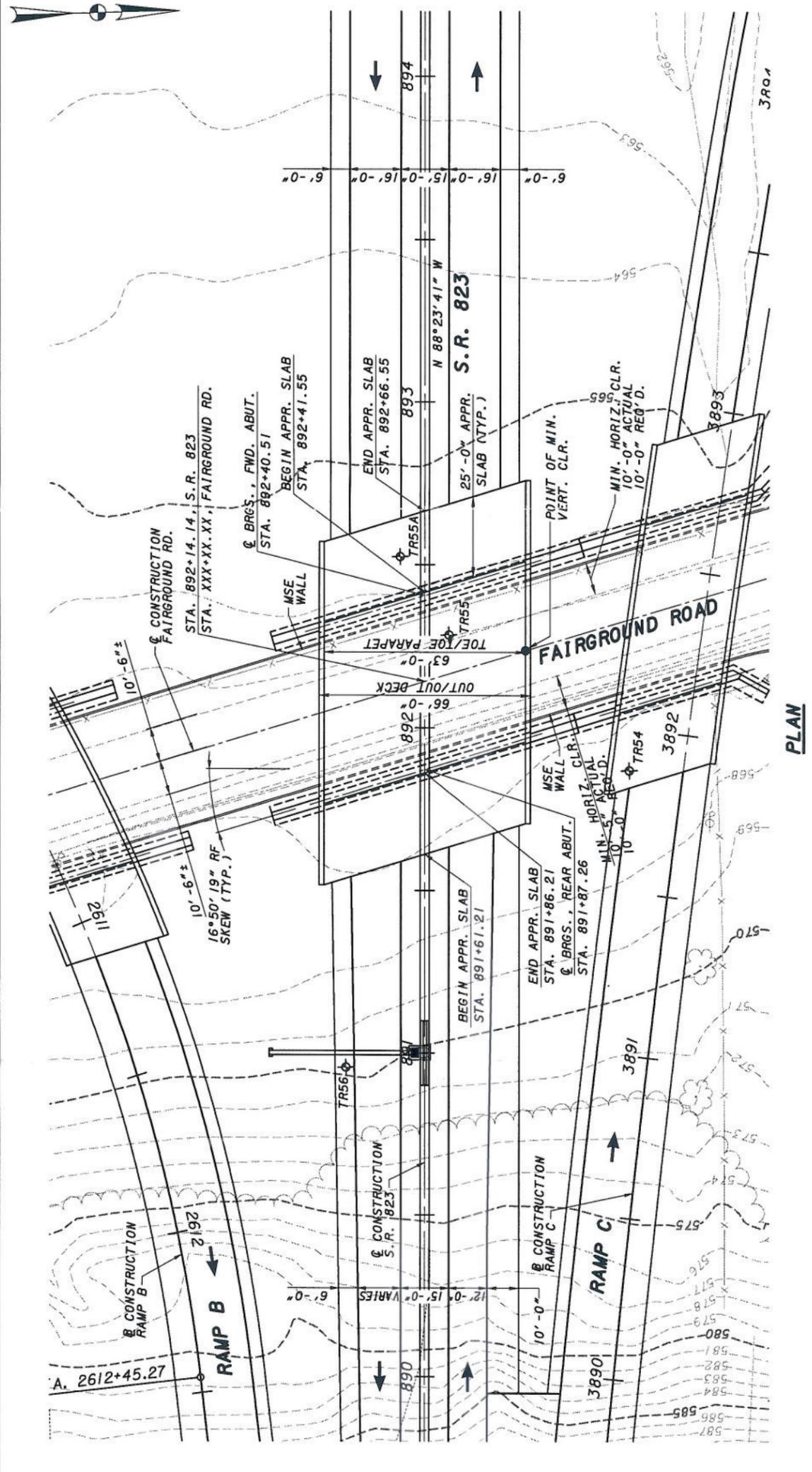
**APPROACH SLABS:** AS-1-81 (25'-0" LONG)

**ALIGNMENT:** TANGENT

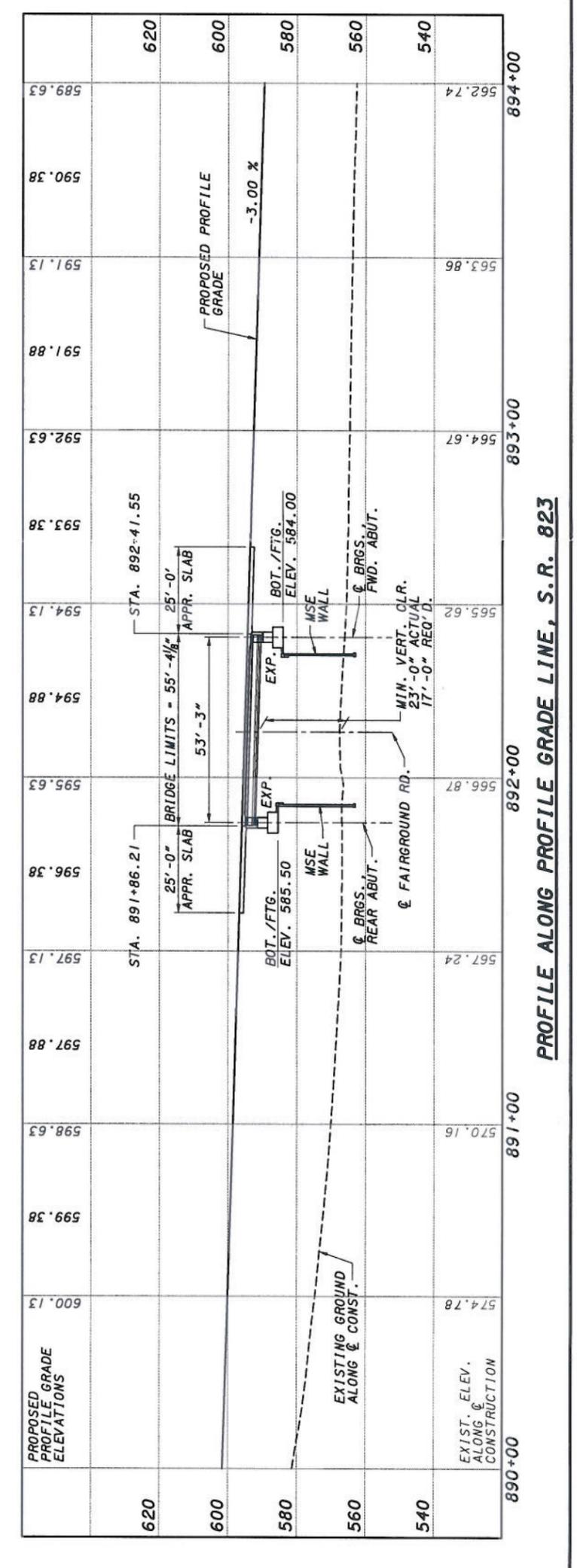
**CROWN:** 0.016 FT/FT

**LATITUDE:** N 38°53'32"

**LONGITUDE:** W 82°59'52"

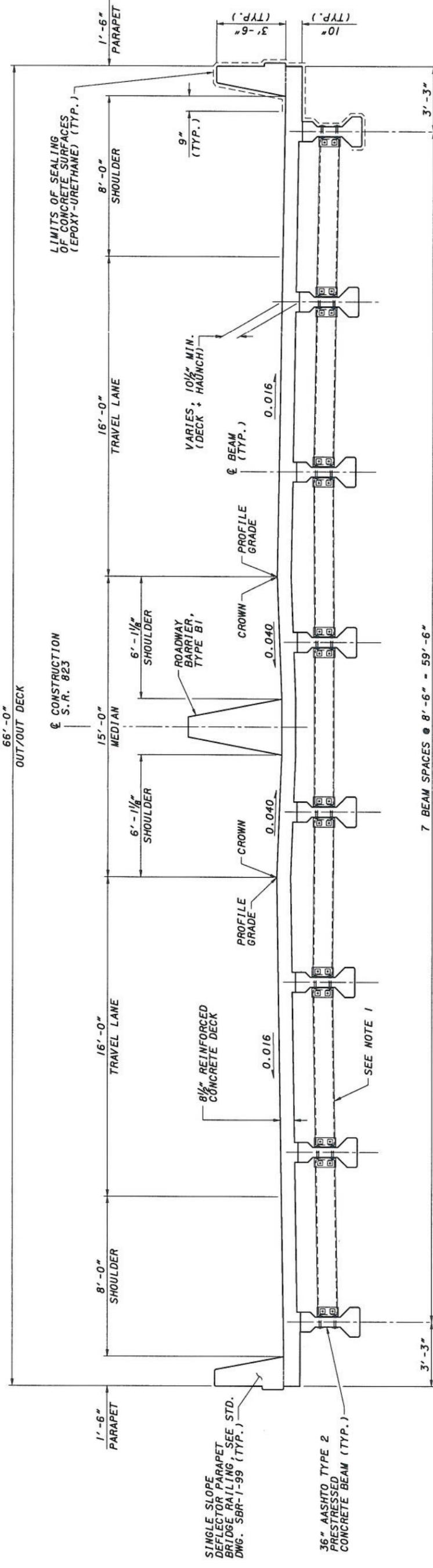


**PLAN**



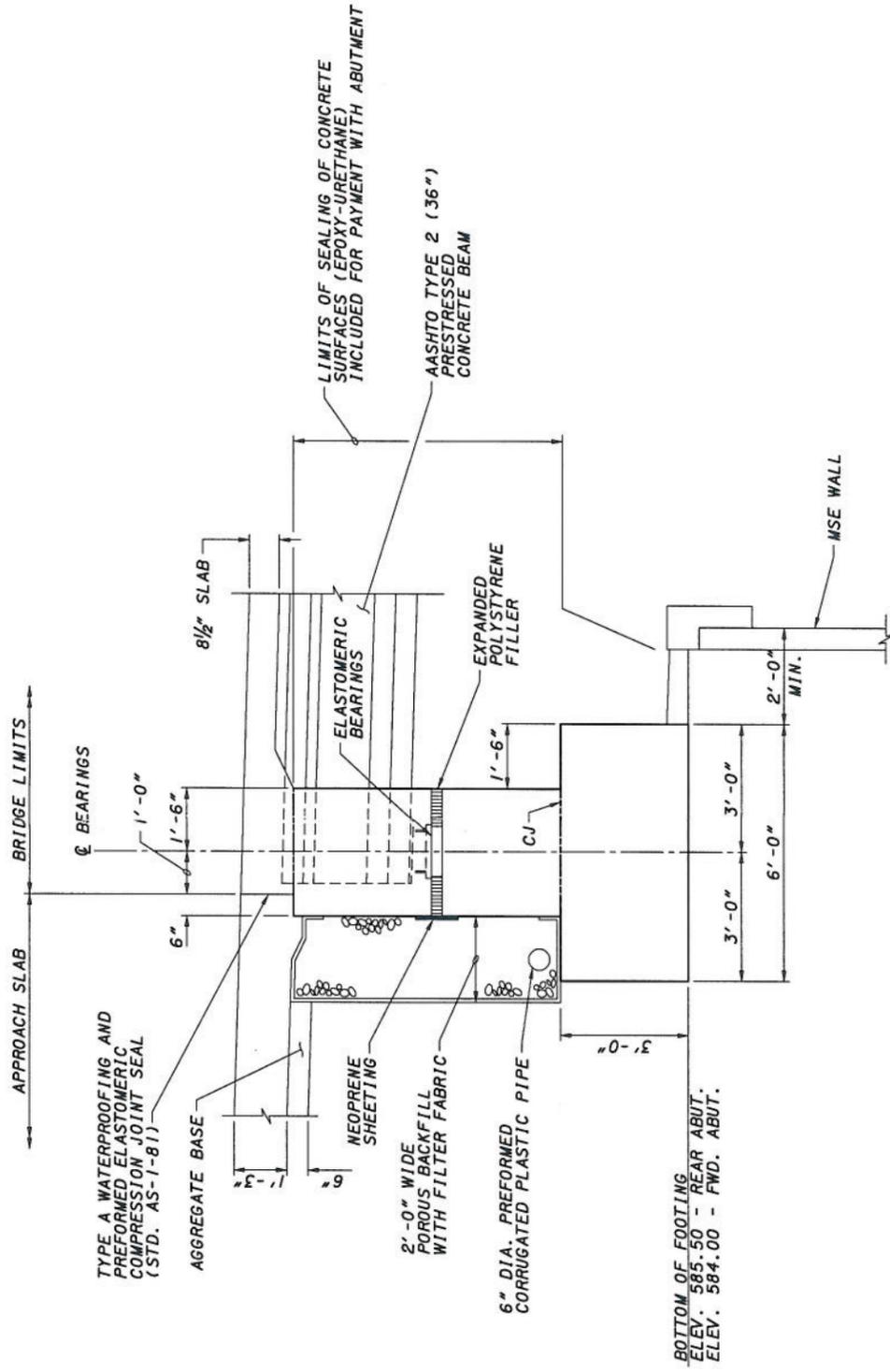
**PROFILE ALONG PROFILE GRADE LINE, S.R. 823**

DESIGNED	DGS	DATE
CHECKED	DGS	DATE
REVISED	STRUCTURE FILE NUMBER	DATE
REVISED	GAS	DATE



TYPICAL TRANSVERSE SECTION

**NOTES:**  
1. INTERMEDIATE DIAPHRAGMS MAY BE CAST-IN-PLACE CONCRETE OR GALVANIZED STEEL. FOR DETAILS OF BOTH DIAPHRAGM TYPES, SEE STANDARD CONSTRUCTION DRAWING PSID-1-99.



**REAR AND FORWARD ABUTMENT SECTION**

BOTTOM OF FOOTING  
ELEV. 585.50 - REAR ABUT.  
ELEV. 584.00 - FWD. ABUT.

**APPENDIX C**

**Vertical Clearance Calculations**

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\aries\proj\tran\systems\31986119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1  
 By: SKT Date: 06/02/2005  
 Checked: Date: **LEGEND:**  
 User Input - Not Critical  
 User Input - Critical to Output

**Alternative 1 - AASHTO Type 4 Modified Concrete I-Beams**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION			SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.			
1	RT. FASCIA BEAM	892+12.36	22.00	595.26	-1.6%	594.91
2	RT. FASCIA BEAM	892+22.75	22.00	594.95	-1.6%	594.59
3	RT. FASCIA BEAM	892+33.52	22.00	594.62	-1.6%	594.27
4	LT. FASCIA BEAM	891+94.54	22.00	595.79	-1.6%	595.44
5	LT. FASCIA BEAM	892+05.01	22.00	595.48	-1.6%	595.13
6	LT. FASCIA BEAM	892+15.58	22.00	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 4.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in
2	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in
3	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in
4	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in
5	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in
6	TYPE IV, MODIFIED	8.50	4.00	0.0	72	0.0	-	84.50 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA BEAM	594.91	84.500	587.86	567.48	20.38
2	RT. FASCIA BEAM	594.59	84.500	587.55	567.60	19.95
3	RT. FASCIA BEAM	594.27	84.500	587.23	567.00	20.23
4	LT. FASCIA BEAM	595.44	84.500	588.40	567.48	20.92
5	LT. FASCIA BEAM	595.13	84.500	588.08	567.74	20.34
6	LT. FASCIA BEAM	594.81	84.500	587.77	567.18	20.59

OK  
OK  
OK  
OK  
OK  
OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\aries\proj\tran\systems\319861\119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1

By: SKT  
 Checked:

Date: 06/02/2005  
 Date:

**LEGEND:**

User Input - Not Critical  
 User Input - Critical to Output

**Alternative 2 - 52" Steel Plate Girders**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION			SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.			
1	RT. FASCIA GIRDER	892+12.36	22.00	595.26	-1.6%	594.91
2	RT. FASCIA GIRDER	892+22.75	22.00	594.95	-1.6%	594.59
3	RT. FASCIA GIRDER	892+33.52	22.00	594.62	-1.6%	594.27
4	LT. FASCIA GIRDER	891+94.54	22.00	595.79	-1.6%	595.44
5	LT. FASCIA GIRDER	892+05.01	22.00	595.48	-1.6%	595.13
6	LT. FASCIA GIRDER	892+15.58	22.00	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 3.0 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in
2	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in
3	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in
4	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in
5	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in
6	52" PLATE GIRDER	9.00	2.00	1.0	52	1.0	-	65.00 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA GIRDER	594.91	65.000	589.49	567.48	22.01
2	RT. FASCIA GIRDER	594.59	65.000	589.18	567.60	21.58
3	RT. FASCIA GIRDER	594.27	65.000	588.85	567.00	21.85
4	LT. FASCIA GIRDER	595.44	65.000	590.02	567.48	22.54
5	LT. FASCIA GIRDER	595.13	65.000	589.71	567.74	21.97
6	LT. FASCIA GIRDER	594.81	65.000	589.39	567.18	22.21

OK  
 OK  
 OK  
 OK  
 OK  
 OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\Aries\Proj\TransSystems\31986\119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1  
 By: SKT Date: 06/02/2005  
 Checked: Date:

**LEGEND:**  
 User Input - Not Critical  
 User Input - Critical to Output

**Alternative 3 - AASHTO Type 2 Concrete I-Beams**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION			SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.			
1	RT. FASCIA BEAM	892+12.43	22.25	595.26	-1.6%	594.90
2	RT. FASCIA BEAM	892+22.83	22.25	594.94	-1.6%	594.59
3	RT. FASCIA BEAM	892+33.60	22.25	594.62	-1.6%	594.26
4	LT. FASCIA BEAM	891+94.47	22.25	595.79	-1.6%	595.44
5	LT. FASCIA BEAM	892+04.94	22.25	595.48	-1.6%	595.12
6	LT. FASCIA BEAM	892+15.51	22.25	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 3.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
2	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
3	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
4	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
5	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
6	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA BEAM	594.90	47.500	590.94	567.48	23.46
2	RT. FASCIA BEAM	594.59	47.500	590.63	567.60	23.03
3	RT. FASCIA BEAM	594.26	47.500	590.31	567.00	23.31
4	LT. FASCIA BEAM	595.44	47.500	591.48	567.48	24.00
5	LT. FASCIA BEAM	595.12	47.500	591.17	567.74	23.43
6	LT. FASCIA BEAM	594.81	47.500	590.85	567.18	23.67

OK  
 OK  
 OK  
 OK  
 OK  
 OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\Aries\Proj\TranSystems\319861\19415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1

By: SKT  
 Checked:

Date: 06/02/2005  
 Date:

**LEGEND:**

User Input - Not Critical  
 User Input - Critical to Output

**Alternative 4 - W24 Steel Rolled Beams**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data: Station Pavement  
 875+00.00 -1.6%  
 904+00.00 -1.6%

POINT	SR 823 MAINLINE LOCATION			SR 823 PG. ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA.	OFF.			
1	RT. FASCIA BEAM	892+12.43	22.25	595.26	-1.6%	594.90
2	RT. FASCIA BEAM	892+22.83	22.25	594.94	-1.6%	594.59
3	RT. FASCIA BEAM	892+33.60	22.25	594.62	-1.6%	594.26
4	LT. FASCIA BEAM	891+94.47	22.25	595.79	-1.6%	595.44
5	LT. FASCIA BEAM	892+04.94	22.25	595.48	-1.6%	595.12
6	LT. FASCIA BEAM	892+15.51	22.25	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 3.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in
2	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in
3	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in
4	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in
5	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in
6	W24 ROLLED BEAM	8.50	2.00	1.0	22	1.0	-	34.50 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA BEAM	594.90	34.500	592.02	567.48	24.54
2	RT. FASCIA BEAM	594.59	34.500	591.71	567.60	24.11
3	RT. FASCIA BEAM	594.26	34.500	591.39	567.00	24.39
4	LT. FASCIA BEAM	595.44	34.500	592.56	567.48	25.08
5	LT. FASCIA BEAM	595.12	34.500	592.25	567.74	24.51
6	LT. FASCIA BEAM	594.81	34.500	591.93	567.18	24.75

OK  
 OK  
 OK  
 OK  
 OK  
 OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\Aries\Proj\TranSystems\319861\119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1

By: SKT  
 Checked:

Date: 06/02/2005  
 Date:

**LEGEND:**

User Input - Not Critical  
 User Input - Critical to Output

**Alternative 5 - AASHTO Type 2 Concrete I-Beams**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION		SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA. OFF.			
1	RT. FASCIA BEAM	892+12.43 22.25	595.26	-1.6%	594.90
2	RT. FASCIA BEAM	892+22.83 22.25	594.94	-1.6%	594.59
3	RT. FASCIA BEAM	892+33.60 22.25	594.62	-1.6%	594.26
4	LT. FASCIA BEAM	891+94.47 22.25	595.79	-1.6%	595.44
5	LT. FASCIA BEAM	892+04.94 22.25	595.48	-1.6%	595.12
6	LT. FASCIA BEAM	892+15.51 22.25	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 3.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
2	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
3	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
4	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
5	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in
6	AASHTO TYPE 2	8.50	3.00	0.0	36	0.0	-	47.50 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. FASCIA BEAM	594.90	47.500	590.94	567.48	23.46
2	RT. FASCIA BEAM	594.59	47.500	590.63	567.60	23.03
3	RT. FASCIA BEAM	594.26	47.500	590.31	567.00	23.31
4	LT. FASCIA BEAM	595.44	47.500	591.48	567.48	24.00
5	LT. FASCIA BEAM	595.12	47.500	591.17	567.74	23.43
6	LT. FASCIA BEAM	594.81	47.500	590.85	567.18	23.67

OK  
 OK  
 OK  
 OK  
 OK  
 OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\Aries\Proj\TranSystems\31986119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1  
 By: SKT Date: 06/02/2005  
 Checked: Date: **LEGEND:** User Input - Not Critical  
 User Input - Critical to Output

**Alternative 6 - W21 Steel Rolled Beams**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.48
5	Centerline	n/a	567.74
6	E/Pavement SB	n/a	567.18

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data: Station Pavement  
 875+00.00 -1.6%  
 904+00.00 -1.6%

POINT	SR 823 MAINLINE LOCATION		SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA. OFF.			
1	RT. FASCIA BEAM	892+12.43 22.25	595.26	-1.6%	594.90
2	RT. FASCIA BEAM	892+22.83 22.25	594.94	-1.6%	594.59
3	RT. FASCIA BEAM	892+33.60 22.25	594.62	-1.6%	594.26
4	LT. FASCIA BEAM	891+94.47 22.25	595.79	-1.6%	595.44
5	LT. FASCIA BEAM	892+04.94 22.25	595.48	-1.6%	595.12
6	LT. FASCIA BEAM	892+15.51 22.25	595.16	-1.6%	594.81

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 3.0 in

POINT	BEAM DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in
2	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in
3	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in
4	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in
5	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in
6	W21 ROLLED BEAM	8.50	2.00	1.0	19	1.0	-	31.50 in

**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. BEAM ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	
1	RT. FASCIA BEAM	594.90	31.500	592.27	567.48	24.79	OK
2	RT. FASCIA BEAM	594.59	31.500	591.96	567.60	24.36	OK
3	RT. FASCIA BEAM	594.26	31.500	591.64	567.00	24.64	OK
4	LT. FASCIA BEAM	595.44	31.500	592.81	567.48	25.33	OK
5	LT. FASCIA BEAM	595.12	31.500	592.50	567.74	24.76	OK
6	LT. FASCIA BEAM	594.81	31.500	592.18	567.18	25.00	OK

**SCI-823-0.00**  
**SR 823 MAINLINE OVER FAIRGROUND ROAD**  
**VERTICAL CLEARANCES**

Filename: \\Ariest\Proj\TranSystems\31986119415\structures documents\Step 7 - Type Study\Bridge SCI823-1594C 823 over Fairground\SR823\_Vert\_Clr.xls\Alternative 1  
 By: SKT Date: 06/02/2005  
 Checked: Date: **LEGEND:** User Input - Not Critical  
 User Input - Critical to Output

**Alternative 7 - 25 1/2" Continuous Concrete Slab**

**PROFILE DATA - Fairground Road**

Use existing pavement elevations as Fairground Road will not be reconstructed in this project

POINT	FAIRGROUND ROAD LOCATION	FAIRGROUND ROAD STATION	FAIRGROUND ROAD - EXISTING ELEV. @ POINT
1	E/Pavement NB	n/a	567.48
2	Centerline	n/a	567.60
3	E/Pavement SB	n/a	567.00
4	E/Pavement NB	n/a	567.49
5	Centerline	n/a	567.76
6	E/Pavement SB	n/a	567.20

**PROFILE DATA - SR 823 MAINLINE**

Linear: PVT Sta. 875+00.00 PVC Sta. 904+00.00  
 PVT Elev. 646.63 PVC Elev. 559.63  
 g -3.00%

Superelevation Data:

Station	Pavement
875+00.00	-1.6%
904+00.00	-1.6%

POINT	SR 823 MAINLINE LOCATION		SR 823 PG ELEV.	PAVEMENT X-SLOPE	SR 823 - FINISHED GRADE @ POINT
	DESCRIPTION	STA. OFF.			
1	RT. EDGE/DECK	892+13.42 25.50	595.23	-1.6%	594.82
2	RT. EDGE/DECK	892+23.81 25.50	594.91	-1.6%	594.51
3	RT. EDGE/DECK	892+34.62 25.50	594.59	-1.6%	594.18
4	LT. EDGE/DECK	891+93.49 25.50	595.82	-1.6%	595.42
5	LT. EDGE/DECK	892+03.96 25.50	595.51	-1.6%	595.10
6	LT. EDGE/DECK	892+14.58 25.50	595.19	-1.6%	594.78

**STRUCTURE DEPTH**

Haunch + Max. Top Flange = 0.0 in

POINT	SUPERSTRUCTURE DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in
2	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in
3	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in
4	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in
5	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in
6	25 1/2" CONC. SLAB	25.50	0.00	0.0	0	0.0	-	25.50 in

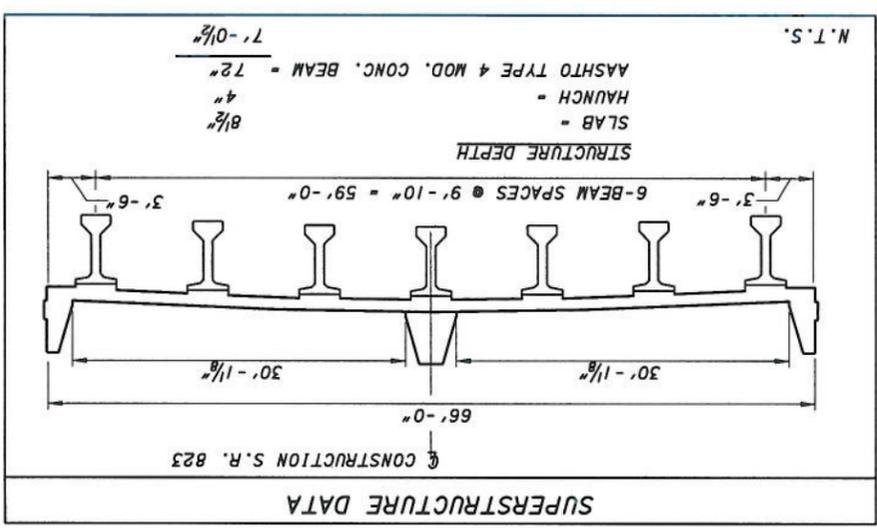
**VERTICAL CLEARANCE - SR 823 MAINLINE OVER FAIRGROUND RD.**

POINT	LOCATION	SR 823 MAINLINE - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. DECK ELEVATION	FAIRGROUND RD. - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)
1	RT. EDGE/DECK	594.82	25.500	592.69	567.48	25.21
2	RT. EDGE/DECK	594.51	25.500	592.38	567.60	24.78
3	RT. EDGE/DECK	594.18	25.500	592.06	567.00	25.06
4	LT. EDGE/DECK	595.42	25.500	593.29	567.49	25.80
5	LT. EDGE/DECK	595.10	25.500	592.98	567.76	25.22
6	LT. EDGE/DECK	594.78	25.500	592.66	567.20	25.46

OK  
OK  
OK  
OK  
OK  
OK

**APPENDIX D**

**Preliminary Structure Site Plans**



**PROPOSED STRUCTURE**

**TYPE:** SINGLE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS

**LENGTH OF SPAN:**

**ROADWAY:**

**SIDEWALK:**

**DESIGN LOADING:**

**SKIEW:**

**WEARING SURFACE:**

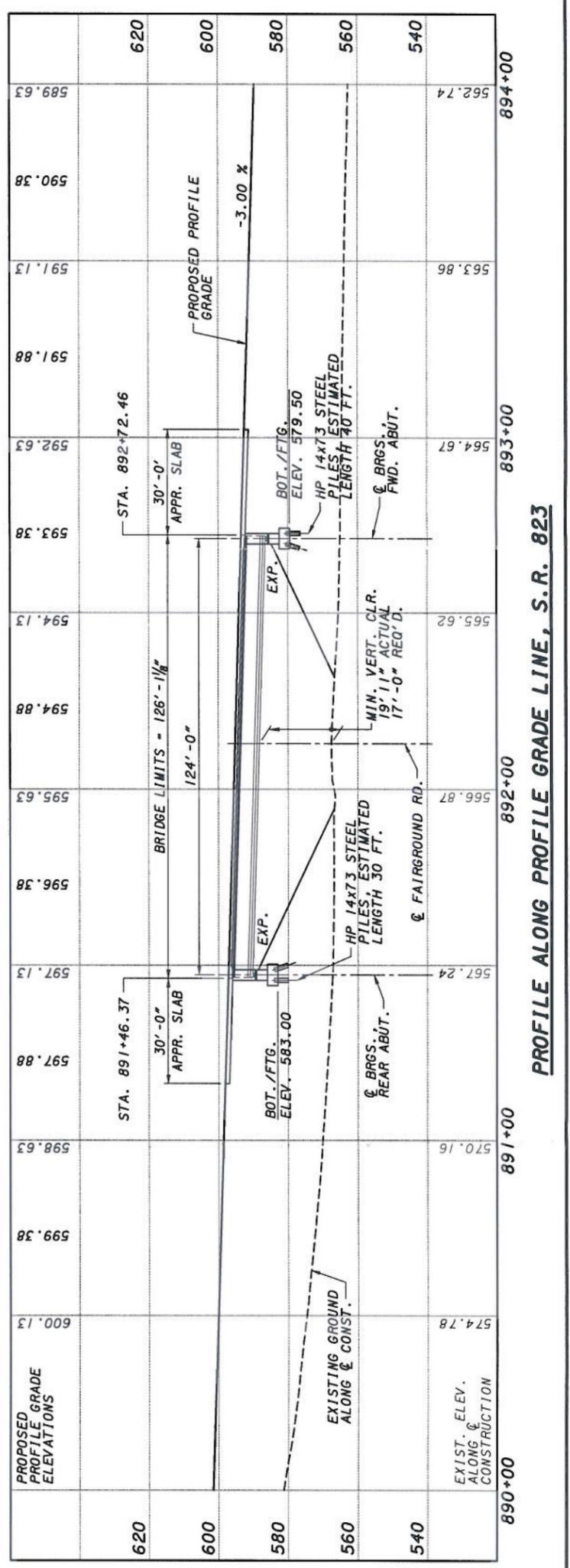
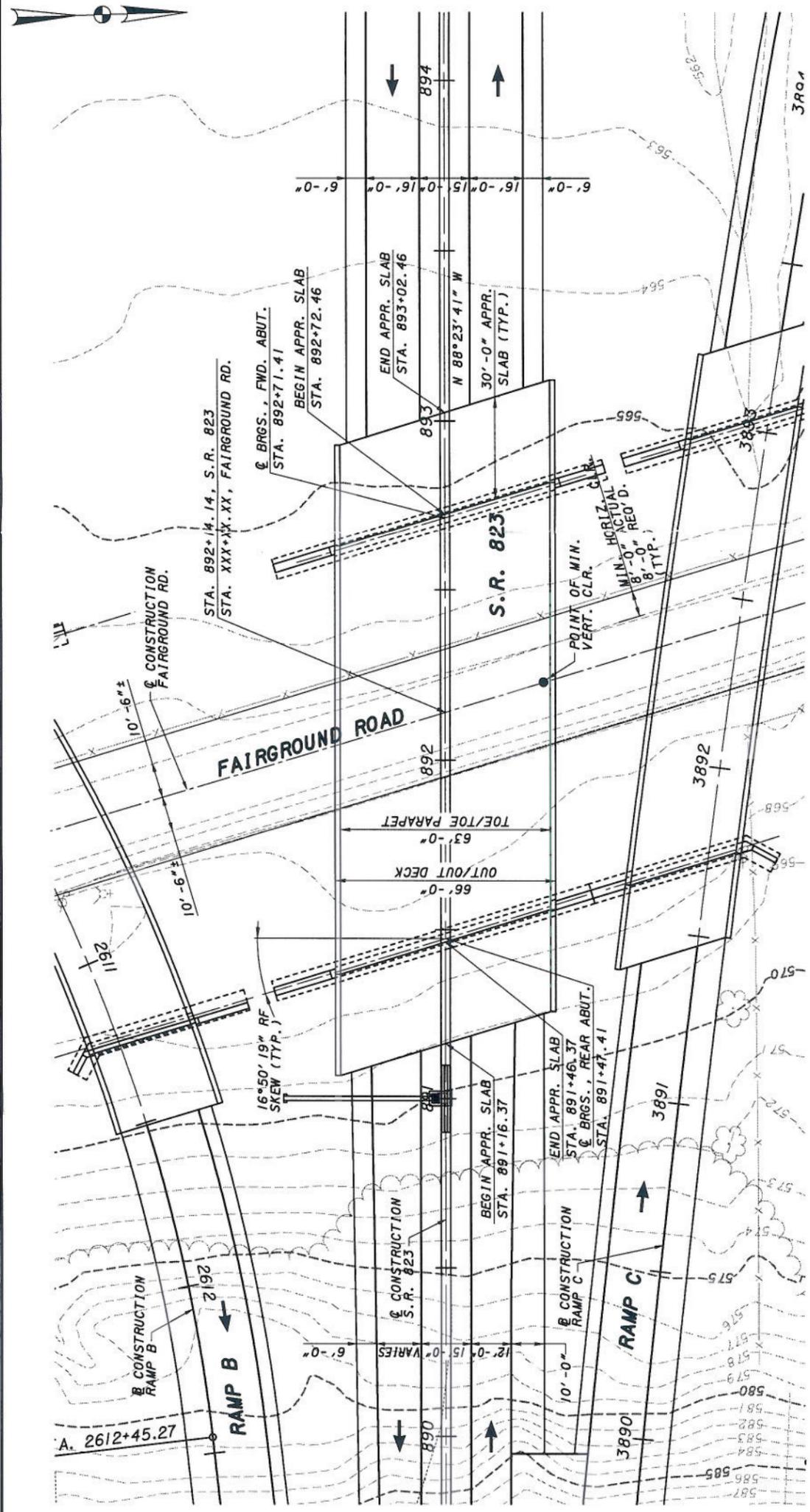
**APPROACH SLABS:**

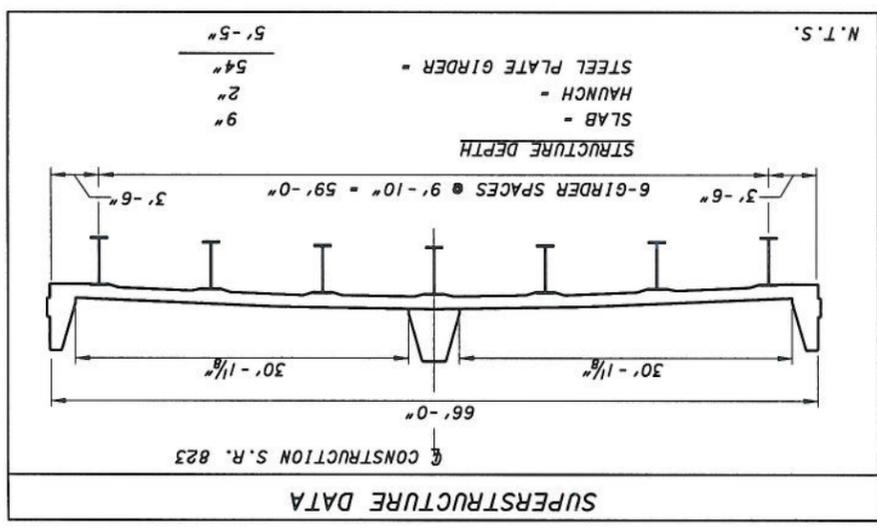
**ALIGNMENT:**

**CROWN:**

**LATITUDE:**

**LONGITUDE:**





**PROPOSED STRUCTURE**

**TYPE:** SINGLE SPAN COMPOSITE STEEL PLATE GIRDERS (PAINTED ASTM A709, GR 50) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS

**LENGTH OF SPAN:**

**ROADWAY:**

**SIDEWALK:**

**DESIGN LOADING:**

**SKEW:**

**WEARING SURFACE:**

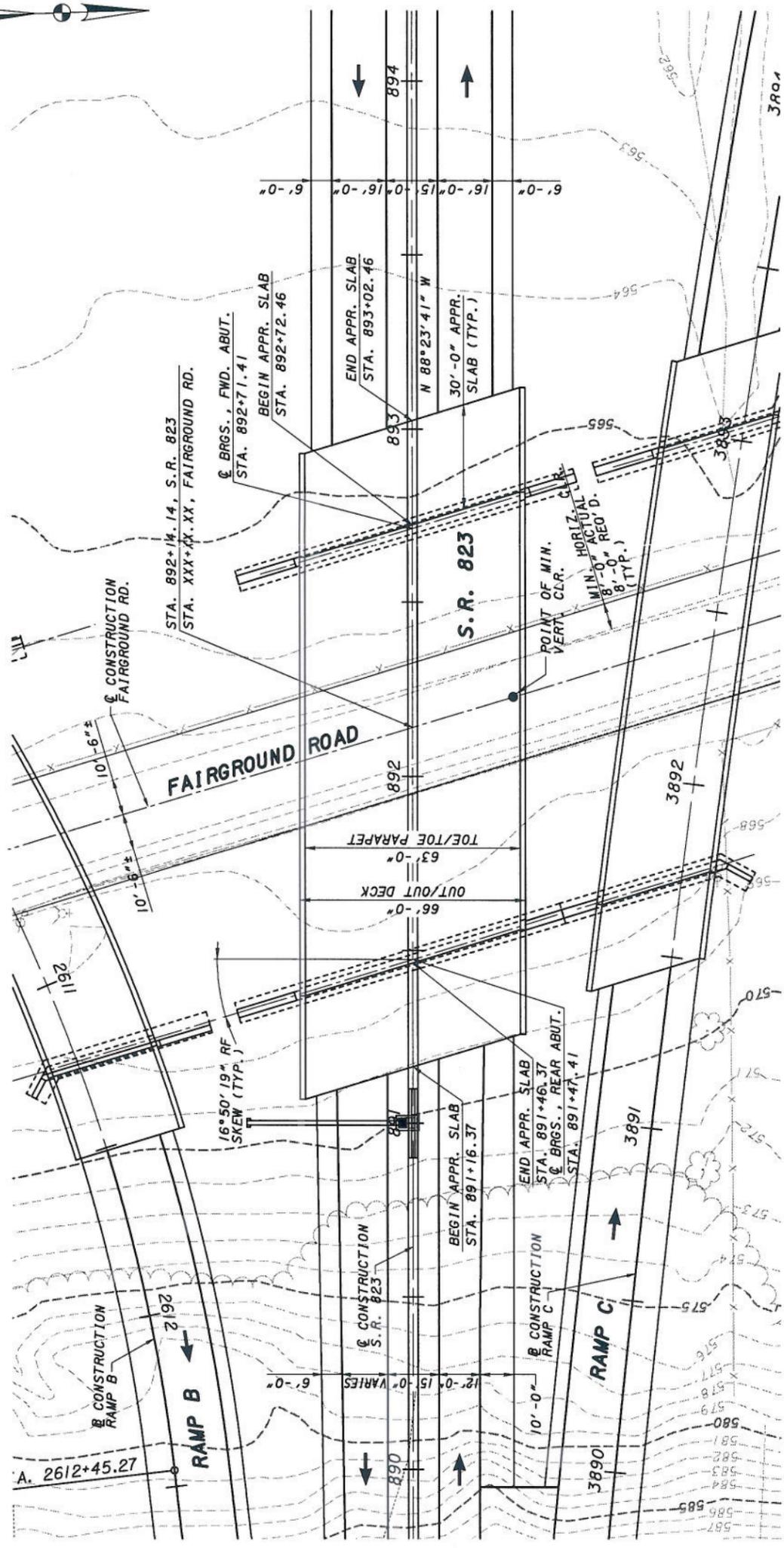
**APPROACH SLABS:**

**ALIGNMENT:**

**CROWN:**

**LATITUDE:**

**LONGITUDE:**



PROPOSED PROFILE ELEVATIONS	890+00	891+00	892+00	893+00	894+00
620	589.63	590.38	591.13	591.88	592.63
600	589.63	590.38	591.13	591.88	592.63
580	583.00	583.00	583.00	583.00	583.00
560	574.78	574.78	574.78	574.78	574.78
540	574.78	574.78	574.78	574.78	574.78
EXIST. ELEV. ALONG CONSTRUCTION	585	586	587	588	589
EXIST. ELEV. ALONG CONSTRUCTION	585	586	587	588	589

PROPOSED PROFILE GRADE: -3.00 %

BRIDGE LIMITS = 126'-1 1/2"

APPROACH SLAB: STA. 891+46.37 to 892+72.46

HP 14x73 STEEL PILES ESTIMATED LENGTH 30 FT.

HP 14x73 STEEL PILES ESTIMATED LENGTH 40 FT.

BRGS. REAR ABUT. STA. 891+47.41

BRGS. FWD. ABUT. STA. 892+71.41

CONSTRUCTION S.R. 823

STATIONING: 890+00, 891+00, 892+00, 893+00, 894+00



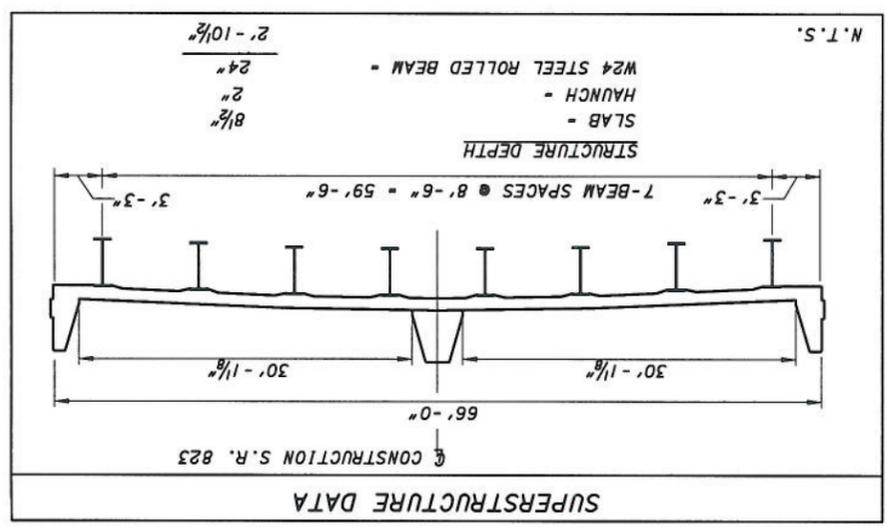
SCI-823-0.00

S I T E P L A N

BRIDGE NO. SCI-823-1594  
S.R. 823 OVER FAIRGROUND ROAD - ALT. 4  
SCOTO COUNTY

DESIGNED SKT  
CHECKED MME  
REVISED GAS  
STRUCTURE FILE NUMBER 06/05

DESIGN AGENCY  
**CH2MHILL**  
5775 Perimeter Drive, Suite 190  
Dublin, Ohio 43017



PROPOSED STRUCTURE

**TYPE:** SINGLE SPAN COMPOSITE STEEL ROLLED BEAMS (PAINTED ASTM A709, GR 50) WITH REINFORCED CONCRETE DECK AND SEMI-INTEGRAL ABUTMENTS ON MSE WALLS

**LENGTH OF SPAN:**

**ROADWAY:**

**SIDEWALK:**

**DESIGN LOADING:**

**SKEW:**

**WEARING SURFACE:**

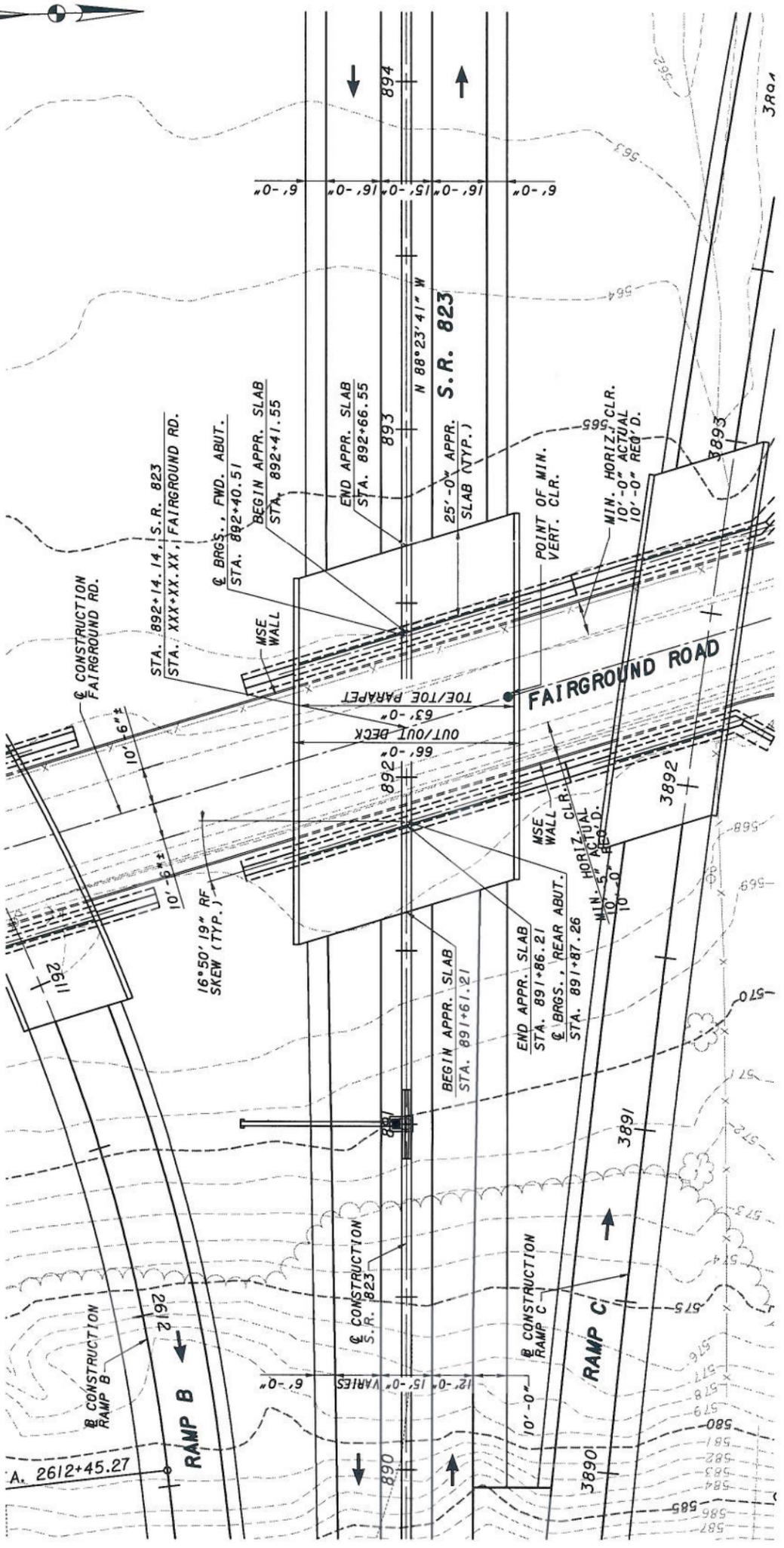
**APPROACH SLABS:**

**ALIGNMENT:**

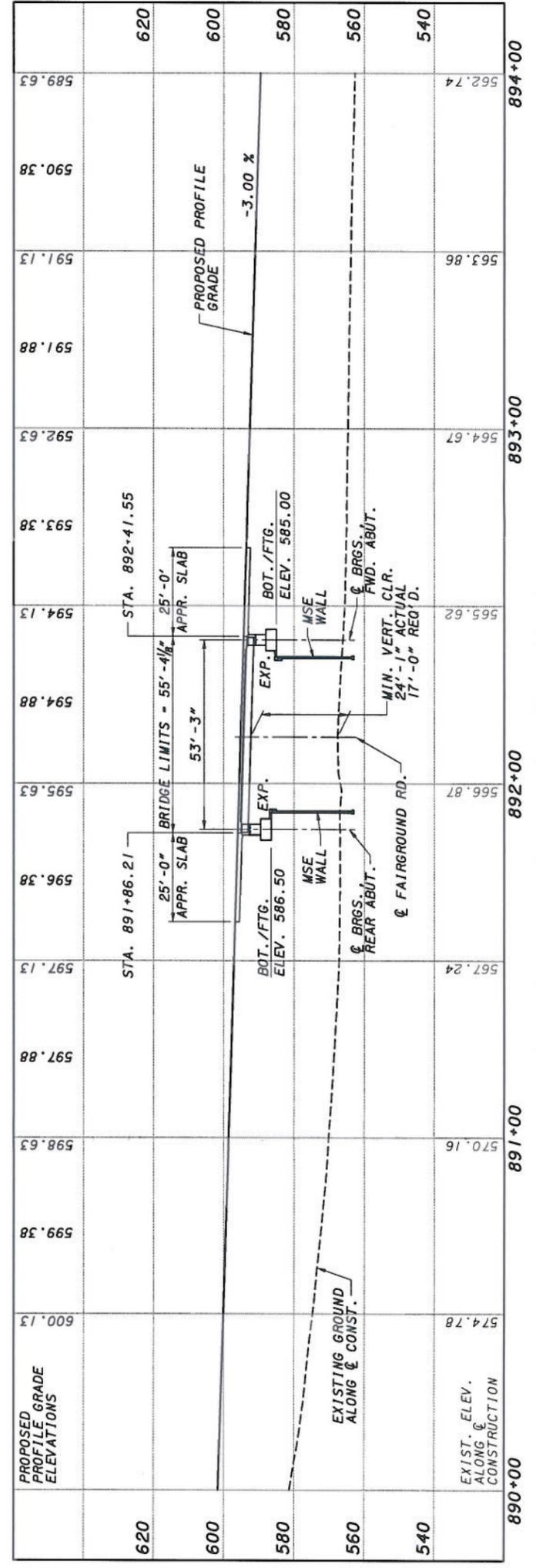
**CROWN:**

**LATITUDE:**

**LONGITUDE:**



PLAN



PROFILE ALONG PROFILE GRADE LINE, S.R. 823



SCI-823-0.00

# S I T E P L A N

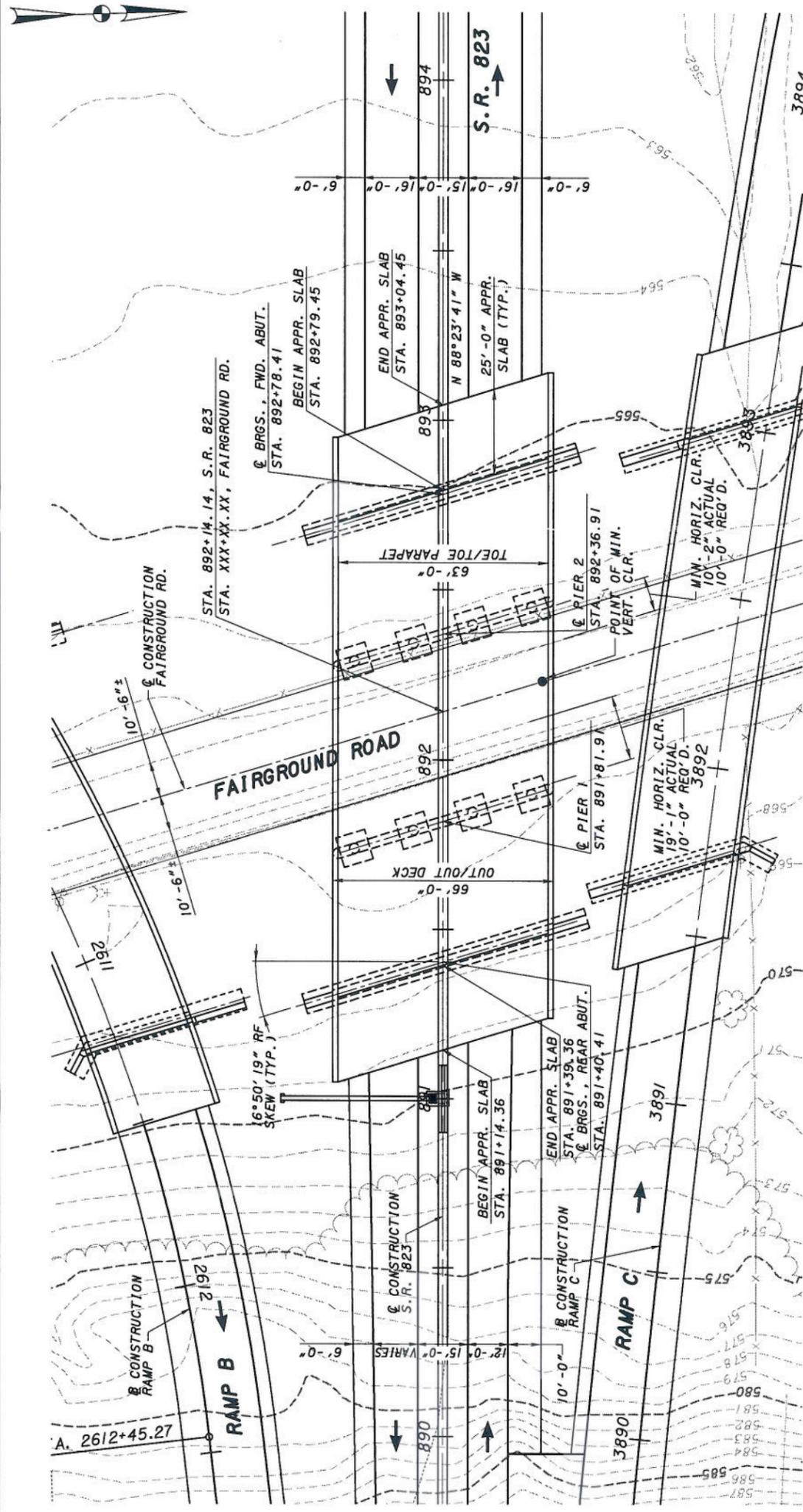
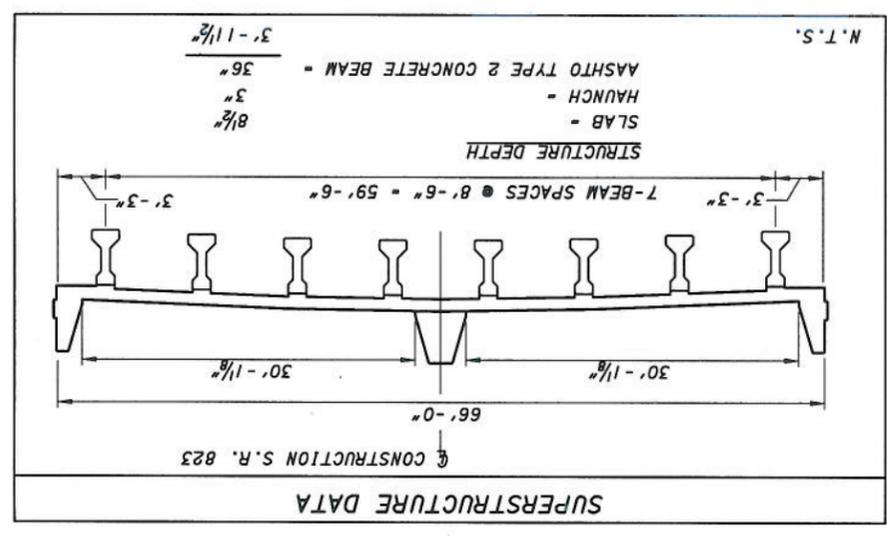
BRIDGE NO. SCI-823-1594  
S.R. 823 OVER FAIRGROUND ROAD - ALT. 5

SCIO TO C O U N T Y  
S T A . 8 9 1 + 3 9 . 3 6  
D G S

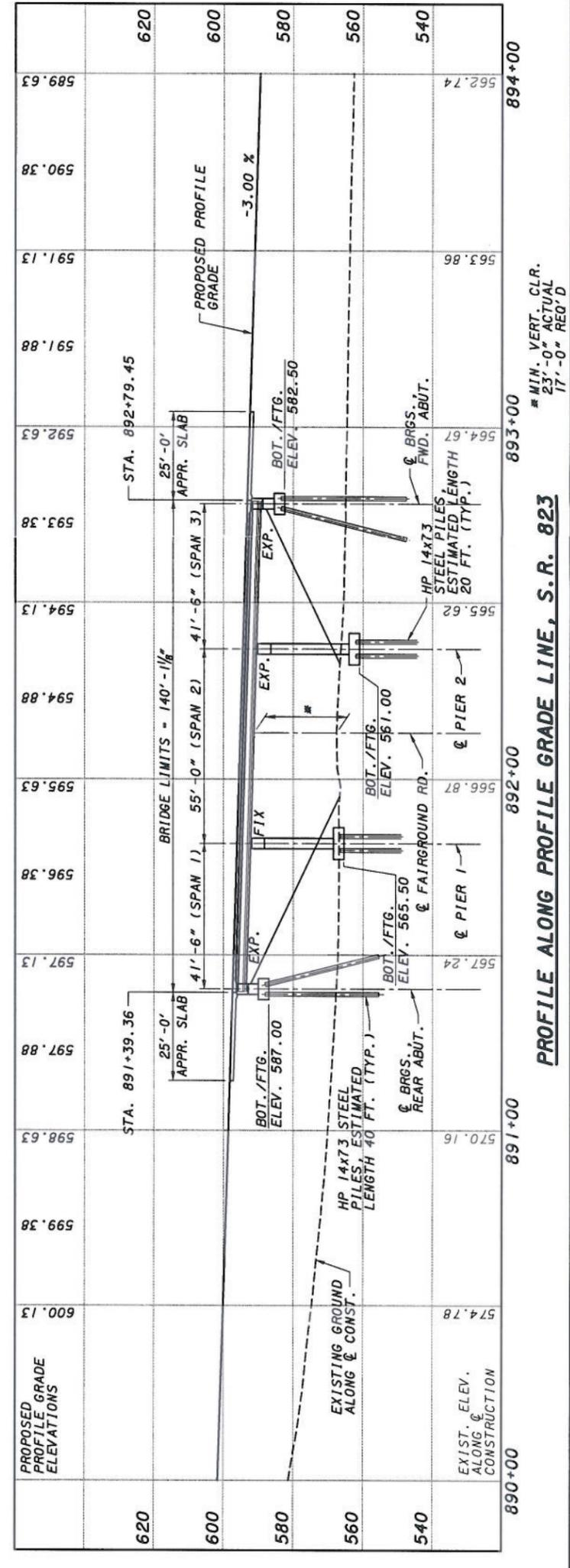
DESIGNED	SKT	MNE	DATE
CHECKED	DGS	GAS	06/05
REVISED	STRUCTURE FILE NUMBER		

CH2MHILL  
DESIGN AGENCY  
5775 Perimeter Drive, Suite 190  
Dublin, Ohio 43017

<b>PROPOSED STRUCTURE</b>	
<b>TYPE:</b>	THREE SPAN COMPOSITE PRESTRESSED CONCRETE I-BEAMS WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS AND CAP AND COLUMN PIERS
<b>LENGTH OF SPAN:</b>	
<b>ROADWAY:</b>	
<b>SIDEWALK:</b>	
<b>DESIGN LOADING:</b>	
<b>SKEW:</b>	
<b>WEARING SURFACE:</b>	
<b>APPROACH SLABS:</b>	
<b>ALIGNMENT:</b>	
<b>CROWN:</b>	
<b>LATITUDE:</b>	
<b>LONGITUDE:</b>	



## PLAN



## PROFILE ALONG PROFILE GRADE LINE, S.R. 823

# MIN. VERT. CLR. 23'-0" ACTUAL 17'-0" REQ'D



SCI-823-0.00

SITE PLAN

BRIDGE NO. SCI-823-1594 S.R. 823 OVER FAIRGROUND ROAD - ALT. 6  
SCIO TO COUNTY STA. 891+39.36 TO STA. 892+79.45  
DESIGNED SKT MME GAS 06/05  
CHECKED REVISED  
DRAWN MME GAS 06/05  
STRUCTURE FILE NUMBER

DESIGN AGENCY  
**CH2MHILL**  
5775 Perimeter Drive, Suite 180  
Dublin, Ohio 43017

PROPOSED STRUCTURE

TYPE: THREE SPAN COMPOSITE STEEL ROLLED BEAMS (PAINTED ASTM A709, GR 50) WITH REINFORCED CONCRETE DECK ON SEMI-INTEGRAL ABUTMENTS AND CAP AND COLUMN PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKIEW:

WEARING SURFACE:

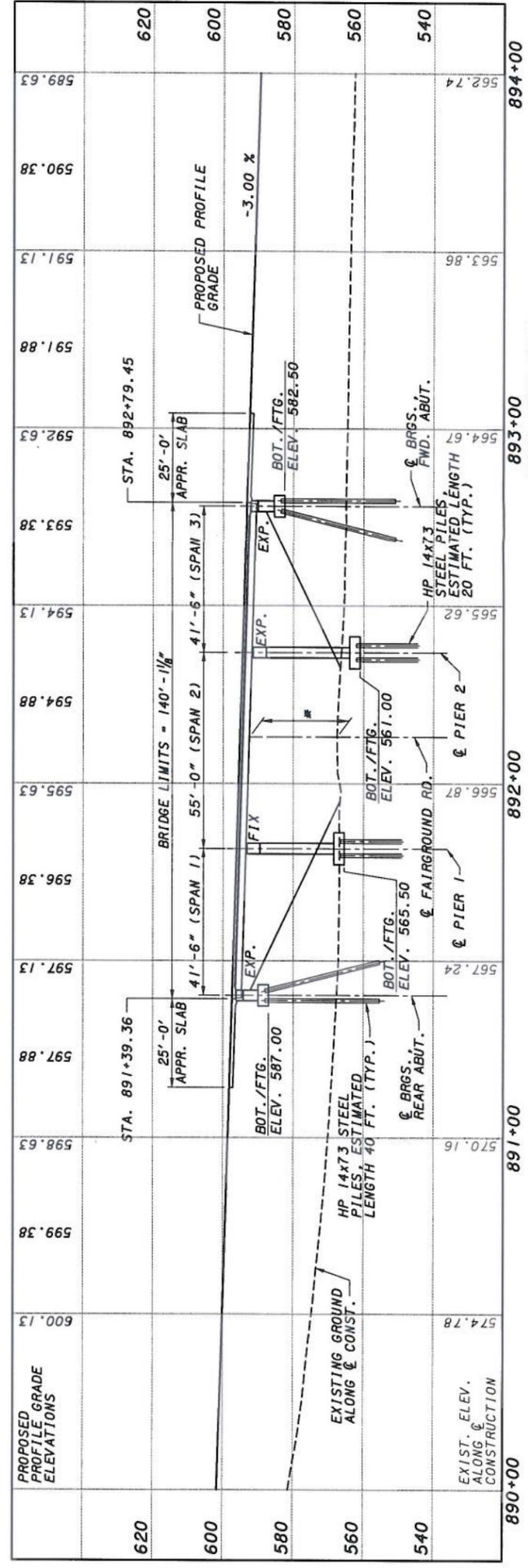
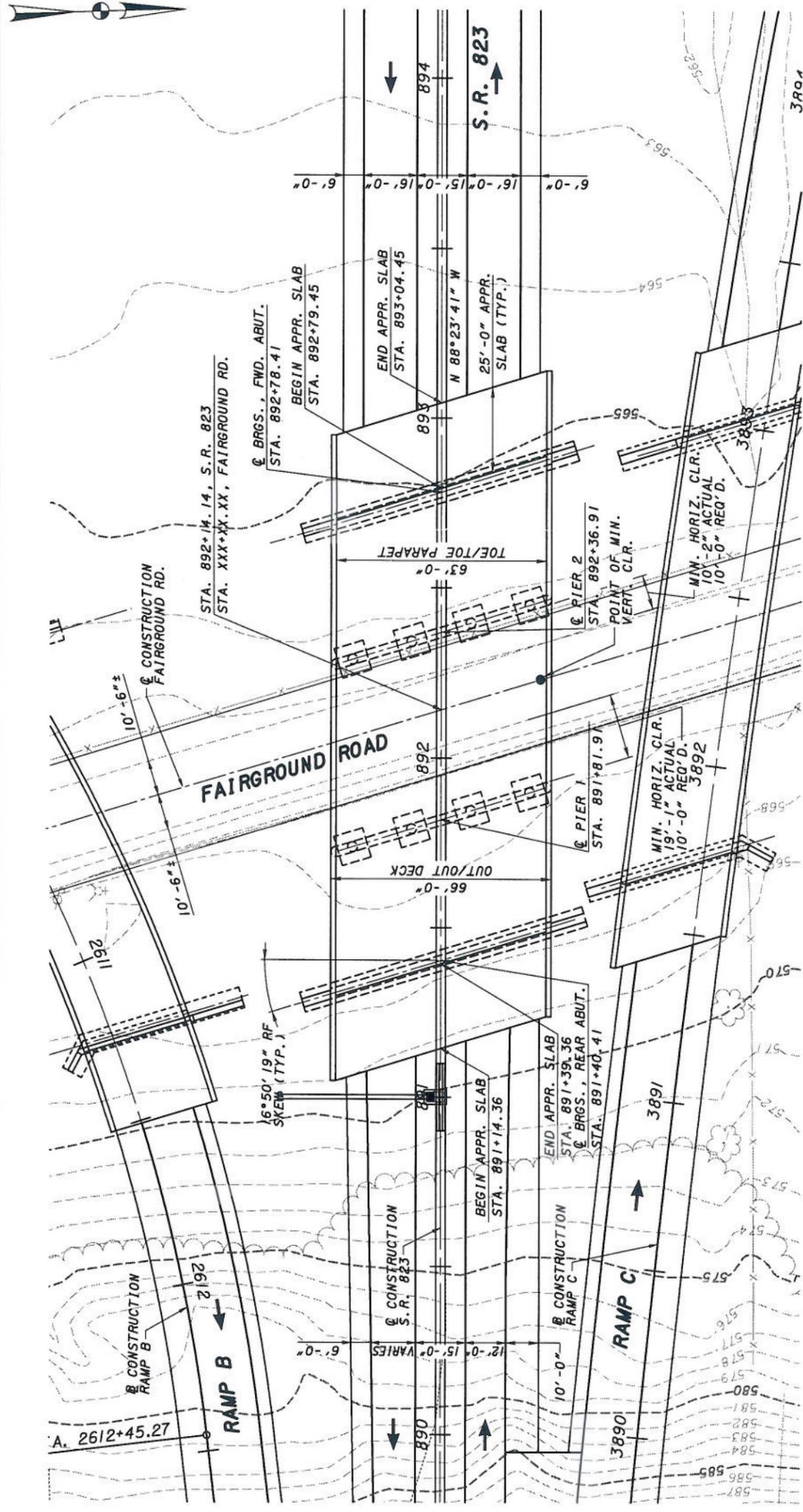
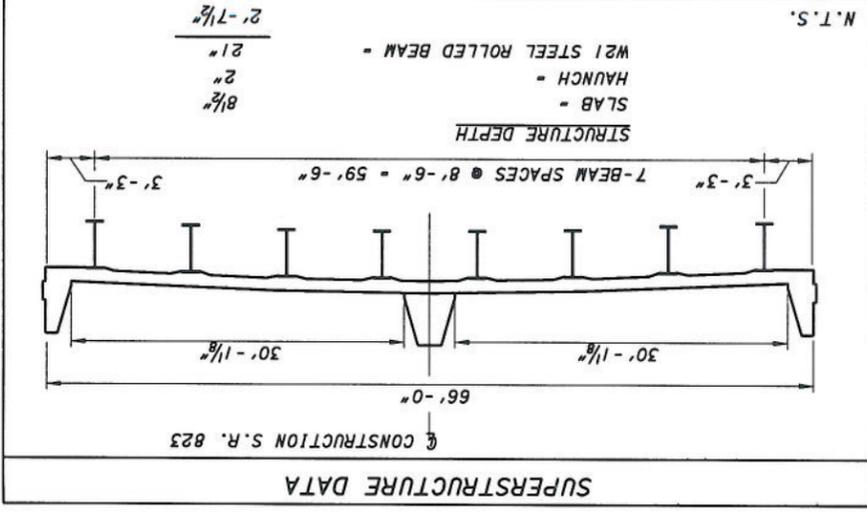
APPROACH SLABS:

ALIGNMENT:

CROWN:

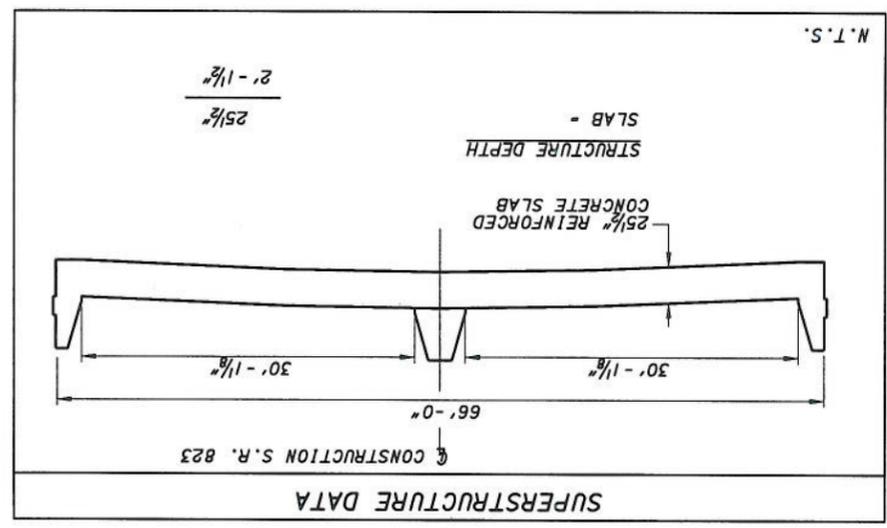
LATITUDE:

LONGITUDE:



PROFILE ALONG GRADE LINE, S.R. 823

\* MIN. VERT. CLR. 24'-4" ACTUAL 17'-0" REQ'D.



**PROPOSED STRUCTURE**

TYPE: THREE SPAN COMPOSITE CONTINUOUS REINFORCED CONCRETE DECK ON INTEGRAL ABUTMENTS AND CAP AND COLUMN PIERS

LENGTH OF SPAN:

ROADWAY:

SIDEWALK:

DESIGN LOADING:

SKEW:

WEARING SURFACE:

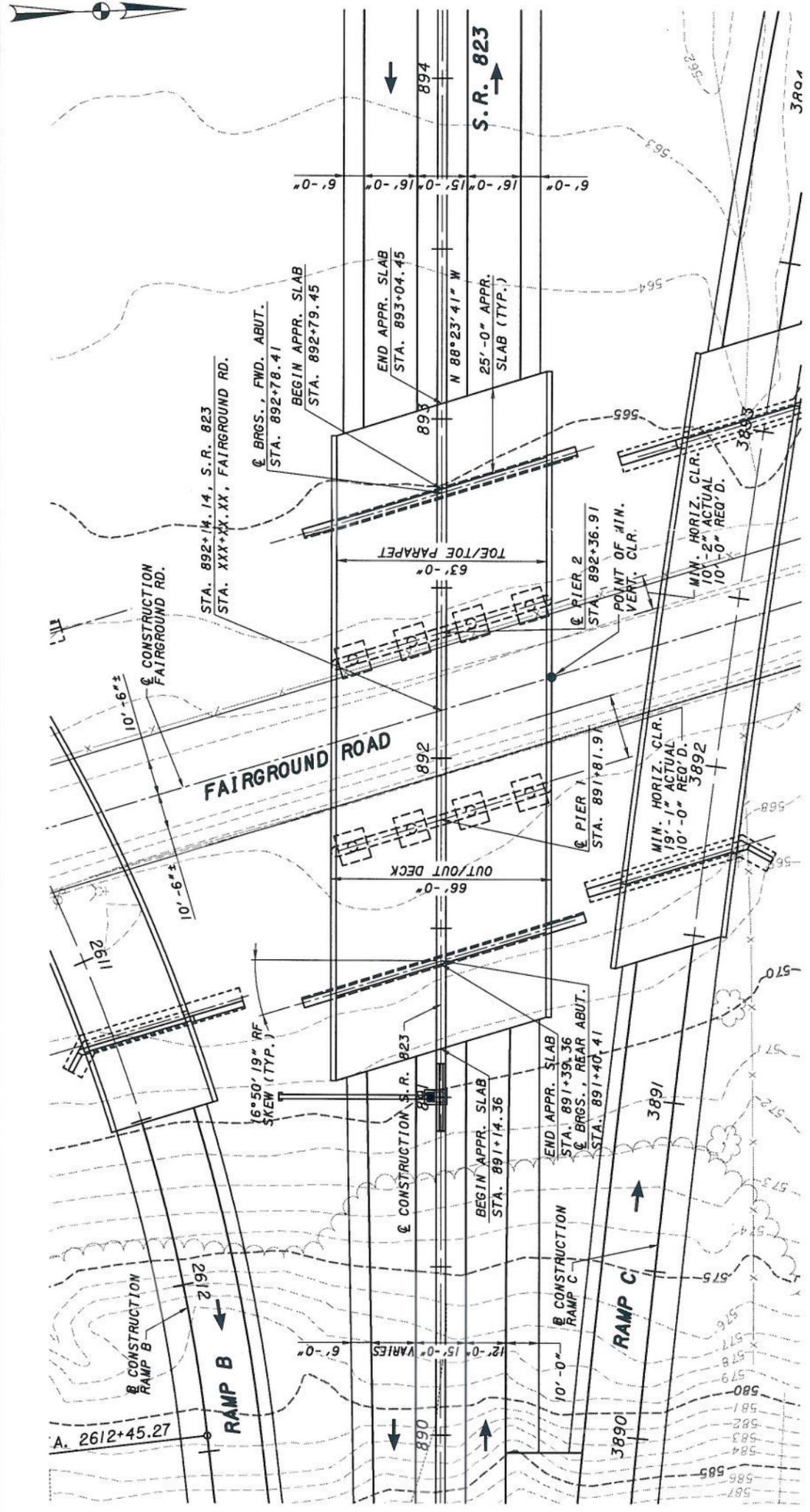
APPROACH SLABS:

ALIGNMENT:

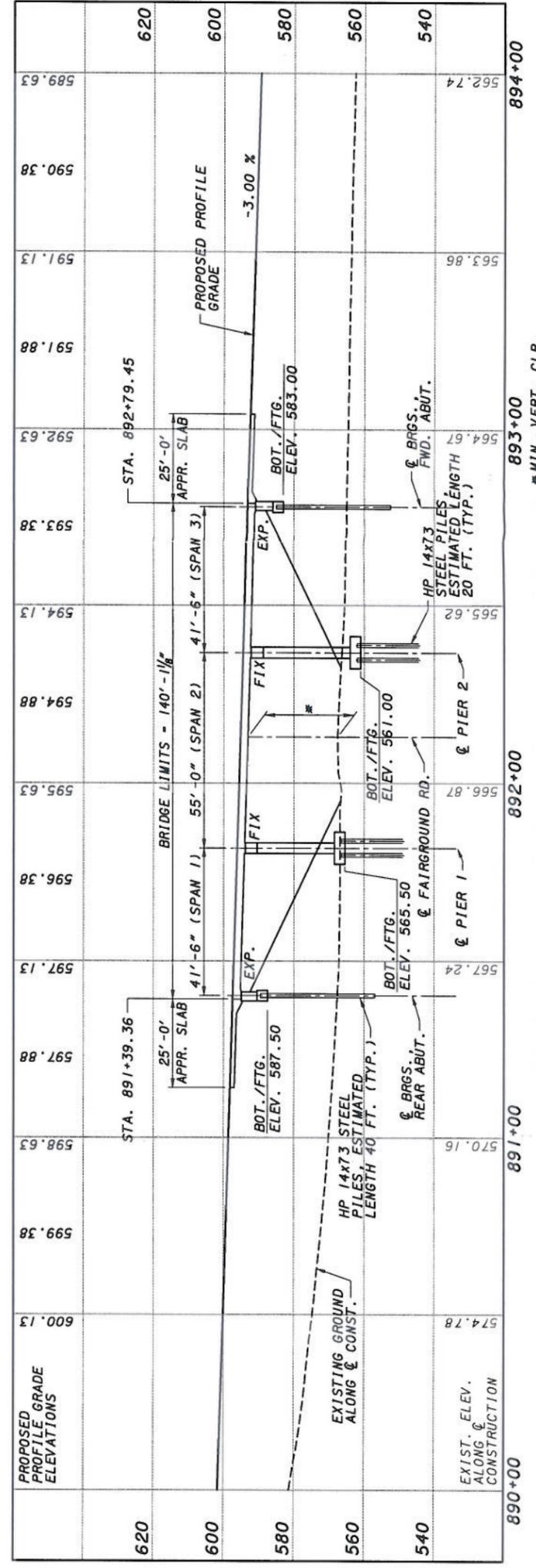
CROWN:

LATITUDE:

LONGITUDE:



**PLAN**



**PROFILE ALONG PROFILE GRADE LINE, S.R. 823**

\* MIN. VERT. CLR. 24'-9" ACTUAL 17'-0" REQ'D.

**APPENDIX E**

**Preliminary Foundation Recommendations**



May 2, 2005

Mr. Greg Parsons, P.E.  
Project Manager  
TranSystems Corporation  
5747 Perimeter Dr., Suite 240  
Dublin, OH 43017

Re: **US 23 and SCI-823-0.00 Interchange**  
**Preliminary Structural Foundation Recommendations**  
**Project SCI-823-0.00**  
**DLZ Job No.: 0121-3070.03**

Dear Mr. Parsons:

This letter reports the findings of the subsurface exploration and preliminary foundation recommendations for the proposed structures at the US 23 and SCI-823-0.00 interchange to be located north of Lucasville, Ohio within the area of the Scioto County Fairgrounds. It is anticipated that six proposed bridges, and MSE walls along Ramps B and C, will be constructed as part of the interchange.

It is our understanding that the western portion of the interchange, Ramp A and Ramp D, will be constructed through earthwork and no structures will be constructed. The existing grade across the proposed interchange location is relatively flat with an elevation range between 530 and 570. Currently, the area has roadways for US 23 and Fairground Road (CR 55) as well as two sets of railroad tracks maintained by CSX Railroad. The area to the west of US 23 is primarily agricultural. It is anticipated that the SCI-823-0.00 mainline and majority of the interchange will require embankment construction with Ramps B and C requiring mostly mechanically stabilized earth (MSE) wall construction. At this time the embankment heights are unknown, however it is anticipated that as much as 50 feet of fill may be required in some areas of embankment and up to 25 feet of fill in areas of MSE wall construction.

The existing area of the proposed interchange is located within the Scioto River valley with the overburden being primarily composed of glacial and alluvial deposits. The following table briefly outlines the anticipated structures, and the attached plan indicated the location of the structures in proximity to existing features.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 2

US 23 – SCI 823 Interchange Structures

Proposed Structure*	Approximate Location	Anticipated Number of Spans	Existing Grade Elevation**	Borings
Mainline Overpass #1	SCI-823 over Fairgrounds Rd	1	565 – 570	TR-55A, TR-56
Mainline Overpass #2	SCI-823 over US 23 & CSX RR.	3	533 – 555	TR-49A, TR-50A, TR-51, TR-52
Ramp B - #1	US 23 NB to SCI-823 over CSX RR	1	546 – 540	TR-60, TR-61
Ramp B - #2	US 23 NB to SCI-823 over Fairgrounds Rd.	2	564 – 570	TR-57, TR-58, TR-59A
Ramp C - #1	SCI-823 to US 23 NB over Fairgrounds Rd	1	565 – 568	TR-53A, TR-54
Ramp C - #2	SCI-823 to US 23 NB over CSX RR	2	543 – 550	TR-46, TR-47, TR-48

\* As indicated on the attached plan.

\*\* Established from established project topographic mapping.

The findings and recommendations presented in this report should be considered preliminary. It is understood that the final number and locations of substructure units have not been determined yet. After the substructure unit locations have been established, the results of the borings should be reviewed to determine if additional exploration is needed to finalize the foundation recommendations for the new structure.

### Field Exploration

A total of sixteen structure borings, TR-46 through TR-48, TR-49A through TR-50A, TR-51, TR-52, TR-53, TR54A, TR-55A, TR-56 through TR-58, TR-59A, TR-60 and TR-61, were drilled at the proposed structures between March 14 and March 21, 2005. It should be noted that

Mr. Greg Parsons, P.E.

May 2, 2005

Page 3

five borings (TR-49, TR-50, TR-53, TR-55, and TR-59) were drilled during 2004, and were not used to prepare these preliminary foundation recommendations. These boring locations were moved due to an adjustment in the project coordinate system. The structure borings were drilled to depths between 25 and 45 feet below the ground surface. The borings were extended into bedrock, which was verified by rock coring. Boring Logs and information concerning the drilling procedures are attached.

The boring locations were selected by TranSystems Corporation. Ground surface elevations at the boring locations were estimated from the established topographic mapping for the project and are presented on the attached Boring Logs.

### **Findings**

The following text presents generalized subsurface conditions encountered by the borings. For a brief discussion of the subsurface conditions at each structure refer to the Conclusions and Recommendations section, or for more detailed information, please refer to the attached Boring Logs.

At the ground surface, topsoil was encountered to depths of 1 to 7 inches. Beneath the topsoil, subsurface materials encountered generally were interbedded granular and cohesive layers. The cohesive soils encountered ranged from sandy silt (A-4a) to silt and clay (A-6b), and ranged in consistency from medium stiff to very stiff. The granular soils encountered ranged from sandy silt (A-4a) to gravel with sand (A-1-b), and ranged in compactness from very loose to very dense. Natural moisture of the cohesive were generally damp to moist, and the granular layers were damp to wet.

Bedrock was encountered in all of the borings ranging in depth from 13.6 to 33.5 feet below the ground surface. The bedrock encountered was either shale that was very soft or soft, siltstone that was medium hard, or sandstone that was medium hard or hard, which was sometimes interbedded with the siltstone. Recovery of the core samples ranged from 70 to 100%, and RQD values ranged from 13 to 92% with an average RQD of 88%.

Seepage was detected in the majority of the borings ranging in depth from 13 to 30 feet below the ground surface. Seepage was generally detected within granular layers. No seepage was detected in Borings TR-53A, TR-54, and TR-56 through TR-58. Water levels recorded prior to coring ranged from dry to 26 feet below the ground surface, and at completion of drilling ranged from 3.5 to 19.0 feet below the ground surface. However, the final water levels include drilling water and may not be representative of the actual groundwater conditions. Groundwater levels may vary seasonally and will most likely be influenced by the Scioto River.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 4

## **Conclusions and Recommendations**

It appears that driven H-piles or drilled shafts on bedrock will be the best-suited foundation types for the support of the proposed structures. If high lateral or uplift loads are anticipated drilled shafts extending into bedrock may be needed. The actual design lengths, or rock sockets, will need to be designed based upon actual loading conditions. Spread footing foundations were evaluated for support of the structures. At the abutment locations, spread footing recommendations are based upon the assumption that the embankment fill will be properly placed and compacted in accordance with CMS Item 203: Roadway Excavation and Embankment. The following is a brief discussion of each structure.

### **Mainline Overpass - #1**

Overpass #1 will be SCI-823-0.00 over Fairgrounds Road. Borings TR-55A, and TR-56 were drilled for this structure. Generally, these borings encountered cohesive soils at the ground surface consisting of silt and clay (A-6a), and silty clay (A-6b). These cohesive soils extended between 8.0 and 13.0 feet below the ground surface. Granular soils are located underlying the cohesive soils consisting of sandy silt (A-4a) and coarse and fine sand (A-3a). Bedrock was encountered at depths of 14.1 and 18.0 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 5

Foundation Recommendations – Mainline Overpass - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-55A	Forward Abutment	565.5	547.5	543	15	1.5
TR-56	Rear Abutment	569.5	555.4	552	15	1.5

\*Existing ground surface elevation was estimated from the established topographic mapping.

\*\*Assuming spread footings founded on embankment fill.

**Mainline Overpass - #2**

Overpass #2 will SCI-823-0.00 over US 23 and CSX Railroad. Borings TR-49A through TR-52 were drilled for this structure. Topsoil was encountered at the ground surface ranging in depth between 1 and 2 inches, except at TR-49A, which did not encounter any topsoil. TR-50A encountered fill beneath the topsoil to a depth of 3.0 feet. Generally, beneath the topsoil the borings encountered cohesive soils at the ground surface consisting of silt and clay (A-6a), and silty clay (A-6b), ranging in consistency from stiff to hard. These cohesive soils extended between 8.0 and 20.5 feet below the ground surface. Granular soils are located underlying the cohesive soils ranging from sandy silt (A-4a) to gravel with sand (A-1-b). The granular soils were very loose to medium dense in compactness, with the majority of the layers being very loose of loose. Bedrock was encountered between depths of 24.5 and 33.5 feet below the ground surface. The bedrock encountered was shale and sandstone.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear that spread footings extending to bedrock could be used at the abutment or pier locations. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 6

Foundation Recommendations – Mainline Overpass - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-49A	Forward Abutment	537.5	505.5	502	20	1.5
TR-50A	Pier 2	540.0	515.5	510	20	NA
TR-51	Pier 1	545.0	519.5	514	20	NA
TR-52	Rear Abutment	558.0	524.5	521	15	1.5

\*Existing ground surface elevation was estimated from the established topographic mapping.

\*\*Assuming spread footings founded on embankment fill.

**Ramp B - #1**

Ramp B-#1 will from US 23 northbound (NB) to SCI-823-0.00 over the CSX railroad. Borings TR-60 and TR-61 were drilled for this structure. A sandy silt (A-4a) fill was encountered at the ground surface in each boring and extended to depths of 3.0 and 5.5 feet below the ground surface. Beneath the fill, Boring TR-60 generally encountered granular soil ranging from sandy silt to coarse and fine sand (A-3a) in very loose to loose compactness to the top of rock at 28.0 feet. Boring TR-61 encountered a very stiff silt and clay (A-6a) to 10.5 feet, which was underlain by a very loose coarse to fine sand (A-3a). Bedrock was encountered at 23 feet below the ground surface. Bedrock encountered in borings was shale.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending bedrock. It does not appear reasonable that spread footings extending to bedrock could be used at either abutment due to the depth to bedrock. However, it is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 7

Foundation Recommendations – Ramp B - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation* (Feet)	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-60	Forward Abutment	554	526	522	15	1.5
TR-61	Rear Abutment	547	524	520	15	1.5

\*Existing ground surface elevation was estimated from the established topographic mapping.

\*\*Assuming spread footings founded on embankment fill.

**Ramp B - #2**

Ramp B-#2 will be from US 23 northbound (NB) to SCI-823-0.00 over Fairground Road. Borings TR-57 through TR-59A were drilled for this structure. Borings TR-57 and TR-58 encountered cohesive soils at the ground surface consisting silt and clay (A-6a) ranging in consistency from stiff to hard. These cohesive soils extended between 14.0 and 8.0 feet below the ground surface, respectively. Granular soils are located underlying the cohesive soils, and at the ground surface at TR-59A, consisting of sandy silt (A-4a) and coarse and fine sand (A-3a). Generally, the granular soils were very loose to medium dense in compactness. Bedrock was encountered between depths of 14.0 and 21.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be considered. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. Spread footings founded on bedrock can be considered at the pier location, if no significant amounts of fill are to be placed. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 8

Foundation Recommendations – Ramp B - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Estimated Spread Footing Elevation*	Allowable Bearing Capacity for Spread Footings (TSF)
TR-57	Forward Abutment	569.5	555.5	552	15	Unknown	1.5**
TR-58	Pier	567.0	553.0	549	15	551.0	12
TR-59A	Rear Abutment	564.5	543.0	538	15	Unknown	1.5**

\*Existing ground surface elevation was estimated from the established topographic mapping.

The Embankment heights at the abutment locations is not know at this time.

\*\*Assuming spread footings founded on embankment fill.

**Ramp C - #1**

Ramp C-#1 is from SCI-823-00 northbound (NB) to US 23 NB over Fairground Road. Borings TR-53A and TR-54 were drilled for this structure. Generally, these borings encountered cohesive soils at the ground surface consisting of sandy silt (A-4a) and silt and clay (A-6a) ranging in consistency from stiff to hard. These cohesive soils extended between 5.5 and 10.5 feet below the ground surface. Coarse and fine sand (A-3a) granular soils are located underlying the cohesive soils, which range from very loose to loose in compactness. Shale bedrock was encountered at depths of 13.6 and 20.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be recommended. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments due to the depth to bedrock. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 9

Foundation Recommendations – Ramp C - #1

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-53A	Forward Abutment	565.5	545.0	541	15	1.5
TR-54	Rear Abutment	567.5	553.9	550	15	1.5

\*Existing ground surface elevation was estimated from the established topographic mapping.

\*\*Assuming spread footings founded on embankment fill.

**Ramp C - #2**

Ramp C-#2 will be from SCI-823-0.00 northbound (NB) to US 23 NB over the CSX railroad. Borings TR-46 through TR-48 were drilled for this structure. Generally, these borings encountered inter-layered cohesive soils and granular soils. Cohesive layers encountered consisted of sandy silt (A-4a), silt and clay (A-6a), and clay (A-7-6). These layers ranged in consistency from stiff to very stiff. Granular soils encountered consisted of sandy silt (A-4a), coarse and fine sand (A-3a), gravel with sand and silt (A-2-4), and gravel with sand (A-1-b). These layers ranged in compactness from very loose to dense. Shale and sandstone bedrock was encountered at depths of 23.5 and 26.5 feet below the ground surface.

Due to the size of the structure, if H-piles are used, it is recommended that HP 14X73 H-pile sections, with a 95-ton capacity, be recommended. H-piles should be driven to refusal to the top of bedrock. H-piles driven to refusal may be designed based on the full allowable capacity of the pile. An alternative to driven H-piles would be the use of drilled shafts extending to bedrock. It is anticipated that at the abutments, significant amounts of fill will be placed and spread footings within the embankment fills may be considered. It does not appear reasonable that spread footings extending to bedrock could be used at the abutments due to the depth to bedrock. The following table summarizes the site conditions and preliminary foundation recommendations.

Mr. Greg Parsons, P.E.  
May 2, 2005  
Page 10

Foundation Recommendations – Ramp C - #2

Boring Number	Structural Element	Existing Ground Surface Elevation* (Feet)	Top of Rock Elevation* (Feet)	Estimated Drilled Shaft Tip Elevation*	Allowable Bearing Capacity for Drilled Shafts (TSF)	Allowable Bearing Capacity for Spread Footings (TSF)**
TR-46	Forward Abutment	543.0	517.0	513	20	1.5
TR-47	Pier	542.0	519.0	514	20	NR
TR-48	Rear Abutment	542.0	523.5	520	15	1.5

\*Existing ground surface elevation was estimated from the established topographic mapping.

\*\*Assuming spread footings founded on embankment fill.

**MSE Wall Stability**

Several MSE walls are proposed within the interchange, mainly along Ramps B and C. Based upon the borings drilled across the proposed interchange, it appears that global stability will not be an issue for the anticipated wall height. This is based on an assumption of a maximum wall height of 25 feet. Once the wall designs have been finalized the geometries of each wall will need to be evaluated for the global stability, sliding, overturning, and bearing capacity at each location. It should be noted that some settlement may be anticipated at some of the MSE wall locations, and wire-faced MSE walls may be considered if significant settlements are anticipated.

**General Information**

Minor amounts of settlement occurring within the very loose to loose granular soils are anticipated during construction of the embankments. Due to the granular nature of the soils, it is assumed that the settlement will occur during the earthwork activities, and will have been completed by the time the full height of the embankment has been constructed.

Because of the many geotechnical factors across the anticipated structure locations, and the design unknowns at this time, a detailed evaluation of all geotechnical parameters will need to be considered for the final design. It is strongly recommended that we discuss the proposed foundation design after TranSystems has had a chance to review these recommendations.



Mr. Greg Parsons, P.E.

May 2, 2005

Page 11

**Closing**

If you have any questions, please contact our office for clarification.

Sincerely,

**DLZ OHIO, INC.**

*P. Paul Painter*

P. Paul Painter  
Engineering Geologist

*Dorothy A. Adams  
for*

Arthur (Pete) Nix, P.E.  
Geotechnical Division Manager

Attachments: General Information – Drilling Procedures and Logs of Borings  
Legend – Boring Log Terminology  
Boring Location Plan  
Boring Logs TR-46 through TR-61

cc: File



Engineers • Architects • Scientists  
Planners • Surveyors

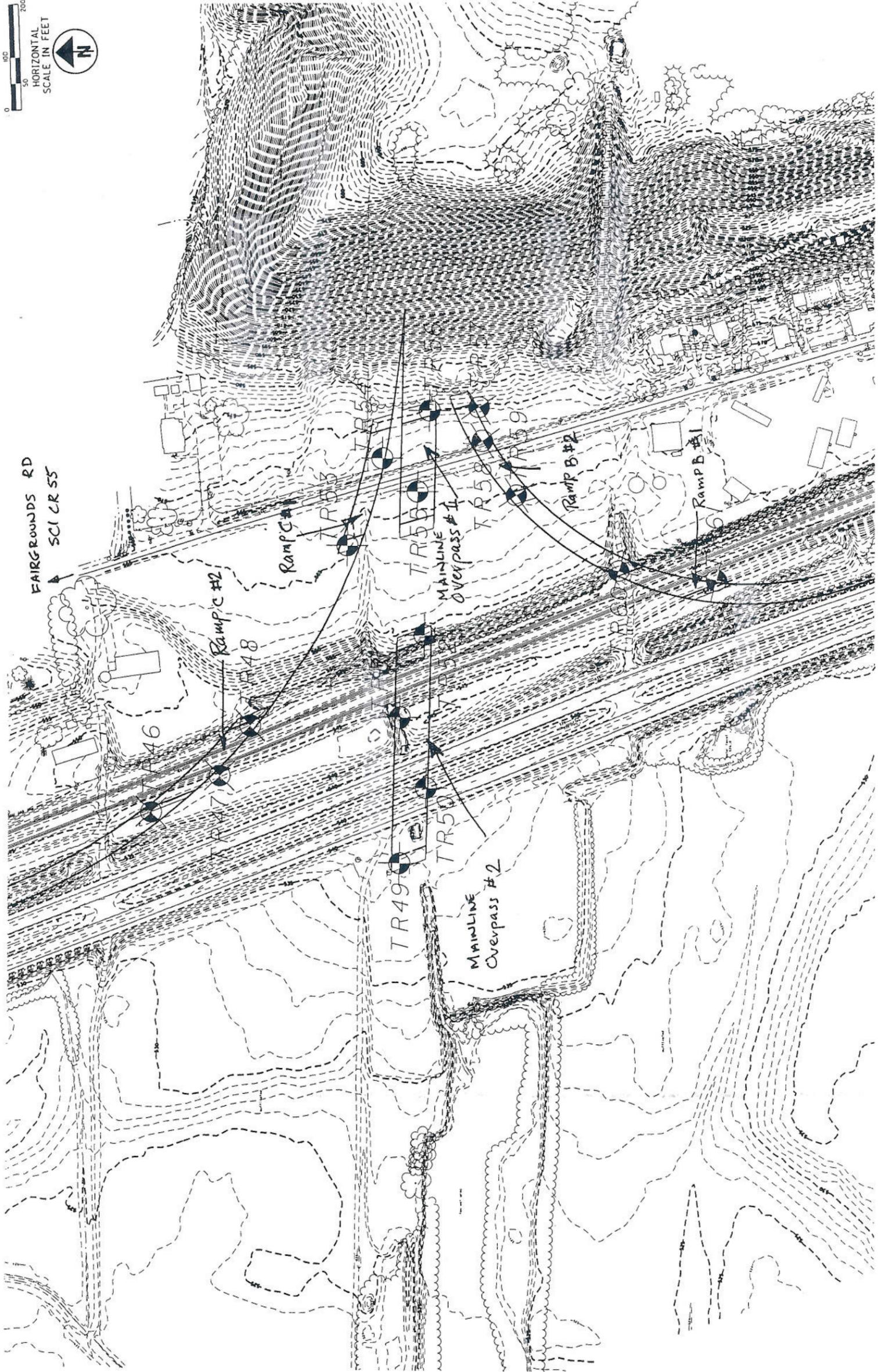
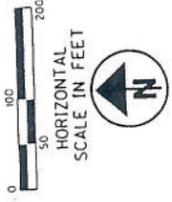
www.dlzcpr.com

DLZ Ohio, Inc.  
6121 Huntley Road  
Columbus, Ohio 43229-1003  
Phone (614) 888-0040 Fax (614) 848-6712

SCI-823-0.00

US 23 / SCI-823-0.00 Interchange

Boring Location Plan



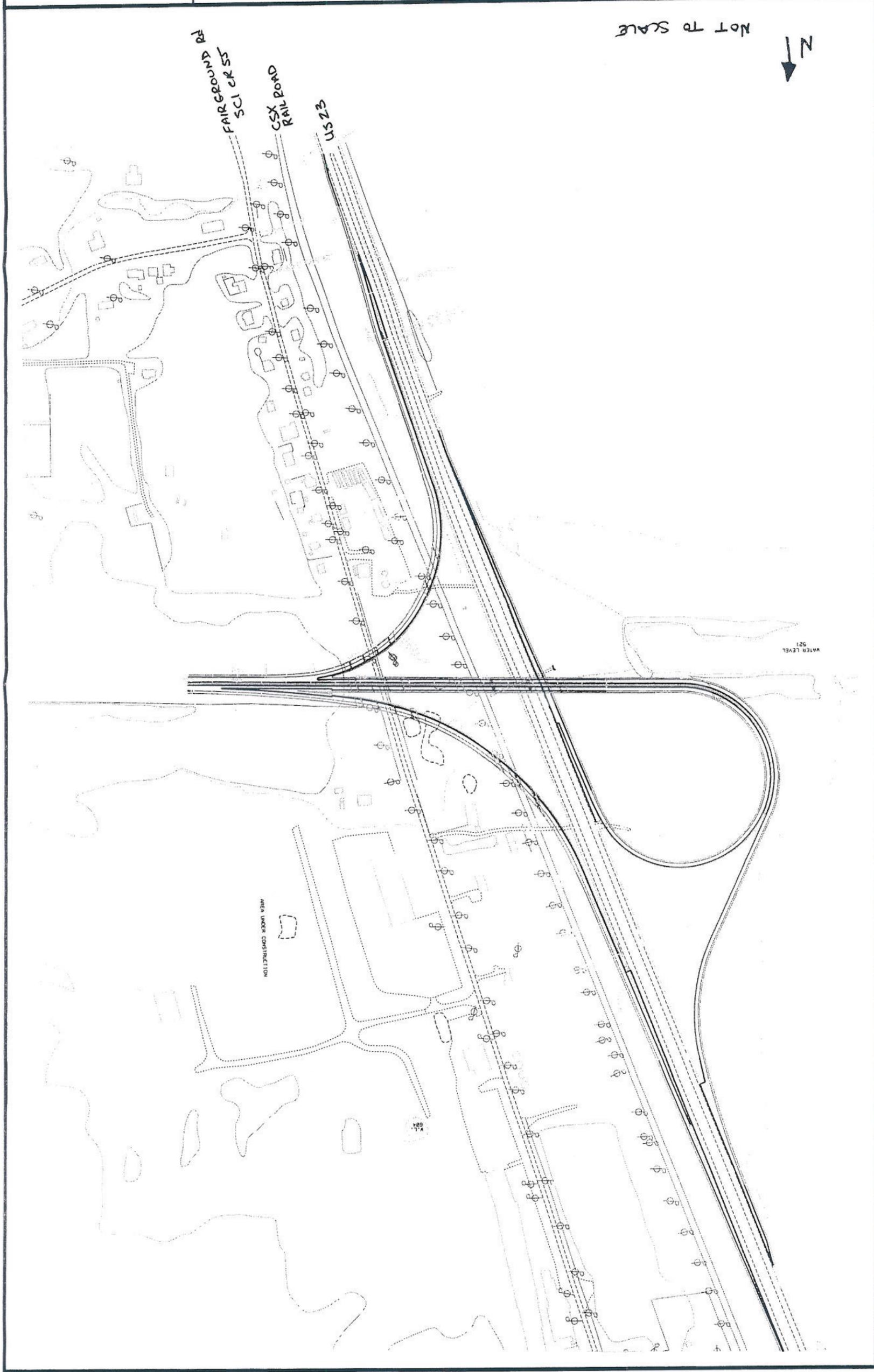


Engineers • Architects • Scientists  
Planners • Surveyors  
www.dlzcorp.com

DLZ Ohio, Inc.  
6121 Huntley Road  
Columbus, Ohio 43229-1003  
Phone (614) 888-0040 Fax (614) 848-6712

US 23 / SCI-823-0.00 Interchange  
SCI-823-0.00

Ramp Layout



## GENERAL INFORMATION DRILLING PROCEDURES AND LOGS OF BORINGS

Drilling and sampling were conducted in accordance with procedures generally recognized and accepted as standardized methods of investigation of subsurface conditions concerning geotechnical engineering considerations. Borings were drilled with either a truck-mounted or ATV-mounted drill rig.

Drive split-barrel sampling was performed in 1.5 foot increments at intervals not exceeding 5 feet. In the event the sampler encountered resistance to penetration of 6 inches or less after 50 blows of the drop hammer, the sampling increment was discontinued. Standard penetration data were recorded and one or more representative samples were preserved from each sampling increment.

In borings where rock was cored, NXM or NQ size diamond coring tools were used.

In the laboratory all samples were visually classified by a geotechnical engineer. Moisture contents of representative fine-grained soil samples were determined. A limited number of samples, considered representative of foundation materials present, were selected for performance of grain-size analyses and plasticity characteristics tests. The results of these tests are shown on the boring logs.

The boring logs included in the Appendix have been prepared on the basis of the field record of drilling and sampling, and the results of the laboratory examination and testing of samples. Stratification lines on the boring logs indicating changes in soil stratigraphy represent depths of changes approximated by the driller, by sampling effort and recovery, and by laboratory test results. Actual depths to changes may differ somewhat from the estimated depths, or transitions may occur gradually and not be sharply defined. The boring logs presented in this report therefore contain both factual and interpretative information and are not an exact copy of the field log.

Although it is considered that the borings have disclosed information generally representative of site conditions, it should be expected that between borings conditions may occur which are not precisely represented by any one of the borings. Soil deposition processes and natural geologic forces are such that soil and rock types and conditions may change in short vertical intervals and horizontal distances.

Soil/rock samples will be stored at our laboratory for a period of six months. After this period of time, they will be discarded, unless notified to the contrary by the client.

## LEGEND – BORING LOG TERMINOLOGY

Explanation of each column, progressing from left to right

1. Depth (in feet) – refers to distance below the ground surface.
2. Elevation (in feet) – is referenced to mean sea level, unless otherwise noted.
3. Standard Penetration (N) – the number of blows required to drive a 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.  
  
50/n – indicates number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other than the normal 6-inch increment.
4. The length of the sampler drive is indicated graphically by horizontal lines across the "Standard Penetration" and "Recovery" columns.
5. Sample recovery from each drive is indicated numerically in the column headed "Recovery".
6. The drive sample location is designated by the heavy vertical bar in the "Sample No., Drive" column.
7. The length of hydraulically pressed "Undisturbed" samples is indicated graphically by horizontal lines across the "Press" column.
8. Sample numbers are designated consecutively, increasing in depth.
9. Soil Description
  - a. The following terms are used to describe the relative compactness and consistency of soils:

**Granular Soils – Compactness**

<u>Term</u>	<u>Blows/Foot Standard Penetration</u>
Very Loose	0 – 4
Loose	4 – 10
Medium Dense	10 – 30
Dense	30 – 50
Very Dense	over 50

**Cohesive Soils – Consistency**

<u>Term</u>	<u>Unconfined Compression tons/sq.ft.</u>	<u>Blows/Foot Standard Penetration</u>	<u>Hand Manipulation</u>
Very Soft	less than 0.25	below 2	Easily penetrated by fist
Soft	0.25 – 0.50	2 – 4	Easily penetrated by thumb
Medium Stiff	0.50 – 1.0	4 – 8	Penetrated by thumb with moderate pressure
Stiff	1.0 – 2.0	8 – 15	Readily indented by thumb but not penetrated
Very Stiff	2.0 – 4.0	15 – 30	Readily indented by thumb nail
Hard	over 4.0	over 30	Indented with difficulty by thumb nail

- b. Color – If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled".
- c. Texture is based on the Ohio Department of Transportation Classification System. Soil particle size definitions are as follows:

<u>Description</u>	<u>Size</u>	<u>Description</u>	<u>Size</u>
Boulders	Larger than 8"	Sand – Coarse	2.0 mm to 0.42 mm
Cobbles	8" to 3"	– Fine	0.42 mm to 0.074 mm
Gravel – Coarse	3" to ¾"	Silt	0.074 mm to 0.005 mm
– Fine	¾" to 2.0 mm	Clay	smaller than 0.005 mm

- d. The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.
- e. Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes.

trace	0 to 10%
little	10 to 20%
some	20 to 35%
"and"	35 to 50%

- f. Moisture content of **cohesionless soils** (sands and gravels) is described as follows:

<u>Term</u>	<u>Relative Moisture or Appearance</u>
Dry	No moisture present
Damp	Internal moisture, but none to little surface moisture
Moist	Free water on surface
Wet	Voids filled with free water

- g. The moisture content of **cohesive soils** (silts and clays) is expressed relative to plastic properties.

<u>Term</u>	<u>Relative Moisture or Appearance</u>
Dry	Powdery
Damp	Moisture content slightly below plastic limit
Moist	Moisture content above plastic limit but below liquid limit
Wet	Moisture content above liquid limit

#### 10. Rock Hardness and Rock Quality Designation

- a. The following terms are used to describe the relative hardness of the **bedrock**.

<u>Term</u>	<u>Description</u>
Very Soft	Permits denting by moderate pressure of the fingers. Resembles hard soil but has rock structure. (Crushes under pressure of fingers and/or thumb)
Soft	Resists denting by fingers, but can be abraded and pierced to shallow depth by a pencil point. (Crushes under pressure of pressed hammer)
Medium Hard	Resists pencil point, but can be scratched with a knife blade. (Breaks easily under single hammer blow, but with crumbly edges.)
Hard	Can be deformed or broken by light to moderate hammer blows. (Breaks under one or two strong hammer blow, but with resistant sharp edges.)
Very Hard	Can be broken only by heavy and in some rocks repeated hammer blows.

- b. Rock Quality Designation, RQD – This value is expressed in percent and is an indirect measure of rock soundness. It is obtained by summing the total length of all core pieces which are at least four inches long, and then dividing this sum by the total length of the core run.

11. Gradation – when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).
12. When a test is performed to determine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture content is indicated graphically.
13. The standard penetration (N) value in blows per foot is indicated graphically.

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL ○			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay		
0.1	543.0							Water seepage at: 13.5'-19.0'									
	542.9							Water level at completion: 6.0' (Prior to coring) 5.0' (Including drill water)									
5		2	1	1	1												
5.5	537.5	2	2	2	2												
		3	3	3	3												
8.5	534.5	2	6	6	6												
10		2	11	7	11												
13.5	529.5	3	4	3	8												
15		5	4	4	12												
19.0	524.0	16	15	20	14												
20		14	19	20	8												
25		5	5	12	14												
26.0	517.0	50/3	3														
30																	

DESCRIPTION

Topsoil - 1"

FILL: Very loose brown and black GRAVEL WITH SAND (A-1-b), some silty clay; contains roots; damp.

Stiff brown SILT AND CLAY (A-6a), little fine to coarse gravel, trace fine to coarse sand; damp to moist.

Medium dense brown and gray GRAVEL WITH SAND (A-1-b), little silty clay; moist.

Loose brown GRAVEL WITH SAND (A-1-b), trace silt, trace clay; wet.

@ 18.0', heaving sand.

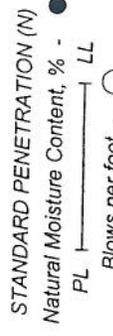
Dense light brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay, trace fine to coarse gravel; moist to wet.

@ 23.0', gray.

Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured.

@ 29.4', very thin clay seam.

@ 29.8', 30.8', thin clay seam.



**LOG OF: Boring TR-46**

Location: Forward Abutment - Ramp C - #2

Date Drilled: 03/17/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL  -----  LL Blows per foot - ○ 40		
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay			
30	513.0						Water seepage at: 13.5'-19.0' Water level at completion: 6.0' (Prior to coring) 5.0' (Including drill water)									
		Core 120"	Rec 118"	RQD 83%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 31.4', very thin clay seam. @ 31.6'-32.0', broken zone with clay and rock fragments. @ 33.4'-33.7', clay layer. @ 33.7'-34.2', cross bedded. @ 35.9', very thin clay seam.									
37.0	506.0															
40																
45																
50																
55																
60							Bottom of Boring - 37.0'									

LOG OF: Boring TR-47 Location: Pier location - Ramp C - #2 Date Drilled: 03/17/05

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL Natural Moisture Content, % - ○ Blows per foot - —		
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay	
0.1	542.0													
0.1	541.9			1	1.5	Topsoil - 1"								
1.0		1 2 4	10	1	1.5	Stiff brown and gray CLAY (A-7-6), trace fine sand; slightly organic; moist. @ 3.0', very stiff.								
2.0		2 4 5	13	2	2.5									
3.0		4 6 10	15	3	4.5									
4.0	535.0	1 3 2	10	4	0.5	Medium stiff brown SANDY SILT (A-4a), trace gravel, trace clay; moist to wet.	0	0	--	2	48	50		
5.0		2 2 2	7	5	--									
6.0	529.0	WOH WOH WOH	18	6	--	Very loose brown COARSE AND FINE SAND (A-3a), trace clay; wet.	1	2	--	83	15			
7.0		WOH WOH WOH	18	7	--									
8.0	524.0	11 14 12	10	8	1.5	Stiff brown SANDY SILT (A-4a), some gravel; moist.	30	11	--	24	22	14		
9.0		42 34 17	12	9	--									
10.0	521.0	4 10 21	11	10	--	Very stiff to hard dark gray SANDY SILT (A-4a), little clay; moist.	15	9	--	35	26	15		
11.0		50/4	4	11	--									
12.0	519.0				--	Very soft black SHALE; highly weathered, carbonaceous, laminated, broken, contains silt filled high angle fracture.	29	23	--	31	12	5		
13.0					--									
14.0	515.5				--	Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 26.7'-28.4', 30.0'-30.2', vertical healed fracture.								
15.0					--									

Location: Pier location - Ramp C - #2 Date Drilled: 03/17/05

LOG OF: Boring TR-47

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ ——— 40	
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
30	512.0	Core 120"	Rec 120"	Drive RQD 74%		Water seepage at: 13.0'-18.0' Water level at completion: 18.0' (Prior to coring) 9.0' (Including drill water)								
35						Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, laminated to medium bedded, slightly fractured. @ 30.2'-32.4', 34.7'-35.4', high angle bedding. @ 31.8'-32.4', broken zone with thin clay seam. @ 33.1'-33.6', low angle healed fracture. @ 33.1'-33.6', high angle healed fracture. @ 33.7'-34.0', very argillaceous. @ 33.7', Highly weathered fracture.								
36.5	505.5					Bottom of Boring - 36.5'								
40														
45														
50														
55														
60														

Date Drilled: 3/21/05

Location: Rear Abutment - Ramp C - #2

LOG OF: Boring TR-48

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ———— LL Blows per foot - ○			
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
0	547.0							Water seepage at: 13.0'-18.0'											
3.0	544.0	2 2 3 14		1				Water level at completion: 8.0' measured inside of augers	FILL: Loose brown GRAVEL WITH SAND (A-1-b); contains mostly coal fragments and cinders; dry to damp.										
5		WOH WOH WOH 1		2					FILL: Very loose brown SILT AND CLAY (A-6a), little fine to coarse sand; contains roots, coal and cinder fragments; damp.										
6.5	540.5	WOH 2 3 16		3			2.5		Very stiff brown and gray SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist.										
10		2 5 7 17		4			3.5												
13.0	534.0	2 5 6 15		5			3.5		Very loose brown COARSE AND FINE SAND (A-3a), little to some gravel, trace clay; wet.										
15		1 2 2 5		6															
18.0	529.0	1 1 1 8		7					Medium dense brown SANDY SILT (A-4a), some gravel, little clay; moist.										
20		6 6 7 10		8					@ 21.0', trace gravel and trace clay.										
23.5	523.5	2 7 30 15		9															
25		20 15 50 12		10					Soft to medium hard black SHALE; very fine grained, slightly weathered, very thinly bedded, highly fractured. @ 25.3'-25.6', 26.0'-26.4', broken 27.15'-27.2', sandstone seam.										
30																			

LOG OF: Boring TR-48

Location: Rear Abutment - Ramp C - #2

Date Drilled: 3/21/05

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.		Hand Penetrometer (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL — LL Blows per foot - ○									
				Drive	Press / Core				% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay										
29.9	517.0						Water seepage at: 13.0'-18.0'																	
35.0	517.1						Water level at completion: 8.0' measured inside of augers																	
							Hard gray SANDSTONE; fine grained, slightly weathered, thinly bedded. @ 32.9' fracture																	
							Bottom of Boring - 35.0'																	

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— LL Blows per foot - ○ —●— 40			
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
0	537.5					Water seepage at: 18.0'-28.0'											
		4 5 7	17	1	4.5+		Hard brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp.										
		3 4 4	16	2	4.0												
		3 5 5	16	3	1.5		@ 6.0', stiff; moist.										
		2 2 3	17	4	1.0												
		3 4 5	18	5	1.5		@ 11.0', little gravel.										
13.0	524.5	WOH 2 2	18	6			Loose brown SANDY SILT (A-4a), trace to little gravel, trace clay; moist.	23	16	--	9	30	22				
15.5	522.0	1 2 3	18	7			Loose brown SILT (A-4b); moist.	0	5	--	16	54	25				
18.0	519.5	WOH 3		8			Very loose brown GRAVEL WITH SAND (A-1-b), trace to little clay; moist to wet.	0	0	--	1	67	33				
		5 9 18	12	9			@ 21.0', medium dense.	62	16	--	8	14					
		2 2 6	18	10													
		6 5 8	13	11													
30		10 43 50/4	18	12			@ 29.0', possible broken sandstone.										

LOG OF: Boring TR-49A

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ 40
30	507.5					Water seepage at: 18.0'-28.0' Water level at completion: 14.0' measured inside of augers		
32.0	505.5					DESCRIPTION Very loose brown GRAVEL WITH SAND (A-1-b), trace to little clay (possible broken sandstone); moist to wet. Medium hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, broken, multiple clay seams, low and high angled fractures.		
35		50/2	1	13				
40		Core 120"	Rec 84"	RQD 13%				
45.0	492.5					Bottom of Boring - 45.0'		
50								
55								
60								

LOG OF: Boring TR-50A

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Drive	Hand Penetrometer (tsf)	WATER OBSERVATIONS	GRADATION						STANDARD PENETRATION (N) Blows per foot - ○ Natural Moisture Content, % - ● PL ——— LL		
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay			
0.1	540.0						Topsoil - 1"									
3.0	539.9	3	2	3	10		FILL: Loose dark brown SANDY SILT (A-4a), trace gravel; contains roots; damp.									
5	537.0	2	1	2	8	1.0	Stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.									
		2	3	3	13	2.0	@ 6.0'-7.5', little to some gravel.									
10		1	2	3	16	1.5										
10.5	529.5	1	2	3	18	1.25	Stiff brown SILTY CLAY (A-6b), little gravel, trace fine to coarse sand; moist to wet.	1	4	-	7	57	33			
15		WOH	2	3	18	1.5	@ 16.0', trace gravel and some fine to coarse sand.	32	20	-	12	18	18			
18.0	522.0	1	1	2	18	1.25		15	40	-	23	21	21			
20		WOH	1	3	16		Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace gravel; wet.	42	24	-	20	14	14			
21.0	519.0	2	5	11	16		Medium dense brown GRAVEL WITH SAND (A-1-b), trace clay; wet.	42	24	-	20	14	14			
24.5	515.5	2	7	50	18		Medium hard brownish gray SANDSTONE; highly weathered.									
25		25	37	50/4	10		Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded.									
27.5	512.5						@ 28.1', -28.7', 29.0'-29.1' clay seams									
30																

**LOG OF: Boring TR-50A**

Location: Pier # 2 - Mainline Overpass # 2

Date Drilled: 3/22/05

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ 10 20 30 40			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
30	510.0							Water seepage at: 18.0'-25.0' Water level at completion: 18.0' measured inside of augers										
		Core 120"	Rec 117"		RQD 68%			Hard gray SANDSTONE; fine grained, slightly weathered, argillaceous, medium bedded. @ 33.3'; 34.3'-34.4'; 36.2'; 37.2'; clay seams @ 30.8'-32.1'; high angle fracture.										
	-502.5							Bottom of Boring - 37.5'										
35																		
40																		
45																		
50																		
55																		
60																		

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL ——— Blows per foot - ○ ——— 40								
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay									
0.1	545.0	1																			
0.1	544.9	2	7	1	2.0	Topsoil - 2"															
5.5		1				Stiff dark brown SILT AND CLAY (A-6a), little fine to coarse sand, trace fine to coarse gravel; damp to moist.															
5.5	539.5	2	13	2	1.0																
8.0		2				Very stiff brown SILTY CLAY (A-6b), trace fine to coarse sand, trace fine to coarse gravel; damp.															
8.0	537.0	3	8	3	3.5																
10		3				Very loose to loose brown GRAVEL WITH SAND (A-1-b); damp.															
10		3	10	4	2.0																
13.0		1				@ 11.0', moist.															
13.0	532.0	1	7	5	1.5																
15		WOH				Very loose brown COARSE AND FINE SAND (A-3a), trace fine to coarse gravel, trace clay; wet.															
15		WOH	18	6																	
15		WOH																			
15		WOH	18	7																	
18.0		16				Medium dense reddish brown SANDY SILT (A-4a), little gravel; damp to moist.															
18.0	527.0	7																			
20		8																			
20		7	18	8																	
23.0		7				Stiff gray CLAY (A-7-6); moist.															
23.0	522.0	14																			
25.5		3																			
25.5	519.5	5	11	10	1.5																
25.5		20				Medium hard black SHALE; moderately weathered, pyritic, laminated, broken.															
25.5		50/3	8	11																	
28.6						@ 28.1'-28.2', gray.															
28.6	516.4					Hard gray SANDSTONE															
30																					

Location: Pier # 1 - Mainline Overpass # 2 Date Drilled: 03/17/05

LOG OF: Boring TR-51

Depth (ft)	Elev. (ft)	Blows per foot	Recovery (in)	Sample No.		Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION							
				Drive	Press / Core			% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
30	515.0						Water seepage at: 13.0'-18.0' Water level at completion: 21.0' (Prior to coring) 13.0' (including drill water)								
		Core 120"	Rec 116"	RQD 71%	R1		<b>DESCRIPTION</b> Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, very thinly bedded to medium bedded. @ 28.7'-28.8', pyritic. @ 31.8', very thin clay seam. @ 33.1'-33.3', clay and gravel seam. @ 33.5', fracture. @ 34.5', very thin clay seam. @ 35.5'-36.2', broken zone with clay infilling. @ 36.6'-36.8', highly weathered.								
37.5	507.5							Bottom of Boring - 37.5'							
40															
45															
50															
55															
60															



**LOG OF: Boring TR-52**

Location: Rear Abutment - Mainline Overpass # 2

Date Drilled: 03/15/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.		Hand Penetro- meter (tsf)	WATER OBSERVATIONS: Water seepage at: 23.0'-30.0' Water level at completion: 27.0' (Prior to coring) 6.0' (including drill water)	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL   LL Blows per foot - ○				
				Drive	Press / Core				% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay					
30	528.0																		
33.5	524.5	22						Medium dense brown SANDY SILT (A-4a), trace clay; wet.											
35		50/5	10					Medium hard black SHALE; moderately weathered, pyritic, laminated, broken.											
40	517.6							Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, very thinly bedded to medium bedded.											
40.4		Core 120"	Rec 120"																
40.4		120"																	
45.0	513.0							Bottom of Boring - 45.0'											
50																			
55																			
60																			

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	OBSERVATIONS: WATER Water seepage at: None Water level at completion: Dry (Prior to coring) 11.0' (Including drill water)	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL Blows per foot - ○					
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay				
0.2	567.5																		
2	567.3	2	14	1			1.0	Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp. @ 0.0'-2.5', contains roots.	0	0	4	61	35						
5		2	17	2			3.5		0	0	12	67	21						
5.5	562.0	3	18	3			2.25	Very stiff brown SANDY SILT (A-4a), trace clay; damp.	0	0	8	38	18						
10		1	11	4			2.0												
10.5	557.0	1	13	5				Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.											
13.6	553.9	7		6				Soft gray SHALE; moderately weathered.											
15.0	552.5	35	14					Medium hard gray SHALE; fine grained, moderately weathered, laminated. @ 15.0'-17.3', broken with high angles fractures and thin clay seams. @ 18.9'-19.0', 20.6'-20.9', high angle fractures.											
20		Core 120"	Rec 120"	RQD R-1 83%															
22.6	544.9							Hard gray SILTSTONE; very fine to fine grained, slightly weathered, argillaceous, medium bedded, slightly fractured.											
23.5	544.0							Hard gray SHALE; slightly weathered, argillaceous, very thinly bedded.											
25.0	542.5							Bottom of Boring - 25.0'											

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○							
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay								
0	565.5																			
3.0	562.5	3	5	10	4.5+	Hard gray SILTY CLAY (A-6b); damp.	22	15	--	23	21	19								
5		6	7	9	4.5+	Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.	5	25	--	39	16	16								
8.0	557.5	11	11	9	4.5+	Very stiff to hard brown SANDY SILT (A-4a), trace gravel; damp.	9	38	--	41	13									
10		4	5	4	3.5	@ 11.0', hard.														
13.0	552.5	5	4	3	4.5+	Loose brown COARSE AND FINE SAND (A-3a), trace gravel; wet.														
15		2	2	2																
18.0	547.5	1	2	2		Hard gray SHALE interbedded with SANDSTONE; fine grained, highly weathered, very thinly bedded, highly fractured. @ 20.0'-22.0', 26.7'-27.5', 28.3'-28.5', 29.3'-29.6', highly fractured with clay seams. @ 21.0'-21.3', 21.7'-21.9', 26.5'-26.7', 26.9'-22.0', Hard brown sandstone; slightly weathered laminated.														
20		35	50/5	12																
25		Core 120"																		
30.0	535.5					Bottom of Boring - 30.0'														

**LOG OF: Boring TR-55A**

Location: Forward Abutment - Mainline Overpass #1

Date Drilled: 3-15-05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS: Water seepage at: 13.0'-18.0' Water level at completion: 18.0' (Prior to coring) 18.0' (Including drill water)	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL   LL Blows per foot - ○ 10 20 30 40							
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay								
30	535.5																						
35																							
40																							
45																							
50																							
55																							
60																							

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION					STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○		
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt		% Clay	
0.2	569.5							Water seepage at: None	Topsoil -3"								
2	569.3	2	15	1			2.5	Water level at completion: Dry (Prior to coring) 7.5 (including drill water)	Very stiff brown SANDY SILT (A-4a), trace clay, trace gravel; damp to moist.								
3.0	566.5	4	17	2			4.5+		Hard brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.								
5		6															
8.0	561.5	4	16	3			4.25		Loose brown and gray SANDY SILT (A-4a), trace clay; damp to moist.	0	0	2	58	41			
10		2	18	4													
14.1	555.4	2															
15		2	9	5													
		6															
		4															
		8															
		23	15	6					Medium hard grayish brown SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, highly fractured. @ 16.4'-17.2', high angle fracture and clay seam. @ 17.2', gray. @ 19.2'-19.7', clay seam. @ 20.4'-20.8', highly broken, clay seam.	0	1	19	55	25			
		50/4															
20		Core 120"	Rec 120"	RQD R-1 68%													
25.0	544.5								Bottom of Boring - 25.0'								
30																	

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS: Water seepage at: None Water level at completion: Dry (Prior to coring) 3.5' (including drill water)	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○				
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay					
0.3	569.5						Topsoil -4"											
2	569.2	2	14	1	4.0		Very stiff to hard brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp.	0	0	1	64	35						
3		3		2	4.5				0	0	10	67	23					
5		3	12	3	3.5				0	0	19	26	17					
8.0	561.5	4	17	4	1.0				23	15	4	64	31					
10		1	18	5			Stiff brown SILT AND CLAY (A-6a), little fine to coarse sand; damp to moist.											
10.5	559.0	2		6			Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.											
14.0	555.5	2	14	6			Soft to medium hard gray SHALE; moderately weathered, laminated. @ 15.8'-16.3', 19.1'-19.5', clay seams											
15		12	13				Hard gray SILTSTONE interbedded with SHALE; slightly weathered, laminated. @ 22.7'-22.9' high angle fracture Hard gray SHALE; slightly weathered, laminated, slightly fractured.											
20.9	548.6	27																
22.9	546.6	50/3																
25.0	544.5						Bottom of Boring - 25.0'											

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	DESCRIPTION	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - PL ——— LL Blows per foot - 10 20 30 40		
										% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay			
0.3	567.0							Water seepage at: None	Topsoil -4"									
1	566.7	1	16	1			--	Water level at completion: Dry (Prior to coring) 4.0' (including drill water)	Soft brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist. @ 0.0'-2.5', contains roots. @ 3.5', very stiff to hard, damp.	0	0	6	65	29				
2		2		2			4.25											
3		3	15	3			3.5											
4		4	18	4														
5		5		5														
6		6	16	6														
7		7		7														
8.0	559.0	2	16	8					Loose dark brown COARSE AND FINE SAND (A-3a), trace to little clay, trace gravel; damp.	7	34	--	40	19				
9		3		9														
10		4	15	10														
11		4		11														
12		4	15	12														
13		3		13														
14.0	553.0	2	16	14					Soft to medium hard gray SHALE; moderately weathered, argillaceous, thinly bedded, slightly fractured. @ 15.0'-16.7', broken with clay seams and high angle fractures @ 17.5'-17.8', 19.5'-20.1', clay seams with high angle fractures @ 20.9'-21.0', clay seam. @ 24.2' and 24.4', very thin clay seam.	0	0	0	0	0				
15		20		15														
16		50/5		16														
17				17														
18				18														
19				19														
20		Core 120"	Rec 120"	20														
21				21														
22				22														
23				23														
24				24														
25.0	542.0			25					Bottom of Boring - 25.0'									
26				26														
27				27														
28				28														
29				29														
30				30														

**LOG OF: Boring TR-59A**

Location: Forward Abutment - Ramp B - #2

Date Drilled: 3-14-05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Dive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
0	564.5							Water seepage at: 19'-21.5' Water level at completion: Dry (Prior to coring) 17.0' (Including drill water)										
3		3	14	1				DESCRIPTION Loose dark gray SANDY SILT (A-4a), trace clay, trace gravel; damp.  @ 3.5'; brown; Moist.  Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace silt; moist.  Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp to moist.  @ 16.0'; little to some clay.  @ 19.0'-21.5'; wet.  Medium hard gray SHALE; slightly weathered.  Medium hard to hard gray SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, slightly fractured. @ 25.4'-25.7', 28.5', 29.6', clay seams @ 25.9', 26.5'-26.7', 27.8', high angle fractures @ 28.6'-29.6', moderately weathered SHALE.	7	13	--	26	32	22				
5		2	12	2					15	36	--	37	12					
10		2	15	3					14	25	--	31	9	21				
10.5		2	13	4														
15		2	16	5														
20		1	15	6														
21.5		2	12	7														
21.5		0	14	8														
21.5		1	36	9														
25.0		32	12	10														
25.0		50/3	9															
30																		

**LOG OF: Boring TR-59A**

Depth (ft)	Elev. (ft)	Blows per ft	Recovery (in)	Sample No.	Drive Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○ 10 20 30 40	
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
30	534.5						<p>Water seepage at: 19'-21.5'</p> <p>Water level at completion: Dry (Prior to coring) 17.0' (Including drill water)</p> <p><b>DESCRIPTION</b></p> <p>Medium hard to hard gray SILTSTONE interbedded with SHALE; very fine to fine grained, slightly weathered, argillaceous, thinly bedded, slightly fractured. @ 31.4'-31.7', clay seams with high angle fractures Hard black SHALE; fine grained, slightly weathered, carbonaceous, thinly bedded. @ 33.8'-34.0', high angle fractures and broken. Bottom of Boring - 35.0'</p>								
33.0	531.5														
35.0	529.5														
40															
45															
50															
55															
60															

Date Drilled: 3-14-05

Location: Rear Abutment - Ramp B - #1

LOG OF: Boring TR-60

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ————— LL Blows per foot - ○									
								% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay										
0.1	554.0																						
0.1 - 553.9																							
3.0	551.0	4	8	1	12																		
5		4	4	2	4	12																	
		3	2	3	2	9																	
		3	2	3	2	13																	
10	543.5	3	3	3	3	14																	
10.5		3	3	3	3	14																	
15		3	3	3	4	1																	
		2	3	3	3	14																	
18.0	536.0	1	1	2	17																		
20		4	3	3	16																		
23.0	531.0	7	4	4	18																		
25		3	6	4	18																		
25.5	528.5	50/4	4	12																			
28.0	526.0																						
30																							

WATER OBSERVATIONS: Water seepage at: 18'-28'  
Water level at completion: 26.0' (Prior to coring)  
19.0' (Including drill water)

DESCRIPTION

Topsoil - 1"  
FILL: Medium dense brown SANDY SILT (A-4a), little gravel, trace clay; damp.  
Loose brown COARSE AND FINE SAND (A-3a), little gravel, trace clay; damp.  
Loose brown SANDY SILT (A-4a), little gravel, trace clay; damp.  
@ 13.5', moist.  
Very loose to loose brown COARSE AND FINE SAND (A-3a), trace clay, trace gravel; wet.  
Stiff brown SILT AND CLAY (A-6a), little to some gravel, little fine to coarse sand; wet.  
Loose reddish brown FINE SAND (A-3), trace clay; wet.  
Soft black SHALE; highly weathered.

Location: Rear Abutment - Ramp B - #1 Date Drilled: 3-14-05

LOG OF: Boring TR-60

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetro-meter (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL  -----  LL Blows per foot - ○			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
30	524.0							Water seepage at: 18'-28' Water level at completion: 26.0' (Prior to coring) 19.0' (Including drill water)										
								<b>DESCRIPTION</b> Medium hard black SHALE; moderately weathered, carbonaceous, laminated, highly fractured. @ 30.0'-32.3', clay seam. @ 32.3' hard. @ 33.2', 38.0'-38.2', clay seams. @ 39.4'-39.8', high angle fracture.										
								@ 39.9', Hard gray SANDSTONE.										
								Bottom of Boring - 40.0'										

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL Blows per foot - ○	
							% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay		
0	547.0													
2		2	2	1										
3		4	3	2										
5.5	541.5													
10		1	3	5	2.5									
10.5	536.5													
1		2	2	13										
2		0	0	16										
0		0	0	1	2.25									
1		1	3	2										
1		1	1	3										
50/3		50/3	3	10										
23.0	524.0													
25.0	522.0													
30		Core 120"	Rec 114"	RQD 92%										

DESCRIPTION

FILL: Loose black SANDY SILT (A-4a), little gravel; organic; dry to damp.

Very stiff light brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp.

@ 8.5', brown.

Very loose brown COARSE AND FINE SAND (A-3a); moist.

@ 10.5'-12.5', little clay

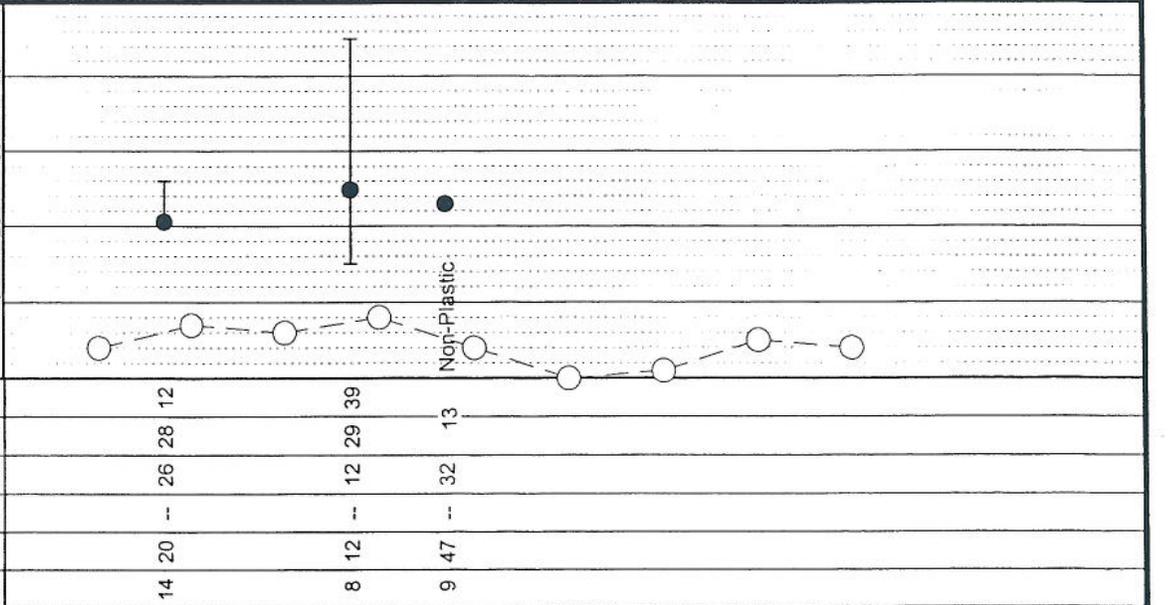
@ 13.5', wet.

@ 18.0', very loose to loose.

Medium hard black SHALE; moderately weathered.

Hard black SHALE; fine grained, moderately weathered, carbonaceous, thinly bedded, moderately fractured, fissile.

@ 25.0'-25.2'; 27.5'-27.6'; 28.1'-28.2'; 29.3'-30.0'; high angle fractures



Location: Forward Abutment - Ramp B - #1 Date Drilled: 3-16-05

LOG OF: Boring TR-61

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No.	Drive	Press / Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS:	GRADATION						STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ——— LL Blows per foot - ○			
									% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay				
30	517.0							Water seepage at: 13.5'-23.0' Water level at completion: 14.0' Prior to coring 9.0' Measured from inside the augers after coring										
30.5	516.5							DESCRIPTION  Hard gray SANDSTONE; fine to medium grained, slightly weathered, thinly to medium bedded. @ 31.2'-31.6'; high angle fracture. 33.7'-33.9', clay seam.										
35.0	512.0								Bottom of Boring - 35.0'									
40																		
45																		
50																		
55																		
60																		

