# SCI-823-0.00

## PID No. 19415

## S.R. 823 over Shumway Hollow Road

### Structure Type Study Submittal

*Prepared for:*
**Ohio Department of Transportation**
**District 9**
**650 Eastern Ave.**
**Chillicothe, Ohio 45601**

**April 28, 2006**

*Prepared by:*

TranSystems Corporation

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# BRIDGE TYPE STUDY NARRATIVE

## 1. Introduction

TranSystems Corporation is providing engineering services to the Ohio Department of Transportation for the design of new left and right overpass structures that will carry the proposed S.R. 823 bypass over relocated Shumway Hollow Road. As requested by the Scope of Services, a Structure Type Study report is to be submitted before any plan development. The purpose of this report is to investigate various span arrangements and superstructure and substructure types in order to determine the most appropriate and economical structure type that will meet the project requirements. An initial Structure Type Study report dated 7/15/2005 was submitted to the Department and comments, dated 8/29/2005, were in turn received by Transystems Corporation. However, since these dates, the entire project has experienced a change in profile – the original project profile presented in the Preferred Alternative Verification Report (PAVR) submitted July 2005 has been altered and the revised profile has been approved by the Department. The revised profiles now have S.R. 823 crossing over Shumway Hollow Road as opposed to the reverse in the July 2005 PAVR. This follow-up Structure Type Study presents a reevaluation of the new structure arrangement at this location incorporating the 9/1/2005 ODOT comments as applicable. As a result, two (2) alternatives for construction of the proposed S.R. 823 Mainline over Shumway Hollow Road are evaluated in this study and are designated as Alternatives 1 and 2. Each of these alternatives is evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, constructability and maintenance of traffic. Discussion of these alternatives is presented later in this report.

## 2. Design Criteria

The proposed structure will be designed according to the most current version of the Ohio Department of Transportation Bridge Design Manual and the 2002 AASHTO Standard Specifications for Highway Bridges, 17$^{th}$ Edition. Horizontal clearances (clear zone width and horizontal sight distance) are based on the Ohio Department of Transportation Location and Design Manual, Volume One – Roadway Design.

## 3. Subsurface Conditions and Foundation Recommendation

DLZ Ohio, Inc. performed the subsurface exploration for the proposed bridge and prepared the Preliminary Bridge Foundation Recommendations which were presented in Section 3 and Appendix E of the original 7/15/2005 Structure Type Study report. The borings were drilled to coincide with the proposed span arrangement that carried Shumway Hollow Road over S.R. 823 and are therefore not under either of the revised substructures locations. The SSI found rock to be uniform within the three borings drilled. The soil borings are ongoing through Step 8 of the PDP and the borings at these structures will be re-evaluated before the TS&L submittal. Updated boring logs for the three test borings (TR-24, TR-25 and TR-26) and preliminary MSE wall evaluations – performed by DLZ Ohio, Inc. – accompany this modified/updated Structure Type Study Report. The preliminary evaluations reveal that MSE walls can be used at the rear and forward abutment locations as long as the naturally occurring soils beneath the proposed MSE walls are over excavated 7'-0" and replaced with compacted, granular fill. DLZ also recommends a wire faced MSE wall built in stages to tolerate anticipated settlements and recommends the use of wick drains to reduce the time for primary consolidation. Conversations with DLZ Ohio, Inc. indicate that regardless of whether a single span or three span structure was being evaluated, the construction costs for the wick drains are similar and thus not included in the structure estimates of this report. The wick drain costs will be included in the

roadway costs for future submittals. Refer to the preliminary MSE wall evaluation report for more details and information.

## 4. Roadway

The purpose of this project is to construct a new bypass state route around the town of Portsmouth, Ohio. The proposed alignment will carry two lanes of traffic, 15 plus miles in either direction, from an interchange with US 52 just east of Portsmouth to another interchange with US 23, located north of Portsmouth in Valley Township.

Both the left and right structures are similar and will consist of two 12'-0" travel lanes with 6'-0" median shoulders and 12'-0" outside shoulders. Including a 1'-6" inside median parapet and a 1'-6" outside straight face deflector parapet yields a structure deck width of 45'-0" out to out.

The distance from the centerline of construction of SR 823 to the near edge of both the left and right structures is constant at 3'-6". Horizontal and vertical sight distances are in accordance with the design standards, for all alternatives considered.

Shumway Hollow Road will be relocated to the proposed horizontal and vertical alignment shown. Below the structure, Shumway Hollow Road will have three 12'-0" travel lanes with 8'-0" paved shoulders.

**Vertical and Horizontal Clearances** – The 17'-0" preferred vertical clearance will be provided for each structure alternative considered. The Shumway Hollow Road profile will be adjusted for the TS&L submittal to be within 3" of the preferred clearance for the selected structure. In accordance with the ODOT L&D manual, Volume 1 a minimum horizontal clear zone width of 30'-0" from edge of traveled way to face of obstruction will be provided for the twin structures at this location.

**Pavement Drainage** - The collection of storm water runoff will be addressed off of the bridge, thus scuppers will not be required. The type of drainage system will be investigated as part of the preliminary design.

**Utilities** - No utilities will be placed on the bridge. However, lighting and ITS conduits will be provided as necessary. There are no utility relocations at the bridge site known at this point in time.

**Maintenance of Traffic** – Mainline SR 823 and Shumway Hollow are both new construction and maintenance is not a concern.

## 5. Proposed Structure Configurations

**Alignment & Profile:** The proposed horizontal geometry of SR 823 is along a tangent for the entire length of both the left and right structures. The cross section is a normal crown. The proposed mainline profile grade line is located on the inside edge of pavement for both bridges and at a +1.5% grade. The horizontal and vertical geometry for all alternatives considered are the same. Embankment slopes will be a maximum of 2:1 in order to minimize right-of-way impacts. Shumway Hollow Road is on a tangent horizontal alignment below the proposed structures with a spiral curve starting 20' north of the right structure. The profile of Shumway

Hollow Road is in a 300' vertical curve with grades of -3.30% and -1.00%, PVI Sta. 29+00, Elev. = 669.86.

**Structure Types:** As per the Scope of Services, we investigated several bridge types and alternatives as part of this type study. Various span configurations were investigated and were refined to the layouts discussed below. Considering the preferred clearance to the clear zones on either side of Shumway Hollow Road a single span bridge was selected as the most economical. Three span structure alternatives were also investigated and dismissed. The 3-span arrangements provided for poorly balanced loading conditions to maintain clearances as well as being cost prohibitive in comparison to other options. Preliminary cost analysis also indicates that an option with MSE walls at the clear zones is cheaper than a single span spill through structure. The different alternatives discussed below modify the type of superstructure on the single span MSE supported embankments.

A preliminary bridge construction cost has been prepared for the two (2) Alternatives (See Appendix A). The unit prices were based on ODOT's Summary of Contracts Awarded Year 2004 and were inflated 3.5% each year to the 2008 sale date, unless different unit prices were recommended by ODOT in August 2005. These estimates were used as a guide to select the most economical alternative. Maintenance costs such as painting, overlays and re-decking were included for each Alternative.

The structure types that were considered are outlined in the Structure Type Alternative Table below:

| STRUCTURE TYPE ALTERNATIVE TABLE | | |
|---|---|---|
| **Structure Type Alternative** | **1** | **2** |
| **Superstructure Type Description** | Straight, 56"web, steel plate girders A709 Grade 50W | Prestressed Concrete Girders 72" Modified AASHTO Type 4 beams |
| **Proposed Beam Spacing** | 4 Spaces @ 9'-6" | 4 Spaces @ 9'-6" |
| **No. of Spans** | 1 (107') | 1 (107') |
| **Abutment Type** | Stub Type abutments on MSE wall supported embankments (Semi-Integral) | Stub Type abutments on MSE wall supported embankments (Semi-Integral) |
| **No. of Piers** | None | None |
| **Pier Type** | N/A | N/A |
| **Substructure Orientation** | 0°00'00" | 0°00'00" |
| **Approximate Bridge Length** | 107' | 107' |
| **Approximate Structure Depth** | | |
| **Slab** | 8.75" | 8.5" |
| **Haunch** | 2" | 2" |
| **Beam** | 59.0" | 72.0" |
| **Total** | 69.75" (5.8125') | 82.5" (6.875') |

## Alternatives Discussion:

### *Alternative 1*

This alternative is comprised of a single span structure with a span length of 107'-0" from centerline bearings at abutments. The abutments and pier are oriented with a 0°00'00" skew. Embankment slopes are supported by MSE walls approximately 20' in height at both abutments. The MSE walls are set at the clear zones of 30'-0" on either side of Shumway Hollow Road. A ditch will be required in front of both MSE walls to convey the roadway drainage.

The abutments will be semi-integral type supported on H-piles as they are located in new embankment fill. The piles shall be HP14x73 with a design capacity of 90-tons per pile, driven to refusal on bedrock. The details of the abutments will follow ODOT Standard Construction drawings. Piles will need to be sleeved through the MSE wall embankment zone in accordance with the MSE wall Special Provisions. Due to anticipated settlements (see Appendix E) wire faced MSE walls, built in stages, are recommended, and to reduce primary consolidation time, wick drains should be used within the embankment area.

The preliminary design of this alternative consists of 5 - 56" web Grade 50W plate girders, spaced at 9'-6" with 3'-6" deck overhangs. The design loading applied was HS-25 (Case I fatigue) with Alternate Military Loading and a future wearing surface of 60 psf. Both the left and right bridge width will be 42'-0" from toe to toe of parapets with an overall bridge deck width of 45'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 ¾".

The initial bridge construction cost for Alternative 1 is estimated to be $2,040,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $923,000, resulting in a total estimated ownership cost of $2,963,000 in year 2008 dollars.

***Alternative 2***

Alternative 2 is similar to Alternative 1 except that the superstructures for the left and right structures consist of 5 - 72" Type 4 Modified prestressed beams, spaced at 9'-6" with 3'-6" overhangs. Both the left and right bridge width will be 42'-0" from toe to toe of parapets with an overall bridge deck width of 45'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2". Standard beam strengths of 5000psi release and 7000psi final were used for this alternative.

The initial bridge construction cost for Alternative 2 is estimated to be $2,310,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $491,000, resulting in a total estimated ownership cost of $2,801,000 in year 2008 dollars.

## 6. Recommendations:

Based upon the above information and discussions, we recommend for both the left and right structures **Structure Type Alternative 2**, which consists of a single span with 72" AASHTO Type 4 Modified prestressed beams supported on semi-integral abutments, behind MSE walls. (See Appendix B for the Site Plan and Structure Details).

Our recommendation for Alternative 2 is based on the following items:

A. This Alternative appears to be economical when considering the construction costs.

B. Lowest life cycle costs.

C. Lowest total ownership costs.

# APPENDIX A

## Cost Comparison Summary

TRANSYSTEMS CORPORATION

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## S.R. 823 over Shumway Hollow Road L&R

### STRUCTURE TYPE STUDY

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

## ALTERNATIVE COST SUMMARY

| Alternative No. | Span Arrangement No. Spans | Span Arrangement Lengths | Total Span Length (ft.) | Framing Alternative | Proposed Stringer Section | Subtotal Superstructure Cost | Subtotal Substructure Cost | Structure Incidental Cost (16%) | Structure Contingency Cost (20%) | Total Alternative Const. Cost | Life Cycle Maintenance Cost | Total Relative Ownership Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 107' | 107.00 | 5 Steel Girders /per BRIDGE | 56" Web Grade 50W | $710,000 | $757,000 | $234,700 | $340,300 | $2,040,000 | $923,000 | $2,963,000 |
| 2 | 1 | 107' | 107.00 | 5 Prestressed Concrete Girders /per BRIDGE | Modified AASHTO Type 4 (72") | $776,000 | $883,000 | $265,400 | $384,900 | $2,310,000 | $491,000 | $2,801,000 |

**NOTES:**

1. Structure incidental cost allowance includes provision for structure excavation, porous backfill, sealing of concrete surfaces, structural steel painting, bearings, and crushed aggregate slope protection costs.

2. Estimated construction cost does not include existing structure removal (if any), which should be quantified seperately, if required.

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## S.R. 823 over Shumway Hollow Road L&R

### STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 1 - SUPERSTRUCTURE

By: PJP Date: 4/17/2006
Checked: JRC Date: 4/18/2006

## SUPERSTRUCTURE

| Alternative No. | Span Arrangement No. Spans | Lengths | Total Span Length (ft.) | Deck Length (ft.) | Deck Volume (cu. yd.) | Deck Concrete Cost | Deck Reinforcing Cost | Approach Slab Cost | Approach Roadway Cost | Framing Alternative | Proposed Girder Section | Structural Steel Weight (Pounds) | Steel Girder Cost | Subtotal Superstructure Cost | Construction Complexity Factor | Subtotal Superstructure Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 107' | 107.00 | 110 | 364 | $214,500 | $91,200 | $99,000 | $0 | 5 Steel Girders /per BRIDGE | 56" Web Grade 50W | 262150 | $305,183 | $710,000 | 0% | **$710,000** |

## COST SUPPORT CALCULATIONS

**Deck Cross-Sectional Area:**

Parapets:

| | No. | Individual Area (sq. ft.) | Parapet Area (sq. ft.) |
|---|---|---|---|
| Parapets | 1 | 4.26 | 4.26 |
| Parapets | 1 | 4.26 | 4.26 |

Slab:

| | T (ft.) | W (ft.) | Slab Area | Haunch & Overhang Area | Total Concrete Area (sq. ft.) |
|---|---|---|---|---|---|
| Left Bridge | 0.73 | 45.00 | 32.8 | 3.3 | 44.6 |
| Right Bridge | 0.73 | 45.00 | 32.8 | 3.3 | 44.6 |

Note: Deck width is out to out
10% of deck area allowed for haunches and overhangs.

**QC/QA Concrete, Class QSC2**
**Unit Cost ($/cu. yd):**

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Deck | $491.00 | 3.5% | $563.00 |
| Parapets | $615.00 | 3.5% | $706.00 |
| Weighted Average = | | | $590.00 |

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

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Deck Reinforcing | $0.77 | 3.5% | $0.88 |

**Structural Steel Unit Costs ($/lb.):**

| | Cost Ratio | Year 2005 | Annual Escalation | Year 2008 | |
|---|---|---|---|---|---|
| Rolled Beams - Grade 50 | n/a | $0.74 | 3.5% | $0.85 | |
| Level 4 Plate Girders - Grade 50W | n/a | $1.05 | 3.5% | $1.16 | Straight Girders |
| level 5 Plate Girders - Grade 50W | n/a | $1.20 | 3.5% | $1.38 | Curved Girders |

**Construction Complexity Factor**
**Percent of Superstructure** = 0% Due to Deck forming, Screed and Varying Girder Spaces

**Reinforced Concrete Approach Slabs (T=17")**
**Unit Cost ($/sq. yd.):**
Length = 30 ft. Width = 90 ft
Area = 600 sq. yd.

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Approach Slabs | $144.00 | 3.5% | $165.00 |

**Approach Roadway**

| | | Year 2005 | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Embankment fill | 0.00 cu.yd. | $4.00 | 3.5% | $4.43 |
| Roadway incl. base | 0.00 sq.yd. | $26.00 | 3.5% | $28.83 |
| Barrier (single faced) | 0 ft. | $50.00 | 3.5% | $55.44 |
| Barrier (dble faced) | 0 ft. | $80.00 | 3.5% | $88.70 |

**Expansion Joints**
**Unit Costs ($/Lin.Ft.):**

| | Cost Ratio | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Strip Seal Expansion Joints | 1.00 | $250 | 3.5% | $318 |

# SCI-823-0.00 - PORTSMOUTH BYPASS
## S.R. 823 over Shumway Hollow Road L&R
### STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 1 - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

## SUBSTRUCTURE

| Alternative No. | Span Arrangement No. Spans | Lengths | Framing Alternative | Proposed Stringer Section | Pier Concrete Cost | Pier Reinforcing Cost | Abutment Concrete Cost | Abutment Reinforcing Cost | Pile Foundation Cost | MSE Wall Cost | Additional Crane Cost | Subtotal Substructure Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 107' | 5 Steel Girders /per BRIDGE | 56" Web Grade 50W | $0 | $0 | $155,500 | $25,500 | $115,200 | $460,900 | $0 | **$757,000** |

## COST SUPPORT CALCULATIONS

**Pier QC/QA Concrete, Class QSC1 Cost: (Spread Footing)**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Total Cost |
|---|---|---|---|---|---|
| Cap | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Stem | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Footings | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Total | 0 | | | | $0 |

**Pier QC/QA Concrete, Class QSC1 Cost: (Drilled Shaft)**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Total Cost |
|---|---|---|---|---|---|
| Cap | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Columns | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Footings | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Total | | | | | $0 |

**Abutment QC/QA Concrete, Class QSC1 Cost:**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Total Cost |
|---|---|---|---|---|---|
| Abutment | 280 | $421.00 | 3.5% | $483.00 | $135,200 |
| Wingwalls | 42 | $421.00 | 3.5% | $483.00 | $20,300 |

Note: 15% of abutment volume allowed for wingwalls.

**Epoxy Coated Reinforcing Steel Unit Cost ($/lb):**

Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Pier | $0.77 | 3.5% | $0.88 |
| Abutment | $0.77 | 3.5% | $0.88 |

**MSE Abutment Unit Cost ($/sq. ft.):**

| | Total Area (sq. ft.) | Year 2005 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Alt. 1 | 8,320 | $50.00 | 3.5% | $55.40 |

**Pile Foundation Unit Cost ($/ft.):** *HP 14X73 Piles, Furnished & Driven*

| Number of Piles | | Total Pile Length |
|---|---|---|
| 64 | SEE QUANTITY CALCULATIONS | 2,880 |

**Pile Foundation Unit Cost ($/ft.):**

| | Year 2005 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|
| Furnished | $26.47 | 3.5% | $29.30 |
| Driven | $9.62 | 3.5% | $10.70 |
| Total | | | $40.00 |

**Shaft Foundation Unit Cost ($/ft.):** 36" Drilled Shaft

| Number of Shafts | | Total Shaft Length |
|---|---|---|
| Alt. 1 0 | SEE QUANTITY CALCULATIONS | 0 |

**Shaft Foundation Unit Cost ($/ft.):**

| Unit Cost | Escalation | 2008 |
|---|---|---|
| $300.00 | 4.5% | $358.00 |

**Cost of Shafts:** $ -

**Temporary Shoring and Support Unit Costs ($/sq. ft.):**

| | Temp. Shoring Area (sq. ft.) | Temp. Girder Support (lump sum) |
|---|---|---|
| Alt. 1 | 0 | $ - |

| | Year 2004 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|
| Temporary Shoring | $22.50 | 3.5% | $25.80 |
| Cofferdam | $32.00 | 3.5% | $36.70 |

**Additional Crane Cost**

$ -

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### STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 1 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

**Pier Quantities**

| Pier Location | Length | Cap | | | | Stem | | | | Footing | | | | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Width* | *Depth* | *Area* | *Volume* | *Width* | *Height* | *Length* | *Volume* | *Width* | *Depth* | *Length* | *Volume* | |
| Pier 1 (Spr Ftg) | 0 | 0 | 0 | 0.00 | 0 | 0 | 0 | 0.00 | 0 | 0 | 0 | 0.00 | 0 | 0 |
| Pier 2 | | | | | | | | | | | | | | |
| Pier 3 | | | | | | | | | | | | | | |
| Pier 4 | | | | | | | | | | | | | | 0 |
| Pier 5 | | | | | | | | | | | | | | 0 |
| Pier 6 | | | | | | | | | | | | | | 0 |
| Pier 7 | | | | | | | | | | | | | | 0 |
| **Total (Cu.Ft.)** | | | | | 0 | | | | 0 | | | | 0 | 0 |
| **Total (Cu.Yd.)** | | | | | 0 | | | | 0 | | | | 0 | 0 |
| | | | Qty x 2 (L/R) | | 0 | | | | 0 | | | | 0 | 0 |

**Abutment Quantities**

| Abut Location | Length (feet) | Backwall | | | | Beam Seat | | | | Footing | | | | | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Width* | *Depth* | *Area* | *Volume* | *Width* | *Height* | *Area* | *Volume* | *Width* | *Depth* | *Area* | *# Footi* | *Volume* | |
| Rear Abut | 45 | 3 | 6.5 | 19.50 | 878 | 3 | 1.5 | 4.50 | 203 | 6 | 3 | 18 | 1 | 810 | 1890 |
| Fwd. Abut | 45 | 3 | 6.5 | 19.50 | 878 | 3 | 1.5 | 4.50 | 203 | 6 | 3 | 18 | 1 | 810 | 1890 |
| **Total (Cu.Ft.)** | | | | | 1755 | | | | 405 | | | | | 1620 | 3780 |
| **Total (Cu.Yd.)** | | | | | 65 | | | | 15 | | | | | 60 | 140 |
| | | | Qty x 2 (L/R) | | 130 | | | | 30 | | | | | 120 | 280 |

**MSE Abutment Wall Quantities**

| Abut Location | | Wall | | | |
|---|---|---|---|---|---|
| | | *Height* | *Length* | *Area* | *Volume* |
| Rear Abut | | 24 | 125 | 3000.0 | |
| RA Wing ( L ) | | 5 | 40 | 580.0 | |
| RA Wing ( R ) | | 5 | 40 | 580.0 | |
| | | | | | |
| Fwd Abut | | 24 | 125 | 3000.0 | |
| FA Wing ( L ) | | 5 | 40 | 580.0 | |
| FA Wing ( R ) | | 5 | 40 | 580.0 | |
| | | | | | |
| | | | | | |
| **Total (Sq.Ft.)** | | | | 8320 | |

**Pile Quantities**

| Location | Load/girder (Kips) | # Girders | Total Girder Load | Subst Wt (kips) | Pile Cap.(Kips | No. Piles | Increase Factor | Total Piles | Top Elev. | Bot Elev. | Pile Length | Total Pile Length (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rear Abut. | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *16* | 684.5 | 640.0 | 45.0 | *720* |
| Pier 1 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 2 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 3 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 4 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 5 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 6 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 7 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Fwd. Abut. | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *16* | 685 | 640 | 45.0 | *720* |
| **Total** | | | | | | | | 32 | | | | 1440 |
| | | | | | | | Qty x 2 (L/R) | 64 | | | | 2880 |

**36" Drilled Shafts for Piers**

| Location | Load/girder (Kips) | # Girders | Total Load | Subst Wt (kips) | Pile Cap.(Kips | No. Piles | Increase Factor | Total Shafts | Top Elev. | Bot Elev. | Pile Length | Total Shaft Length (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rear Abut. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Fwd. Abut. | 0 | 10 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| **Total** | | | | | | | | 0 | | | | 0 |

**Superstructure Steel Quantities**

| Location | Wt.of girder (lb)/ft | # Girders | Span Length | Total Weight |
|---|---|---|---|---|
| Span 1 | 245 | 10 | 107.00 | 262150 |
| Span 2 | 0 | 0 | 0 | 0 |
| Span 3 | 0 | 0 | 0 | 0 |
| Span 4 | 0 | 0 | 0 | 0 |
| Span 5 | 0 | 0 | 0 | 0 |
| Span 6 | 0 | 0 | 0 | 0 |
| Span 7 | 0 | 0 | 0 | 0 |
| Span 8 | 0 | 0 | 0 | 0 |
| | | | | |
| **Total** | | | | 262150 |

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## S.R. 823 over Shumway Hollow Road L&R

### STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2 - SUPERSTRUCTURE

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

## SUPERSTRUCTURE

| Alternative No. | Span Arrangement No. Spans | Lengths | Total Span Length (ft.) | Deck Length (ft.) | Deck Volume (cu. yd.) | Deck Concrete Cost | Deck Reinforcing Cost | Approach Slab Cost | Approach Roadway Cost | Framing Alternative | Proposed Stringer Section | Prestressed Concrete Cost | Subtotal Superstructure Cost | Construction Complexity Factor | Subtotal Superstructure Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1 | 107' | 107 | 110 | 355 | $209,900 | $89,100 | $99,000 | $0 | 5 Prestressed Concrete Girders /per BRIDGE | Modified AASHTO Type 4 (72") | $378,060 | $776,000 | 0% | **$776,000** |

## COST SUPPORT CALCULATIONS

**Deck Cross-Sectional Area:**

| Parapets: | No. | Individual Area (sq. ft.) | Parapet Area (sq. ft.) |
|---|---|---|---|
| Parapets | 1 | 4.26 | 4.26 |
| Parapets | 1 | 4.26 | 4.26 |

| Slab: | T (ft.) | W (ft.) | Slab Area | Haunch & Overhang Area | Total Concrete Area (sq. ft.) |
|---|---|---|---|---|---|
| Left Bridge | 0.71 | 45.00 | 31.9 | 3.2 | 43.6 |
| Right Bridge | 0.71 | 45.00 | 31.9 | 3.2 | 43.6 |

Note: Deck width is out to out
10% of deck area allowed for haunches and overhangs.

**QC/QA Concrete, Class QSC2**
**Unit Cost ($/cu. yd):**

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Deck | $491.00 | 3.5% | $563.00 |
| Parapets | $615.00 | 3.5% | $706.00 |
| Weighted Average = | | | $591.00 |

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

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Deck Reinforcing | $0.77 | 3.5% | $0.88 |

**Prestressed Concrete Girders**
**Unit Costs:**

| | Year 2005 | | Annual Escalation | Year 2008 | | No. Required | |
|---|---|---|---|---|---|---|---|
| **AASHTO Type IV Beams** | | | | | | | |
| Pier Diaphragms | $1,800 | ea. | 3.5% | $2,070 | ea. | 0 | $0 |
| Abutment Diaphragms | $1,200 | ea. | 3.5% | $1,380 | ea. | 0 | $0 |
| Intermediate Diaphragms | $905 | ea. | 3.5% | $1,040 | ea. | 24 | $24,960 |
| Modified Type 4 I-Beams (72") | $300 | per ft. | 3.5% | $330 | ea. | 1070 | $353,100 |
| | | | | | | | **$378,060** |

**Construction Complexity Factor**
**Percent of Superstructure** = 0% Due to Deck forming, Screed and Varying Girder Spaces

**Reinforced Concrete Approach Slabs (T=17")**
**Unit Cost ($/sq. yd.):**
Length = 30 ft. Width = 90 ft
Area = 600 sq. yd.

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Approach Slabs | $144.00 | 3.5% | $165.00 |

**Expansion Joints**
**Unit Costs ($/Lin.Ft.):**

| | Cost Ratio | Year 2003 | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Strip Seal Expansion Joints | 1.00 | $250.00 | 3.5% | $318.07 |

**Approach Roadway**

| | | Year 2005 | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Embankment fill | 0.00 cu.yd. | $4.00 | 3.5% | $4.43 |
| Roadway incl. base | 0.00 sq.yd. | $26.00 | 3.5% | $28.83 |
| Barrier (single faced) | 0 ft. | $50.00 | 3.5% | $55.44 |
| Barrier (dble faced) | 0 ft. | $80.00 | 3.5% | $88.70 |

# SCI-823-0.00 - PORTSMOUTH BYPASS

## S.R. 823 over Shumway Hollow Road L&R

### STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2 - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

## SUBSTRUCTURE

| Alternative No. | Span Arrangement No. Spans | Span Arrangement Lengths | Framing Alternative | Proposed Stringer Section | Pier Concrete Cost | Pier Reinforcing Cost | Abutment Concrete Cost | Abutment Reinforcing Cost | Pile Foundation Cost | MSE Wall Cost | Additional Crane Cost | Subtotal Substructure Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2 | 1 | 107' | 5 Prestressed Concrete Girders /per BRIDGE | Modified AASHTO Type 4 (72") | $0 | $0 | $167,600 | $27,500 | $152,000 | $460,900 | $75,000 | **$883,000** |

## COST SUPPORT CALCULATIONS

**Pier QC/QA Concrete, Class QSC1 Cost: (Spread Footing)**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Alt 1 Total Cost |
|---|---|---|---|---|---|
| Cap | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Stem | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Footings | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Total | 0 | | | | $0 |

**Pier QC/QA Concrete, Class QSC1 Cost: (Drilled Shaft)**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Alt 1 Total Cost |
|---|---|---|---|---|---|
| Cap | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Columns | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Footings | 0 | $421.00 | 3.5% | $483.00 | $0 |
| Total | | | | | $0 |

**Abutment QC/QA Concrete, Class QSC1 Cost:**

| Component | Volume (cu. yd.) | Year 2004 | Annual Escalation | Year 2008 | Total Cost |
|---|---|---|---|---|---|
| Abutment | 302 | $421.00 | 3.5% | $483.00 | $145,900 |
| Wingwalls | 45 | $421.00 | 3.5% | $483.00 | $21,700 |

Note: 15% of abutment volume allowed for wingwalls.

**Epoxy Coated Reinforcing Steel**
**Unit Cost ($/lb):**
Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Pier | $0.77 | 3.5% | $0.88 |
| Abutment | $0.77 | 3.5% | $0.88 |

**MSE Abutment Unit Cost ($/sq. ft.):**

| | Total Area (sq. ft.) | Year 2005 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|---|
| Alt. 2 | 8,320 | $50.00 | 3.5% | $55.40 |

**Pile Foundation Unit Cost ($/ft.):** *HP 14x73 Piles, Furnished & Driven*

| Number of Piles | | Total Pile Length |
|---|---|---|
| 80 | SEE QUANTITY CALCULATIONS | 3,800 |

**Pile Foundation Unit Cost ($/ft.):**

| | Year 2005 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|
| Furnished | $26.47 | 3.5% | $29.30 |
| Driven | $9.62 | 3.5% | $10.70 |
| Total | | | $40.00 |

**Shaft Foundation Unit Cost ($/ft.):** 36" Drilled Shaft

| | Number of Shafts | | Total Shaft Length |
|---|---|---|---|
| Alt. 1a | 0 | SEE QUANTITY CALCULATIONS | 0 |

**Shaft Foundation Unit Cost ($/ft.):**

| Unit Cost | Escalation | 2008 |
|---|---|---|
| $300.00 | 4.5% | $358.00 |

**Cost of Shafts:** $ -

**Temporary Shoring and Support Unit Costs ($/sq. ft.):**

| | Temp. Shoring Area (sq. ft.) | Temp. Girder Support (lump sum) |
|---|---|---|
| Alt. 1a | 0 | $ - |

| | Year 2004 Unit Cost | Annual Escalation | Year 2008 |
|---|---|---|---|
| Temporary Shoring | $22.50 | 3.5% | $25.80 |
| Cofferdam | $32.00 | 3.5% | $36.70 |

**Additional Crane Cost**

**$ 75,000**

# SCI-823-0.00 - PORTSMOUTH BYPASS

## S.R. 823 over Shumway Hollow Road L&R

### STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

**Pier Quantities**

| Pier Location | Length | Cap | | | | Stem | | | | | Footing | | | | | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Width* | *Depth* | *Area* | *Volume* | *Width* | *Height* | *Length* | | *Volume* | *Width* | *Depth* | *Length* | | *Volume* | |
| Pier 1 (Spr Ftg) | 0 | 0 | 0 | 0.00 | 0 | 0 | 0 | 0.00 | | 0 | 0 | 0 | 0.00 | | 0 | 0 |
| Pier 2 | | | | | | | | | | | | | | | | 0 |
| Pier 3 | | | | | | | | | | | | | | | | 0 |
| Pier 4 | | | | | | | | | | | | | | | | 0 |
| Pier 5 | | | | | | | | | | | | | | | | 0 |
| Pier 6 | | | | | | | | | | | | | | | | 0 |
| Pier 7 | | | | | | | | | | | | | | | | 0 |
| **Total (Cu.Ft.)** | | | | | **0** | | | | | **0** | | | | | **0** | **0** |
| **Total (Cu.Yd.)** | | | | | **0** | | | | | **0** | | | | | **0** | **0** |
| | | | | **Qty x 2 (L/R)** | **0** | | | | | **0** | | | | | **0** | **0** |

**Abutment Quantities**

| Abut Location | Length (feet) | Backwall | | | | Beam Seat | | | | | Footing | | | | | Total Volume |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Width* | *Depth* | *Area* | *Volume* | *Width* | *Height* | *Area* | | *Volume* | *Width* | *Depth* | *Area* | *# Footin* | *Volume* | |
| Rear Abut | 45 | 3 | 7.6 | 22.80 | 1026 | 3 | 1.5 | 4.50 | | 203 | 6 | 3 | 18 | 1 | 810 | 2039 |
| Fwd. Abut | 45 | 3 | 7.6 | 22.80 | 1026 | 3 | 1.5 | 4.50 | | 203 | 6 | 3 | 18 | 1 | 810 | 2039 |
| **Total (Cu.Ft.)** | | | | | **2052** | | | | | **405** | | | | | **1620** | **4077** |
| **Total (Cu.Yd.)** | | | | | **76** | | | | | **15** | | | | | **60** | **151** |
| | | | | **Qty x 2 (L/R)** | **152** | | | | | **30** | | | | | **120** | **302** |

**MSE Abutment Wall Quantities**

| Abut Location | | Wall | | | |
|---|---|---|---|---|---|
| | | *Height* | *Length* | *Area* | *Volume* |
| Rear Abut | | 24 | 125 | 3000.0 | |
| RA Wing ( L ) | | 5 | 40 | 580.0 | |
| RA Wing ( R ) | | 5 | 40 | 580.0 | |
| | | | | | |
| Fwd Abut | | 24 | 125 | 3000.0 | |
| FA Wing ( L ) | | 5 | 40 | 580.0 | |
| FA Wing ( R ) | | 5 | 40 | 580.0 | |
| | | | | | |
| | | | | | |
| **Total (Sq.Ft.)** | | | | **8320** | |

**Pile Quantities**

| Location | Load/girder (Kips) | # Girders | Total Girder Load | Subst Wt (kips) | Pile Cap.(Kips | No. Piles | Increase Factor | Total Piles | Top Elev. | Bot Elev. | Pile Length | Total Pile Length (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rear Abut. | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *20* | 684.3 | 640.0 | 45.0 | *900* |
| Pier 1 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 2 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 3 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 4 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 5 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 6 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 7 | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Fwd. Abut. | 0 | 0 | 0 | 0 | 140 | 0 | 1 | *20* | 685.9 | 640 | 50.0 | *1000* |
| **Total** | | | | | | | | **40** | | | | **1900** |
| | | | | | | | **Qty x 2 (L/R)** | **80** | | | | **3800** |

**36" Drilled Shafts for Piers**

| Location | Load/girder (Kips) | # Girders | Total Load | Subst Wt (kips) | Pile Cap.(Kips | No. Piles | Increase Factor | Total Shafts | Top Elev. | Bot Elev. | Pile Length | Total Shaft Length (Feet) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Rear Abut. | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 2.0 | *0* |
| Pier 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 2.0 | *0* |
| Pier 3 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 4 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 6 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Pier 7 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| Fwd. Abut. | 0 | 10 | 0 | 0 | 0 | 0 | 1 | *0* | 0 | 0 | 0.0 | *0* |
| **Total** | | | | | | | | **0** | | | | **0** |

# SCI-823-0.00 - PORTSMOUTH BYPASS
## S.R. 823 over Shumway Hollow Road L&R
### STRUCTURE TYPE STUDY - LIFE CYCLE COSTS

By: PJP
Checked: JRC

Date: 4/17/2006
Date: 4/18/2006

## LIFE CYCLE MAINTENANCE COST

| Alt. No. | Span Arrangement No. Spans | Lengths | Framing Alternative | Structural Steel Painting * Cost Per Cycle | Number of Maintenance Cycles | Total Life Cycle Cost | Superstructure Sealing Cost Per Cycle | Number of Maintenance Cycles | Total Life Cycle Cost | Approach Pavement Resurfacing Cost Per Cycle | Number of Maintenance Cycles | Total Life Cycle Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 107.00 | 5 Steel Girders /per BRIDGE | $236,700 | 2 | $473,400 | $0 | 0 | $0 | $0 | 10 | $0 |
| 2 | 1 | 107.00 | 5 Prestressed Concrete Girders /per BRIDGE | $0 | 0 | $0 | $24,000 | 2 | $48,000 | $0 | 10 | $0 |

| Alt. No. | Span Arrangement No. Spans | Lengths | Framing Alternative | Bridge Deck Overlay (5) Deck Demo & Chipping | Deck Overlay | Deck Joint Gland (2) | Number of Maintenance Cycles | Total Life Cycle Cost | Bridge Redecking (5) Deck Concrete Cost (3) | Deck Reinforcing Cost (3) | Deck Joint Cost (2) | Deck Removal Cost | Number of Maintenance Cycles | Total Life Cycle Cost | Superstructure Life Cycle Maintenance Cost (1) | Total Initial Construction Cost | Total Relative Ownership Cost |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1 | 107 | 5 Steel Girders /per BRIDGE | $29,200 | $35,400 | n/a | 1 | $64,600 | $214,500 | $91,200 | n/a | $79,700 | 1 | $385,400 | **$923,000** | **$2,040,000** | **$2,963,000** |
| 2 | 1 | 107 | 5 Prestressed Concrete Girders /per BRIDGE | $29,200 | $35,400 | n/a | 1 | $64,600 | $209,900 | $89,100 | n/a | $79,700 | 1 | $378,700 | **$491,000** | **$2,310,000** | **$2,801,000** |

**Structural Steel Painting:**

Structural Steel Area:

| | Web Depth (in.) | No. Stringers | Total Span Length (ft.) | Assumed Ave. Bot. Flange Width (in.) | Nominal Exposed Girder Area (sq. ft.) | Secondary Member Allowance | Total Exposed Steel Area (sq. ft.) |
|---|---|---|---|---|---|---|---|
| Alt. 1 | 56 | 10 | 107.00 | 18.00 | 14,802 | 20% | 17,800 |

Painting Cost per sq. ft.:

| | Year 2005 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Prep. | $6.75 | 3.5% | $7.48 |
| Prime | $1.75 | 3.5% | $1.94 |
| Intermed. | $1.75 | 3.5% | $1.94 |
| Finish | $1.75 | 3.5% | $1.94 |
| Total | $12.00 | | $13.30 |

**Superstructure Sealing:**

PS Concrete I-Beam Area:

72" Modified AASHTO Type 4

| | H | V | Diag. | No. | Total |
|---|---|---|---|---|---|
| Bot. Flange | 26 | | | 1 | 26.00 |
| | | 8 | | 2 | 16.00 |
| Lower Fillets | 9 | 9 | 12.73 | 2 | 25.46 |
| Web | | 46 | | 2 | 92.00 |
| Upper Fillets | 3 | 3 | 4.24 | 2 | 8.49 |
| | 11 | 2 | 11.18 | 2 | 22.36 |
| Top Flange | | 4 | | 2 | 8.00 |
| Total Exposed Perimeter | | | | | 198.30 in. |

66" Modified AASHTO Type 4

| | H | V | Diag. | No. | Total |
|---|---|---|---|---|---|
| Bot. Flange | 26 | | | 1 | 26.00 |
| | | 8 | | 2 | 16.00 |
| Lower Fillets | 9 | 9 | 12.73 | 2 | 25.46 |
| Web | | 40 | | 2 | 80.00 |
| Upper Fillets | 3 | 3 | 4.24 | 2 | 8.49 |
| | 11 | 2 | 11.18 | 2 | 22.36 |
| Top Flange | | 4 | | 2 | 8.00 in. |
| Total Exposed Perimeter | | | | | 186.30 |

PS Concrete Area:

| | No. Stringers | Total Span Length (ft.) | Nominal Exposed Beam Area (sq. ft.) | Secondary Member Allowance | Total Exposed Concrete Area (sq. yd.) |
|---|---|---|---|---|---|
| Alt. 2 | 10 | 107.00 | 17,682 | 10% | 2,160 |

Sealing Cost per sq. yd.:

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Epoxy-Urethane Sealer | $9.68 | 3.5% | $11.11 |

**Bridge Redecking:**

Bridge Deck Joint Cost per foot:

| | Year 2005 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Structural Expansion Joint Including Elastomeric Strip Seal | $250.00 | 3.5% | $277.18 |

| | Bridge Width | No. Joints |
|---|---|---|
| Alt. 1 | 90.00 | 0 |
| Alt. 2 | 90.00 | 0 |

Bridge Deck Removal Cost:

| | Deck Area (3) (sq. ft.) | Year 2008 | Deck Removal Cost |
|---|---|---|---|
| Alt. 1 | 9,630 | $8.28 | $79,700 |
| Alt. 2 | 9,630 | $8.28 | $79,700 |

**Bridge Deck Overlay (Item 848):**

Bridge Deck MSC Overlay Cost per sq. yd.:

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Micro Silica Modified Concrete Overlay Using Hydrodemolition (1.25" thick) | $25.58 | 3.5% | $29.35 |
| Surface Preparation Using Hydrodemolition | $22.85 | 3.5% | $26.22 |
| Hand Chipping | $37.07 | 3.5% | $42.54 |

Bridge Deck MSC Overlay Cost per cu. yd.:

| | | | | |
|---|---|---|---|---|
| Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only | $144.00 | 3.5% | $165.24 | |

| | Deck Area (3) (sq. ft.) | Deck Area (sq. yd.) | Hand Chipping (sq. yd.) | Variable Thickness Repair (cu. yd.) |
|---|---|---|---|---|
| Alt. 1 | 9,630 | 1,070 | 27 | 24 |
| Alt. 2 | 9,630 | 1,070 | 27 | 24 |

Assume 25% of deck area requires removal to depth of 4.5" (3.25" additional removal).

Bridge Deck Joint Gland Replacement Cost per foot:

| | Year 2005 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Elastomeric Strip Seal Gland | $62.50 | 3.5% | $69.29 |

Assume gland replacement cost equals 25% of original deck joint construction cost.

**NOTES:**

1. Life cycle maintenance costs assume a 75 -year structure life, and are expressed in present value (2008 construction year) dollars.
2. Bridges are assumed to have semi-integral abutments, therefore no strip seal deck joints will be required except for Alt. 3.
3. See Superstructure Cost sheet.
4. See Alternative Cost Summary sheet.
5. 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.
6. Life cycle maintenance cost differences are assumed to be predominately a function of superstructure maintenance costs. Consequently, substructure lifecycle maintenance costs are not included in this analysis.

**Approach Pavement Resurfacing:**

Resurface Perpetual Asphalt Pavement:

Resurfacing Units Costs:

| | Year 2004 | Annual Escalation | Year 2008 |
|---|---|---|---|
| Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254) | $0.98 | 3.5% | $1.12 |
| Asphalt Concrete Surface Course, per cu. yd. | $72.00 | 3.5% | $82.62 |

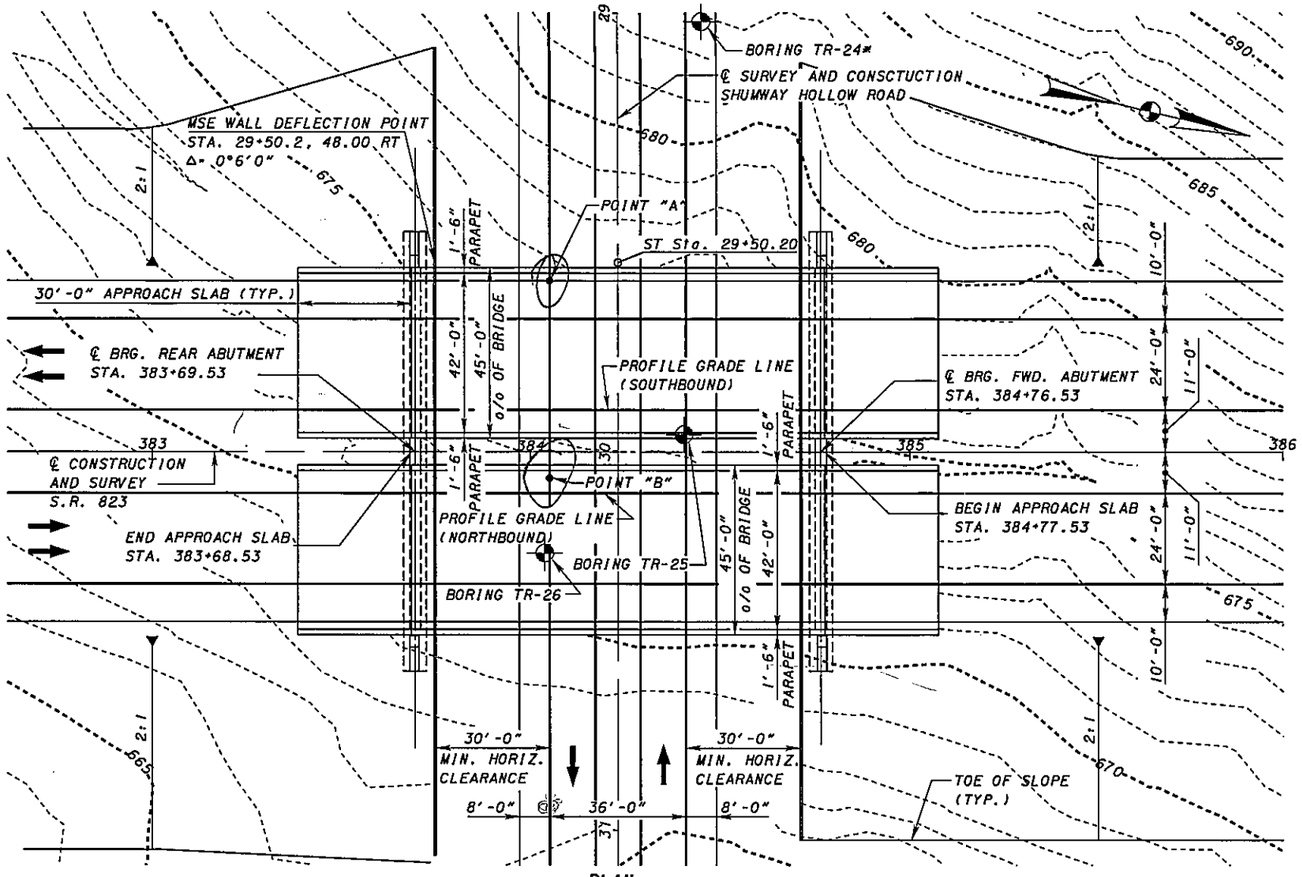
Asphalt Resurfacing Costs:

| | Approach Roadway Length (ft.) (4) | Approach Roadway Width (ft.) | Resurfacing Area (sq. yd.) | Wearing Course Thickness (in.) | Wearing Course Volume (cu. yd.) |
|---|---|---|---|---|---|
| Alt. 1 | 0.0 | 38.0 | 0 | 1.50 | 0.0 |
| Alt. 2 | 0.0 | 38.0 | 0 | 1.50 | 0.0 |

# APPENDIX B

## Preferred Alternative Site Plan and Details

TRANSYSTEMS CORPORATION




PLAN

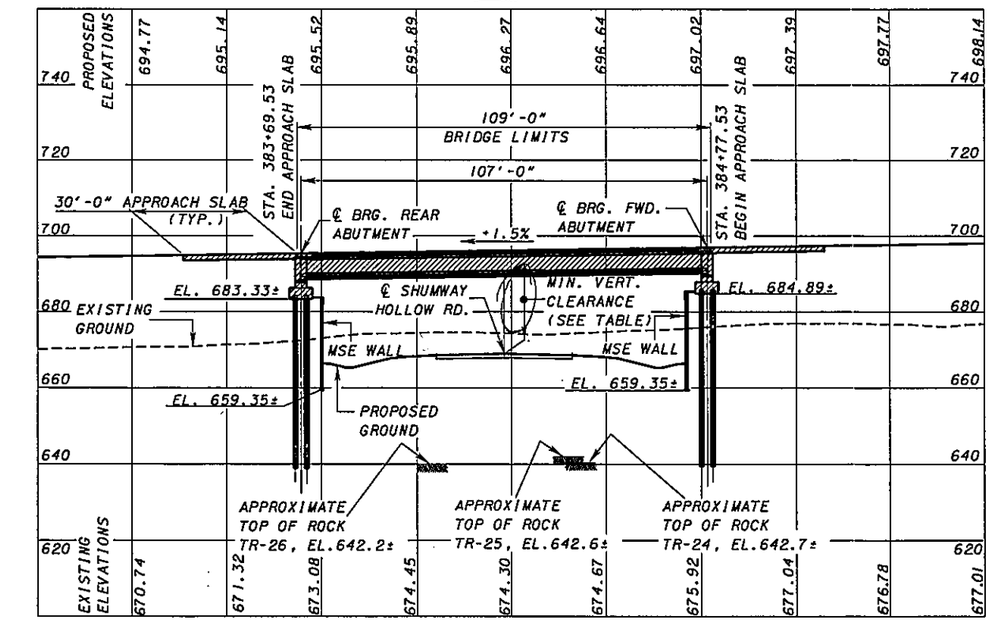
DENOTES BORING LOCATION

* BORING TR-24 NOT SHOWN TO SCALE

| BORING LOCATIONS | | |
|---|---|---|
| BORING No. | STATION | OFFSET |
| TR-24 | 384+43.01 | 147.27' LT. |
| TR-25 | 384+40.48 | 4.45' LT. |
| TR-26 | 384+03.66 | 26.84 RT. |
| | | |

| BENCHMARK 1 | BENCHMARK 2 |
|---|---|
| (TO BE PROVIDED LATER) | (TO BE PROVIDED LATER) |

| TABLE OF VERTICAL CLEARANCES | | |
|---|---|---|
| LOCATION | "A" | "B" |
| PROPOSED | 18.88' | 20.30' |
| PREFERRED | 17.0' | 17.0' |




ELEVATIONS ALONG PROFILE GRADE LINE S.R. 823 LEFT BRIDGE

| TRAFFIC DATA |
|---|
| S.R. 823 |
| CURRENT YEAR ADT (2010) = 19,800 |
| DESIGN YEAR ADT (2030) = 26,000 |
| CURRENT YEAR ADTT (2010) = 2,772 |
| DESIGN YEAR ADTT (2030) = 3,640 |

**PROPOSED STRUCTURE**

TYPE: SINGLE SPAN, 72" TYPE 4 (MOD.) PRESTRESSED CONCRETE I-BEAM WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS FOUNDED ON PILES AND MSE WALL EMBANKMENTS

SPANS: 107'-0" c/c BEARINGS

ROADWAY: 42' TOE TO TOE OF PARAPETS

LOADING: HS-25 AND ALTERTNATE MILITARY LOADING FWS=60 PSF

SKEW: NONE

CROWN: 0.016 FT/FT

ALIGNMENT: TANGENT

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30' LONG)

LATITUDE:

LONGITUDE:

NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 14x73 PILES AND HAVE A MAXIMUM CAPACITY OF 90 TONS PER PILE.

DESIGN AGENCY: TRANSYSTEMS CORPORATION (TRANSPORTATION ENGINEERS), ANTELOPE, CALIFORNIA (ONE AGENCY)

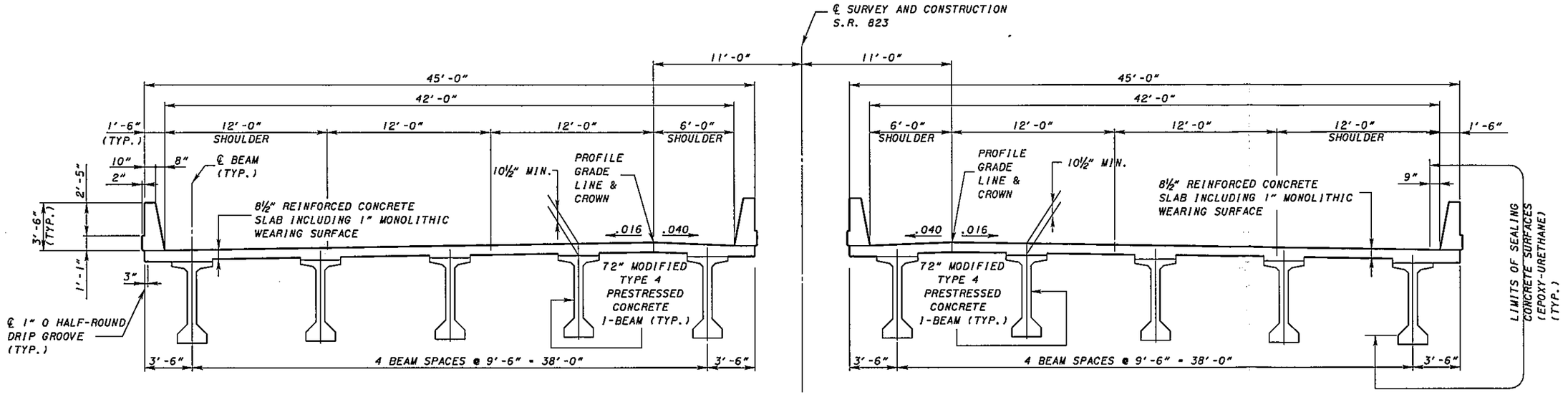
DESIGNED PJP | DRAWN CAS | REVIEWED JRC | DATE 04/25/06 | CHECKED | REVISED | STRUCTURE FILE NUMBER

SCIOTO COUNTY
STA. 383+65.53
STA. 384+77.53

PRELIMINARY SITE PLAN -ALTERNATIVE 2
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER SHUMWAY HOLLOW ROAD

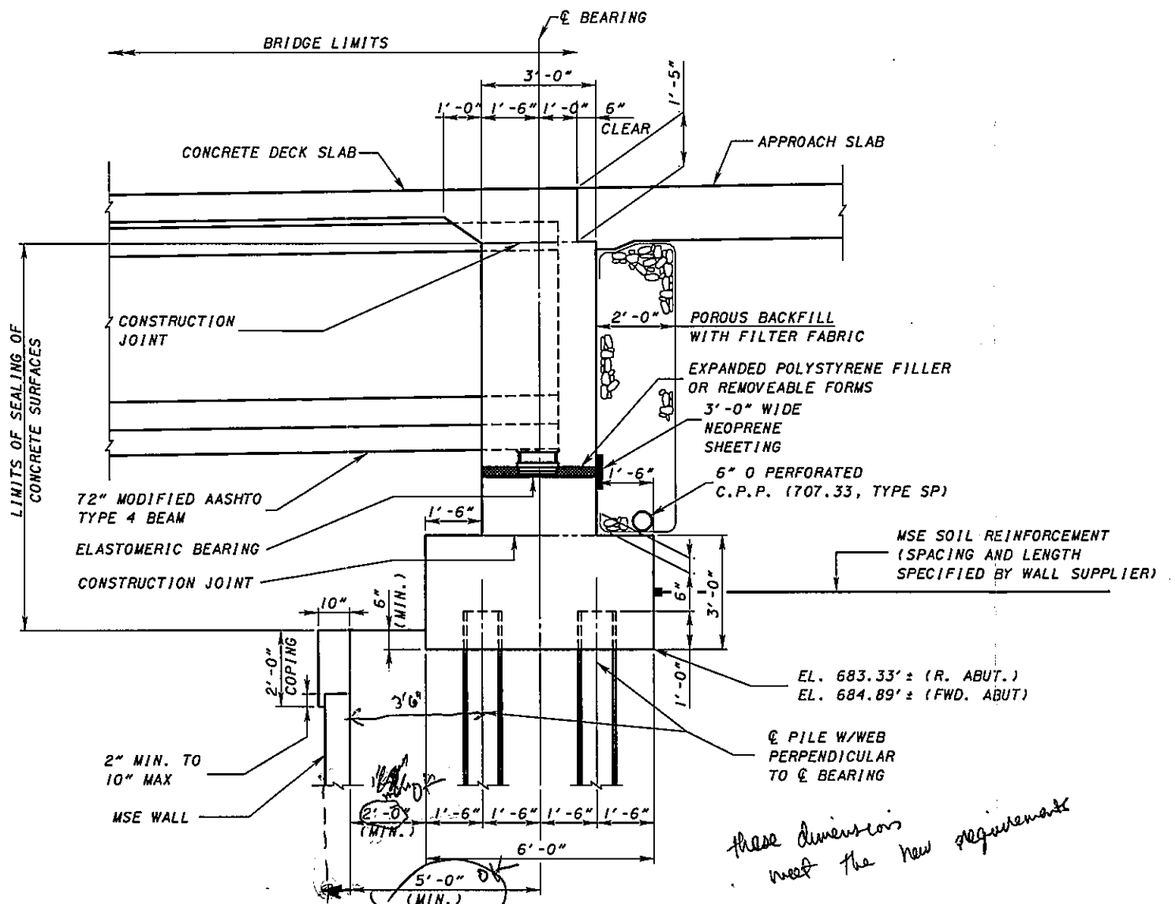
SCI-823-0.00
PID 19415

1 / 2




## PROPOSED TRANSVERSE SECTION

| SUPERSTRUCTURE DEPTH | |
|---|---|
| ITEM | 72" MODIFIED AASHTO TYPE 4 BEAM |
| SLAB (INCLUDING WEARING SURFACE) | 8.5" |
| HAUNCH (BOTTOM OF SLAB TO TOP OF FLANGE) | 2" |
| GIRDER DEPTH | 72" |
| TOP OF WEARING SURFACE TO BOTTOM OF GIRDER FLANGE (INCH) | 82.5" |
| TOP OF WEARING SURFACE TO BOTTOM OF GIRDER FLANGE (FEET) | 6.875' |




## TYPICAL ABUTMENT SECTION

DESIGN AGENCY
TRANSYSTEMS CORPORATION
CONSULTING ENGINEERS, PLANNERS, ECONOMISTS, SCIENTISTS

| DESIGNED | DRAWN | REVISED | DATE |
|---|---|---|---|
| PJP | CAS | JRC | 04/25/06 |
| CHECKED | REVISED | STRUCTURE FILE NUMBER | |

PROPOSED TRANSVERSE & ABUTMENT SECTION - ALTERNATIVE 2
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER SHUMWAY HOLLOW ROAD

SCI-823-0.0
PID 19415

2 / 2

# APPENDIX C

## Vertical Clearance Calculations

TRANSYSTEMS CORPORATION

TRANSYSTEMS CORPORATION

Made By PJP Date 04/14/06 Job No. P403030064
Checked By MTN Date 04/17/06 Sheet No.

# VERTICAL CLEARANCE CALCULATIONS

**Job Name** SCI-823-0.00 **Structure**
**Description** S.R. 823 OVER SHUMWAY HOLLOW ROAD **PID #** 19415

***Alternative 1 - 5-56" Grade 50W Plate Girders, Single span*** | ***Point Location: A***

***Adjstment for Cross Slope***

| Comment | Grade | | Offset | |
|---|---|---|---|---|
| Profile grade line to critical pt.: | -0.016 | x | 34 | -0.544 |
| | | | Total Adjustment = | **-0.54** |

***Superstructure Depth***

| Comment | Depth (in) | Depth (ft) |
|---|---|---|
| Deck Thickness: | 8.75 | 0.73 |
| Haunch: | 2 | 0.17 |
| Girder or Beam Depth: | 59 | 4.92 |
| | 69.75 | 5.82 |

Total Superstructure Depth (ft) = **5.82**

***Vertical Clearance at Critical Point***

| | | |
|---|---|---|
| **Station @ Critical Point** | = | **384+05.03** |
| **Offset Location @ Critical Point** | = | **45' Left** |
| Profile Grade Elevation at Critical Point | = | 695.97 |
| Adjustment for Cross Slopes to Beam CL | = | -0.54 |
| **Top of Deck Elevation @ Critical Point** | = | **695.42** |
| Total Superstructure Depth | = | -5.82 |
| **Bottom of Beam Elevation @ Critical Point** | = | **689.60** |
| **Station @ Critical Point** | = | **29+55.00** |
| **Offset Location @ Critical Point** | = | **18' Rt.** |
| Profile Grade Elevation at Critical Point | = | 669.66 |
| Adjustment for Cross Slopes to EOP | = | -0.02 |
| **Top of Pavement @ Critical Point** | = | **669.64** |
| ***Actual Vertical Clearance*** | = | ***19.96*** |
| *Preferred Vertical Clearance* | = | *17.0* |
| *Required Vertical Clearance* | = | *16.5* |

TRANSYSTEMS CORPORATION

Made By PJP Date 04/14/06 Job No. P403030064
Checked By MTN Date 04/17/06 Sheet No.

# VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure
Description S.R. 823 OVER SHUMWAY HOLLOW ROAD PID # 19415

***Alternative 1 - 5-56" Grade 50W Plate Girders, Single span*** | ***Point Location: B***

***Adjstment for Cross Slope***

| Comment | Grade | | Offset | | |
|---|---|---|---|---|---|
| Shoulder: | -0.04 | x | 4 | = | -0.16 |
| | | | Total Adjustment | = | **-0.16** |

***Superstructure Depth***

| Comment | Depth (in) | Depth (ft) | | |
|---|---|---|---|---|
| Deck Thickness: | 8.75 | 0.73 | | |
| Haunch: | 2 | 0.17 | | |
| Girder or Beam Depth: | 59 | 4.92 | | |
| | 69.75 | 5.82 | | |
| | | Total Superstructure Depth (ft) | = | **5.82** |

***Vertical Clearance at Critical Point***

| | | |
|---|---|---|
| **Station @ Critical Point** | = | **384+05.03** |
| **Offset Location @ Critical Point** | = | **7.0' Rt.** |
| Profile Grade Elevation at Critical Point | = | 695.97 |
| Adjustment for Cross Slopes to Beam CL | = | -0.16 |
| **Top of Deck Elevation @ Critical Point** | = | **695.81** |
| Total Superstructure Depth | = | -5.82 |
| **Bottom of Beam Elevation @ Critical Point** | = | **689.99** |
| **Station @ Critical Point** | = | **30+07.00** |
| **Offset Location @ Critical Point** | = | **18' Rt.** |
| Profile Grade Elevation at Critical Point | = | 668.86 |
| Adjustment for Cross Slopes to EOP | = | -0.25 |
| **Top of Pavement @ Critical Point** | = | **668.61** |
| ***Actual Vertical Clearance*** | = | ***21.38*** |
| *Preferred Vertical Clearance* | = | *17.0* |
| *Required Vertical Clearance* | = | *16.5* |

TRANSYSTEMS CORPORATION

Made By PJP Date 04/14/06 Job No. P403030064
Checked By MTN Date 04/17/06 Sheet No.

# VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure
Description S.R. 823 OVER SHUMWAY HOLLOW ROAD PID # 19415

***Alternative 2 - 5-72" Type 4 Modified Prestressed I-Beams, Single span*** ***Point Location:*** ***A***

***Adjstment for Cross Slope***

| Comment | Grade | | Offset | |
|---|---|---|---|---|
| Profile grade line to critical pt.: | -0.016 | x | 34 | -0.544 |
| | | | Total Adjustment = | **-0.54** |

***Superstructure Depth***

| Comment | Depth (in) | Depth (ft) |
|---|---|---|
| Deck Thickness: | 8.75 | 0.73 |
| Haunch: | 2 | 0.17 |
| Girder or Beam Depth: | 72 | 6 |
| | 82.75 | 6.9 |

Total Superstructure Depth (ft) = **6.90**

***Vertical Clearance at Critical Point***

| | | |
|---|---|---|
| **Station @ Critical Point** | = | **384+05.03** |
| **Offset Location @ Critical Point** | = | **45' Left** |
| Profile Grade Elevation at Critical Point | = | 695.97 |
| Adjustment for Cross Slopes to Beam CL | = | -0.54 |
| **Top of Deck Elevation @ Critical Point** | = | **695.42** |
| Total Superstructure Depth | = | -6.90 |
| **Bottom of Beam Elevation @ Critical Point** | = | **688.52** |
| **Station @ Critical Point** | = | **29+55.00** |
| **Offset Location @ Critical Point** | = | **18' Rt.** |
| Profile Grade Elevation at Critical Point | = | 669.66 |
| Adjustment for Cross Slopes to EOP | = | -0.02 |
| **Top of Pavement @ Critical Point** | = | **669.64** |
| ***Actual Vertical Clearance*** | = | ***18.88*** |
| *Preferred Vertical Clearance* | = | *17.0* |
| *Required Vertical Clearance* | = | *16.5* |

TRANSYSTEMS CORPORATION

Made By PJP Date 04/14/06 Job No. P403030064
Checked By MTN Date 04/17/06 Sheet No.

# VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure
Description S.R. 823 OVER SHUMWAY HOLLOW ROAD PID # 19415

***Alternative 2 - 5-72" Type 4 Modified Prestressed I-Beams, Single span*** ***Point Location: B***

***Adjstment for Cross Slope***

| Comment | Grade | | Offset | | |
|---|---|---|---|---|---|
| Shoulder: | -0.04 | x | 4 | = | -0.16 |
| | | | Total Adjustment | = | **-0.16** |

***Superstructure Depth***

| Comment | Depth (in) | Depth (ft) |
|---|---|---|
| Deck Thickness: | 8.75 | 0.73 |
| Haunch: | 2 | 0.17 |
| Girder or Beam Depth: | 72 | 6 |
| | 82.75 | 6.9 |

Total Superstructure Depth (ft) = **6.90**

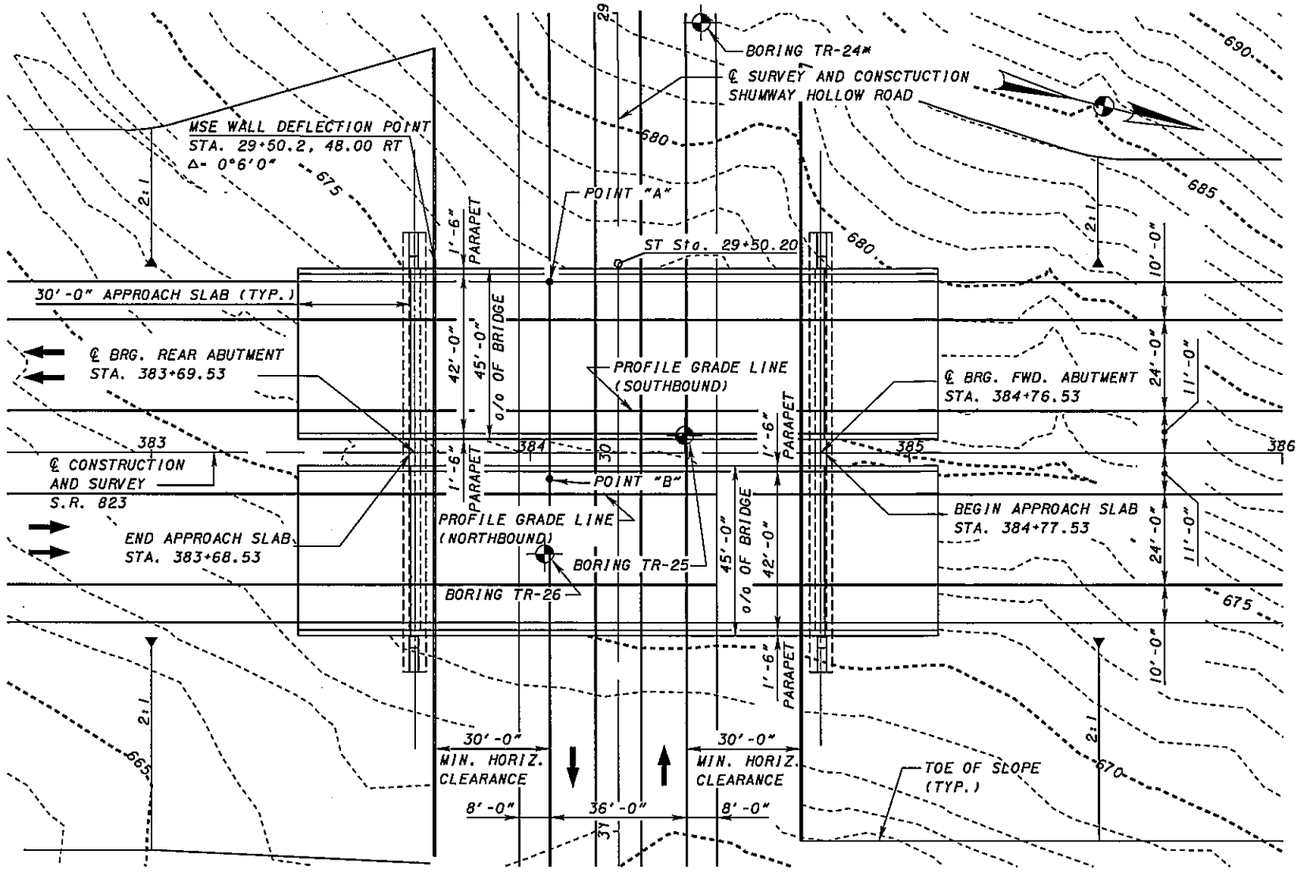
***Vertical Clearance at Critical Point***

| | | |
|---|---|---|
| **Station @ Critical Point** | = | **384+05.03** |
| **Offset Location @ Critical Point** | = | **7.0' Rt.** |
| Profile Grade Elevation at Critical Point | = | 695.97 |
| Adjustment for Cross Slopes to Beam CL | = | -0.16 |
| **Top of Deck Elevation @ Critical Point** | = | **695.81** |
| Total Superstructure Depth | = | -6.90 |
| **Bottom of Beam Elevation @ Critical Point** | = | **688.91** |
| **Station @ Critical Point** | = | **30+07.00** |
| **Offset Location @ Critical Point** | = | **18' Rt.** |
| Profile Grade Elevation at Critical Point | = | 668.86 |
| Adjustment for Cross Slopes to EOP | = | -0.25 |
| **Top of Pavement @ Critical Point** | = | **668.61** |
| ***Actual Vertical Clearance*** | = | ***20.30*** |
| *Preferred Vertical Clearance* | = | *17.0* |
| *Required Vertical Clearance* | = | *16.5* |

# APPENDIX D

## Preliminary Structure Site Plan

TRANSYSTEMS CORPORATION




PLAN

DENOTES BORING LOCATION

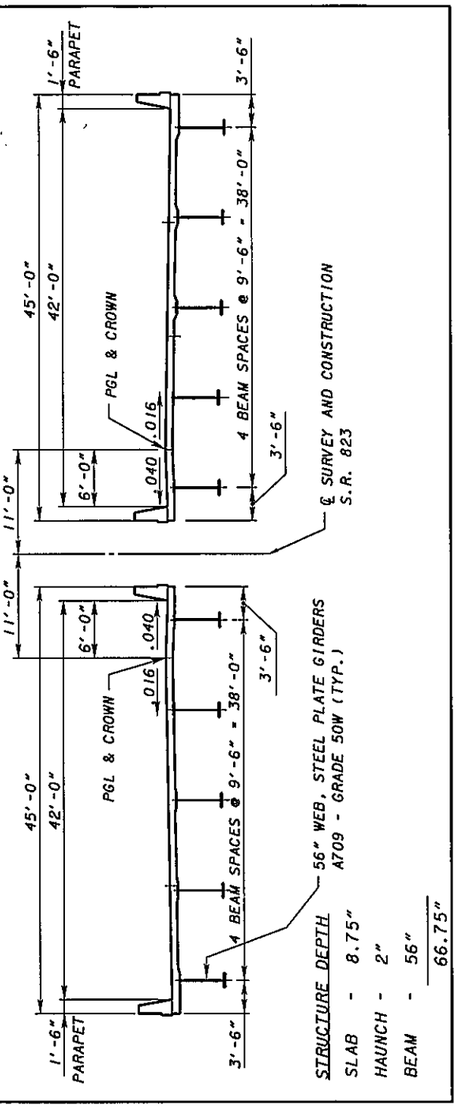
* BORING TR-24 NOT SHOWN TO SCALE




ELEVATIONS ALONG PROFILE GRADE LINE S.R. 823 LEFT BRIDGE

| TABLE OF VERTICAL CLEARANCES | | |
|---|---|---|
| LOCATION | "A" | "B" |
| PROPOSED | 19.96' | 21.38' |
| PREFERRED | 17.0' | 17.0' |

## SUPERSTRUCTURE DATA




### PROPOSED STRUCTURE

TYPE: SINGLE SPAN, 56" WEB STEEL PLATE GIRDERS A709 GRADE 50W WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS FOUNDED ON PILES AND MSE WALL EMBANKMENTS

SPANS: 107'-0" c/c BEARINGS

ROADWAY: 42' TOE TO TOE OF PARAPETS

LOADING: HS-25 AND ALTERNATE MILITARY LOADING FWS-60 PSF

SKEW: NONE

CROWN: 0.016 FT/FT

ALIGNMENT: TANGENT

WEARING SURFACE: MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30' LONG)

LATITUDE:

LONGITUDE:

DESIGN AGENCY
TRANSYSTEMS CORPORATION
DESIGNED PJP
DRAWN CAS
CHECKED
REVIEWED JRC
REVISED
DATE 4/25/06
STRUCTURE FILE NUMBER

SCIOTO COUNTY
STA. 383+65.53
STA. 384+77.53

PRELIMINARY SITE PLAN - ALTERNATIVE 1
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER SHUMWAY HOLLOW ROAD

SCI-823-0.00
PID 19415

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# APPENDIX E

## Preliminary Geotechnical Report & Preliminary MSE Wall Evaluation

TRANSYSTEMS CORPORATION

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

April 26, 2006

Michael D. Weeks, P.E., P.S.
TranSystems Corporation
5747 Perimeter Dr., Suite 240
Dublin, OH 43017

Re: **Preliminary Structural Foundation Recommendations (Revised)**
**SCI-823 over Relocated Shumway Hollow Road**
**Relocated Shumway Hollow over CSX Railroad**
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document # 0011

Dear Mr. Weeks:

This letter reports the revised findings of the subsurface exploration and preliminary foundation recommendations for the proposed structures at the SCI-823-0.00 Airport Interchange: SCI-823 over relocated Shumway Hollow Road and relocated Shumway Hollow Road over the CSX Railroad. It is anticipated that the proposed structure over Shumway Hollow Road will be a one-span elevated bridge. It is anticipated that the proposed abutments will be founded on a fill section, contained in MSE walls.

The proposed structure over the CSX Railroad is understood to be a one-span bridge. The proposed grade at the new bridge location is understood to be approximately 662 feet. It is anticipated that at least part of the structure will be placed on a fill section, using MSE walls to contain the embankments. See attached plan and profile drawings for both planned structures and boring locations.

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 structures.

**Field Exploration**

Three borings, TR-24 through TR-26, were drilled at the proposed structure for SCI-823-0.00 over the realigned Shumway Hollow Road between August 19 and 23, 2004. The borings were drilled to depths from 33.0 to 53.5 feet. The borings were extended into bedrock, which was verified by rock coring. Two borings, TR-27 and TR-28, were drilled at the proposed structure over the CSX Railroad on August 25, 2004 and February 2, 2005. The borings were drilled to depths of 17.5 and 30.0 feet, respectively. The borings were extended into bedrock, which was

verified by rock coring. Boring Logs for both structures and information concerning the drilling procedures are attached.

The boring locations were selected by TranSystems Corporation. Ground surface elevations have been accurately established by as-drilled surveys for this project.

**Findings**

The following text presents generalized subsurface conditions encountered by the borings. For more detailed information, please refer to the attached Boring Logs.

*SCI-823-0.00 over Relocated Shumway Hollow*

The borings for the structure crossing SCI-823-0.00 generally encountered up to 12 inches of topsoil at the surface. Underlying the surficial materials, the borings encountered stiff to hard silt and clay (A-6a), clay (A-7-6), sandy silt (A-4a) and loose to dense gravel with sand (A-1-b) and fine sand (A-3) to depths between 23.0 and 43.5 feet where bedrock was encountered.

Bedrock encountered at the proposed structure location was composed primarily of hard sandstone that was generally slightly fractured to intact. Recovery of the core samples ranged from 93 to 100% and RQD values ranged from 42 to 90% with an average RQD of 74%.

Seepage was encountered between depths of 6.0 and 21.0 feet below the ground surface. At completion of drilling, water levels ranged from 8.5 to 29.8 feet. However, the final water levels include drilling water and may not be representative of the actual groundwater conditions. Groundwater levels may vary seasonally.

*Relocated Shumway Hollow over CSX Railroad*

Boring TR-28 encountered 8 inches of asphalt concrete at the surface. Underlying the pavement, the boring encountered very stiff to hard silt and clay (A-6a) and loose to medium dense coarse and fine sand (A-3a) to a depth of 16.0 feet where bedrock was encountered. Boring TR-27 was drilled off the road, but did not encounter topsoil. Underlying the surface, the boring encountered hard sandy silt to a depth of 7.5 feet where bedrock was encountered.

Bedrock encountered at the proposed structure location was composed primarily of medium hard to hard sandstone that was generally slightly fractured to intact. Recovery of the core samples ranged from 50 to 100% and RQD values ranged from 12 to 100% with an average RQD of 76%.

Seepage was encountered at depths between 14.0 and 18.5 feet below the ground surface in boring TR-28. No seepage was encountered in boring TR-27. At completion of drilling, the water level in TR-28 was 10.0 feet. Boring TR-27 collapsed at a depth of 6.0 feet. It should be noted that the final water levels include drilling water and consequently may not be representative of the actual groundwater conditions. Groundwater levels may vary seasonally.

**Conclusions and Recommendations**

*SCI-823-0.00 over Relocated Shumway Hollow*

Due to the embankment fill, it appears that driven H-piles to bedrock will be the best-suited foundation type for support of the proposed structure. If high lateral or uplift loads are anticipated, drilled shafts founded in bedrock may be needed. The actual design lengths or rock sockets will need to be designed based upon actual loading conditions. A table summarizing the site conditions and foundation recommendations follows subsequently.

Additionally, since the SCI-823-0.00 mainline and the Relocated Shumway Hollow will be located on a relatively large embankment and could be potentially underlain by compressible soils, the abutment and pier locations may need special construction procedures, and/or an additional load applied to the design loads to account for any negative skin friction associated with the embankment loading.

not for H-piles

It should be noted that if driven H-piles are selected, special pile-driving techniques may be required. Soils that have high silt and fine sand contents that also have high moisture contents, such as those encountered within this area, tend to produce exaggerated blow counts during pile driving, which do not reflect the actual load carrying ability of the strata due to pore pressures. Piles should be driven to their design capacity, allowed to sit at least 24 hours, then re-driven to ensure that the design capacity has been achieved. If the design capacity has not been achieved due to elevated pore pressures, continue to drive the pile until adequate capacity has been achieved with confirmation after 24 hours.

need shown on logs

not required

Because of the large potential lateral loads, embankment heights and depths of relatively compressible soils, differential settlement will also need to be evaluated. It is strongly recommended that we discuss the proposed foundation design after TranSystems has had a chance to review these recommendations.

No grain size analyses were performed for scour analysis since the proposed structure location is not located along a stream location.

*Relocated Shumway Hollow over CSX Railroad*

Based upon the amount of embankment fill required for the construction of the bridge over the CSX Railroad, spread footings or drilled shafts could be used to support the rear abutment. Grade is expected to remain near existing levels near the forward abutment; however, bedrock on the eastern side of the bridge is deeper so either spread footings on rock or drilled shafts to rock can be used to support the forward abutment. Any footings should be embedded into the bedrock. The table summarizing the site conditions and foundation recommendations follows subsequently. It should be noted that the plan location and elevation of the proposed abutments varies from the preliminary structural borings. It will be necessary to drill borings for the structures once the design has been set.

The railroad the structure crosses is located within a cut. The stability of this railroad cut section should be evaluated relative to the location of the anticipated abutment locations once the final design is complete.

| Boring Number | Structural Element | Existing Ground Surface Elevation (Feet) | Approximate Bearing Elevation (Feet) | Recommended Foundation Type | Allowable Bearing Capacity |
|---|---|---|---|---|---|
| SCI-823-0.00 over Relocated Shumway Hollow Road | | | | | |
| TR-24 | Rear (west) Abutment | 686 | 643 | H-Piles | 90 tons |
| TR-25 | Pier | 675 | 643 | H-Piles | 90 tons |
| TR-26 | Forward (east) Abutment | 665 | 643 | H-Piles | 90 tons |
| Relocated Shumway Hollow Road over CSX Railroad | | | | | |
| TR-27 | Rear Abutment | 627* | 630* | Drilled Shafts / Spread Footings | 15 TSF |
| TR-28 | Forward Abutment | 649* | 640* | Drilled Shafts / Spread Footings | 15 TSF |

* Elevations are approximated from topographic surveys and provided plan and profile drawings. Preliminary boring locations and elevations vary from the currently proposed abutment locations.

No grain size analyses were performed for scour analysis since the proposed structure location is not located along a stream location.

**Closing**

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

Sincerely,

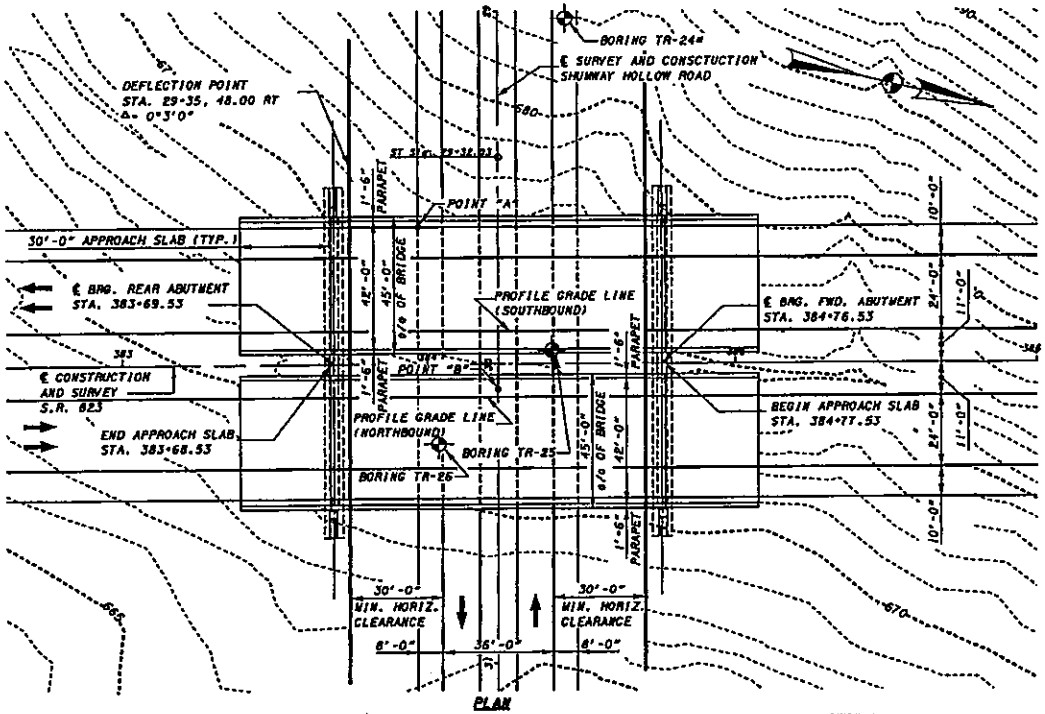
**DLZ OHIO, INC.**

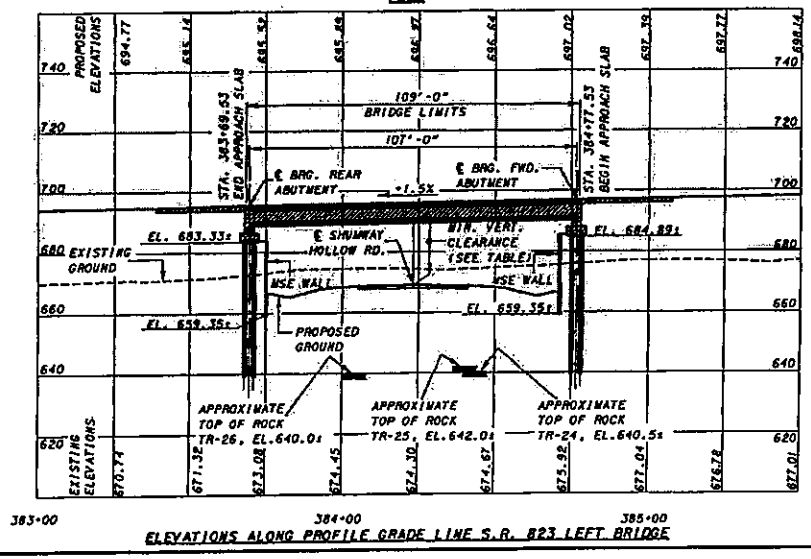
Steven J. Riedy
Geotechnical Engineer

Arthur (Pete) Nix, P.E.
Senior Geotechnical Engineer

Attachments: Site Plan (2)
General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Boring Logs TR-24, TR-25, TR-26, TR-27, TR-28

cc: File




ELEVATIONS ALONG PROFILE GRADE LINE S.R. 823 LEFT BRIDGE

DENOTES BORING LOCATION

* BORING TR-24 NOT SHOWN TO SCALE

| FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS | | |
|---|---|---|
| LOCATION | STATION | SIDE |
| REAR ABUT℄ | | RT. |
| REAR ABUT℄ | | LT. |
| FWD. ABUT℄ | | RT. |
| FWD. ABUT℄ | | LT. |

| BORING LOCATIONS | | |
|---|---|---|
| BORING No. | STATION | OFFSET |
| TR-24 | 28+52.92 | 20.23' LT. |
| TR-25 | 29+95.64 | 17.40' LT. |
| TR-26 | 30+26.84 | 19.37 RT. |
| | | |

| BENCHMARK 1 | BENCHMARK 2 |
|---|---|
| (TO BE PROVIDED LATER) | (TO BE PROVIDED LATER) |

| TRAFFIC DATA |
|---|
| SHUMWAY HOLLLOW<br>CURRENT YEAR ADT (2010) = 3,800<br>CURRENT YEAR ADTT (2030) = 7,800<br>DESIGN YEAR ADT (2010) =228<br>DESIGN YEAR ADTT (2030) = 468 |

| PROPOSED STRUCTURE |
|---|
| TYPE: SINGLE SPAN, 72" TYPE 4 (MOD.) PRESTRESSED CONCRETE I-BEAM WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS FOUNDED ON PILES AND MSE WALL EMBANKMENTS |
| SPANS: 107'-0" c/c BEARINGS |
| ROADWAY: 42' TOE TO TOE OF PARAPETS |
| LOADING: HS-25 AND ALTERTHATE MILITARY LOADING FWS=60 PSF |
| SKEW: NONE |
| CROWN: 0.016 FT/FT |
| ALIGNMENT: TANGENT |
| WEARING SURFACE: 1" MONOLITHIC CONCRETE |
| APPROACH SLABS: AS-1-81 (30' LONG) |
| LATITUDE: |
| LONGITUDE: |

| TABLE OF VERTICAL CLEARANCES | | |
|---|---|---|
| LOCATION | "A" | "B" |
| PROPOSED | 19.34' | 20.42' |
| REQUIRED | 17.0' | 17.0' |

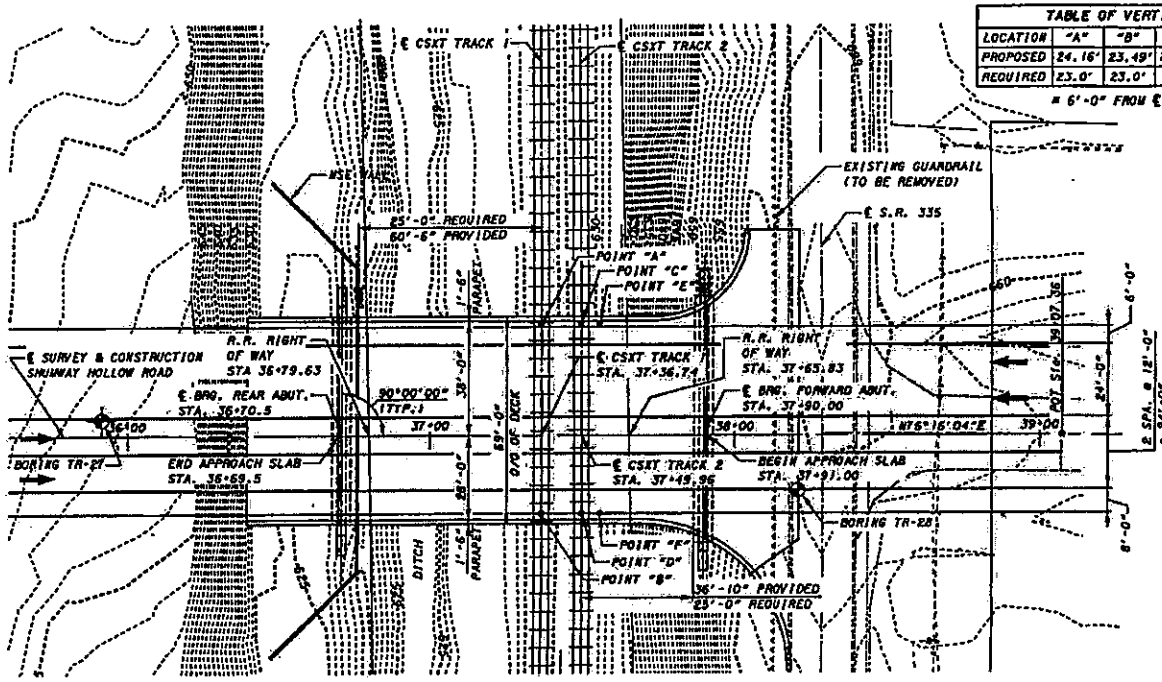
NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.

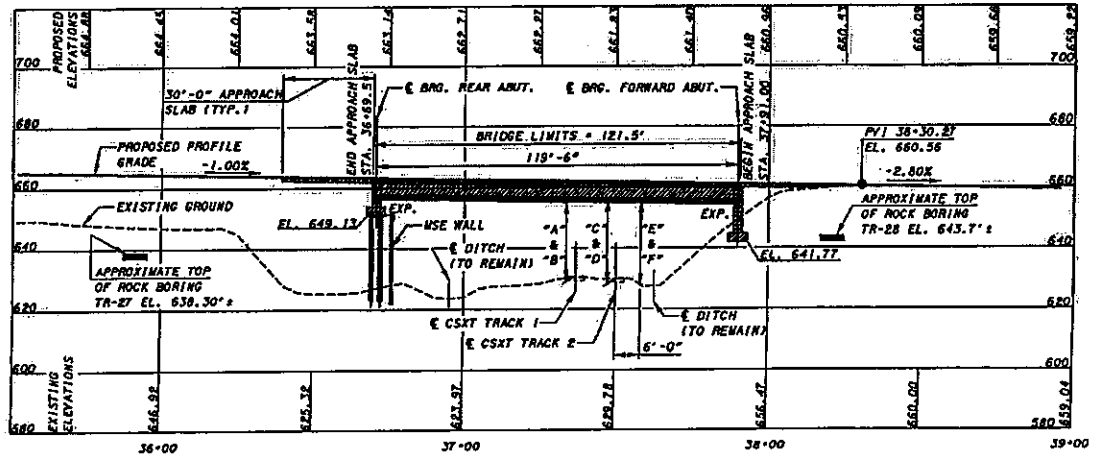
FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 14x73 PILES AND HAVE A MAXIMUM CAPACITY OF 90 TONS PER PILE.


ACTIVE ABOUT
TRANSYSTEMS CORPORATION
DATE 4/19/06
DESIGNED JNC
DRAWN CAS
CHECKED PJP
SCIOTO COUNTY
STA. 383+65.53
STA. 384+77.53
PRELIMINARY SITE PLAN - ALTERNATIVE 2
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER SHUMWAY HOLLOW ROAD
SCI-823-0.00
PID 19415




PLAN




ELEVATION ALONG ℄ SURVEY AND CONSTRUCTION SHUMWAY HOLLOW ROAD

| TABLE OF VERTICAL CLEARANCES | | | | | | |
|---|---|---|---|---|---|---|
| LOCATION | "A" | "B" | "C" | "D" | "E" | "F" |
| PROPOSED | 24.16' | 23.49' | 24.31' | 23.52' | 25.58' | 24.91' |
| REQUIRED | 23.0' | 23.0' | 23.0' | 23.0' | 23.0' | 23.0' |

= 6'-0" FROM ℄ CSXT TRACK 2

| BORING LOCATIONS | | |
|---|---|---|
| BORING No. | STATION | OFFSET |
| TR-27 | 35+91.27 | 5.31' LT. |
| TR-28 | 38+20.74 | 18.43' RT. |

| BENCHMARK 1 | BENCHMARK 2 |
|---|---|
| (TO BE PROVIDED LATER) | (TO BE PROVIDED LATER) |

**TRAFFIC DATA**

(SR 823)
CURRENT YEAR ADT (2010) = 3,800
DESIGN YEAR ADT (2030) = 7,600
CURRENT YEAR ADTT (2010) = 228
DESIGN YEAR ADTT (2030) = 468

**PROPOSED STRUCTURE**

TYPE: SINGLE SPAN 72" MODIFIED AASHTO TYPE 4 PRESTRESSED CONCRETE I-BEAMS WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY REINFORCED CONCRETE SUBSTRUCTURE UNITS AND A MSE WALL SUPPORTED EMBANKMENT.

SPANS: 119'-6" C/C BEARINGS

ROADWAY: 66'-0" TOE TO TOE OF PARAPETS

LOADING: HS-25 AND ALTERNATE MILITARY LOADING, FWS = 60 PSI

SKEW: NONE

CROWN: NORMAL 0.016 FT./FT.

ALIGNMENT: TANGENT

WEARING SURFACE: 1" MONOLITHIC CONCRETE

APPROACH SLABS: AS-1-81 (30'-0" LONG)

LATITUDE:

LONGITUDE:

**NOTES:**

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.
3. THE PROPOSED PROFILE GRADE IS WITHIN BRIDGE LIMITS. SEE ROADWAY PLANS FOR PAVEMENT ELEVATIONS BEYOND BRIDGE LIMITS.

**FOUNDATION DATA:**

ALL NEW PILES SHALL BE HP 14x93, 90 TON CAPACITY AT REAR ABUTMENT. THE FORWARD ABUTMENT SHALL BE ON A SPREAD FOOTING

**UTILITIES:**

UTILITIES DISPOSITION WILL BE ADDRESSED DURING THE TS&L SUBMITTAL

TRANSYSTEMS CORPORATION

PRELIMINARY SITE PLAN - ALTERNATIVE 1
BRIDGE NO. SCI-823-XXXX
SHUMWAY HOLLOW ROAD OVER CSXT RAILROAD

SCIOTO COUNTY
STA. 35+69.50
STA. 37+91.00

SCI-823-0.00
PID 19415

## 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

| Term | Blows/Foot Standard Penetration |
|---|---|
| Very Loose | 0 – 4 |
| Loose | 4 – 10 |
| Medium Dense | 10 – 30 |
| Dense | 30 – 50 |
| Very Dense | over 50 |

   **Cohesive Soils** – Consistency

| Term | Unconfined Compression tons/sq.ft. | Blows/Foot Standard Penetration | Hand Manipulation |
|---|---|---|---|
| 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:

| Description | Size | Description | Size |
|---|---|---|---|
| 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:

| Term | Relative Moisture or Appearance |
|---|---|
| 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.

| Term | Relative Moisture or Appearance |
|---|---|
| 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**.

| Term | Description |
|---|---|
| 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.

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

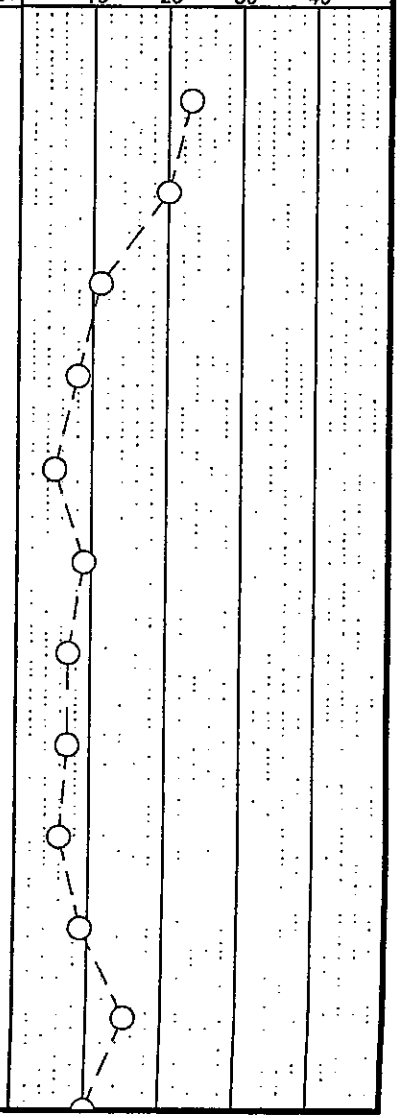
**LOG OF: Boring TR-24** | Location: | Date Drilled: 8/20/04 to 8/23/04

WATER OBSERVATIONS: Water seepage at: 6.0'
Water level at completion: 29.8' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | 686.2 | | | | | | |
| 1.0 | 685.2 | 6 10 13 | 18 | 1 | | 4.5+ | Topsoil - 12"<br>Hard brown SILT AND CLAY (A-6a), little fine to coarse sand; damp. |
| 5 | | 13 10 10 | 18 | 2 | | 4.5+ | |
| 6.0 | 680.2 | 3 3 8 | 12 | 3 | | 2.75 | Stiff to very stiff brown CLAY (A-7-6), little fine to coarse sand, little silt; varved; moist. |
| 10 | | 2 3 5 | 18 | 4 | | 2.0 | |
| | | 2 2 3 | 18 | 5 | | 2.0 | |
| 15 | | 2 4 5 | 18 | 6 | | 2.25 | |
| | | 2 3 4 | 18 | 7 | | 1.25 | |
| 20 | | 1 3 4 | 18 | 8 | | 3.75 | |
| | | 2 3 3 | 18 | 9 | | 1.0 | |
| 25 | | 3 4 5 | 18 | 10 | | 1.5 | |
| 27.0 | 659.2 | 4 3 12 | 18 | 11 | | 1.75 | Medium dense brown FINE SAND (A-3), trace gravel; damp. |
| 30 | | 5 5 5 | 18 | 12 | | | |

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40





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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-24** | Location: | Date Drilled: 8/20/04 to 8/23/04

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press / Core | Hand Penetro-meter (tsf) | WATER OBSERVATIONS / DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 30 | 656.2 | | | | | | Medium dense brown FINE SAND (A-3), trace gravel; damp. |
| 34.0 | 652.2 | 4 2 2 | 18 | 13 | | 0.5 | Soft gray SILTY CLAY (A-6b), little fine to coarse sand, trace gravel; moist. |
| 37.0 | 649.2 | | | | | | Severely weathered gray SANDSTONE argillaceous. DRAFT |
| 40 | | 10 17 22 | 18 | 14 | | | @ 43.0', augers encountered difficult drilling. |
| 43.5 | 642.7 | | | | | | Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, argillaceous, micaceous, moderately to highly fractured. @ 44.8' to 44.9',45.2',45.4',47.0' contains argillaceous laminations and fractures. @ 47.0', slightly weathered, unfractured to slightly fractured. |
| 45 | | | | | | | |
| 50 | | Core 120" | Rec 118" | RQD 77% | R-1 | | |
| 53.5 | 632.7 | | | | | | Bottom of Boring - 53.5' |
| 55 | | | | | | | |
| 60 | | | | | | | |

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-25** | Location: | Date Drilled: 8/19/04 to 8/20/04

WATER OBSERVATIONS: Water seepage at: 16.0', 21.0'
Water level at completion: 16.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 674.6 | 4 7 6 | 18 | 1 | | 4.0 | Hard brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp. | | | | | | |
| | | 6 8 9 | 18 | 2 | | 4.5 | | 4 | 6 | -- | 13 | 37 | 40 |
| 5 | | | | | | | | | | | | | |
| 5.5 | 669.1 | 2 3 5 | 18 | 3 | | 2.0 | Stiff to very stiff brown CLAY (A-7-6), trace fine sand; varved; damp to moist. | 0 | 0 | -- | 1 | 11 | 88 |
| | | 2 3 5 | 18 | 4 | | 1.25 | | | | | | | |
| 10 | | 2 4 4 | 18 | 5 | | 1.75 | | | | | | | |
| | | 3 3 5 | 18 | 6 | | 2.5 | | | | | | | |
| 15 | | 2 3 5 | 18 | 7 | | 2.25 | | | | | | | |
| 18.0 | 656.6 | | | | | | | | | | | | |
| | | 4 3 4 | 18 | 8 | | | Loose brown FINE SAND (A-3), trace silt; damp. | | | | | | |
| 20 | | 1 1 3 | 18 | 9 | | | @ 21.0', moist to wet. | | | | | | |
| | | 9 11 12 | 18 | 10 | | | | | | | | | |
| 25 | | 7 3 7 | 18 | 11 | | | | | | | | | |
| 28.0 | 646.6 | | | | | | | | | | | | |
| | | 2 14 16 | 18 | 12 | | | Dense brown GRAVEL WITH SAND (A-1-b); contains sandstone fragments; moist. | | | | | | |
| 30 | | | | | | | | | | | | | |

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

66



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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-25** | Location: | Date Drilled: 8/19/04 to 8/20/04

WATER OBSERVATIONS: Water seepage at: 16.0', 21.0'
Water level at completion: 16.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 30.0 | 644.6 | | | | | | |
| | | 27 50/5 | 6 | 13 | | | Severely weathered brown and gray SANDSTONE. |
| 32.0 | 642.6 | | | | | | |
| | | Core 48" | Rec 46" | RQD 42% | R-1 | | Hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, micaceous, argillaceous, massively bedded, slightly fractured. @ 32.0' to 37.0', highly fractured. |
| 35 | | | | | | | |
| | | Core 72" | Rec 72" | RQD 90% | R-2 | | |
| 40 | | | | | | | |
| 42.0 | 632.6 | | | | | | Bottom of Boring - 42.0' |
| 45 | | | | | | | |
| 50 | | | | | | | |
| 55 | | | | | | | |
| 60 | | | | | | | |

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40
50+

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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-26** | Location: | Date Drilled: 8/19/04

WATER OBSERVATIONS: Water seepage at: 8.5'
Water level at completion: 8.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press / Core | Hand Penetrometer (tsf) | DESCRIPTION | % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 665.2 | | | | | | | | | | | | |
| 1.0 | 664.2 | 5 5 8 | 18 | 1 | | 4.5 | Topsoil - 12"<br>Hard brown CLAY (A-7-6), some to "and" fine to coarse sand; damp to moist. | | | | | | |
| 5 | | 8 9 11 | 18 | 2 | | 4.5+ | | 0 | 2 | -- | 38 | 12 | 48 |
| 5.5 | 659.7 | 7 7 8 | 18 | 3 | | | Loose to medium dense orangish brown COARSE AND FINE SAND (A-3a), little silt; damp to moist. | 0 | 0 | -- | 81 | 19 | |
| 10 | | 4 9 7 | 18 | 4 | | | | | | | | | |
| | | 3 4 6 | 18 | 5 | | | | | | | | | |
| 15 | | 4 5 10 | 18 | 6 | | | | | | | | | |
| | | 5 4 3 | 18 | 7 | | | @ 16.0', wet. | | | | | | |
| 20 | | 2 3 4 | 18 | 8 | | | | | | | | | |
| 20.5 | 644.7 | 4 8 13 | 18 | 9 | | | Medium dense gray GRAVEL WITH SAND (A-1-b); contains sandstone fragments; moist. | | | | | | |
| 23.0 | 642.2 | | | | | | @ 23.0' to 25.5', moderately fractured.<br>Hard gray SANDSTONE; very fine to fine grained, argillaceous, micaceous, slightly to moderately weathered, massively bedded, slightly fractured.<br>@ 23.1', 23.5', thin clay seams. | | | | | | |
| 25 | | Core 120" | Rec 111" | RQD 73% | R-1 | | | | | | | | |
| 30 | | | | | | | | | | | | | |

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢ LL
Blows per foot - ○
10 20 30 40

Non-Plastic

DRAFT

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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-26** | Location: | Date Drilled: 8/19/04

WATER OBSERVATIONS: Water seepage at: 8.5'
Water level at completion: 8.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetro-meter (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay | STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.0 | 635.2 | | | | | | | | | | | | | |
| | 635.2 | | | | | | Hard gray SANDSTONE; very fine to fine grained, argillaceous, micaceous, slightly to moderately weathered, massively bedded, slightly fractured. | | | | | | | |
| 33.0 | 632.2 | | | | | | Bottom of Boring - 33.0' | | | | | | | |

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Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-27** | Location: Approx. Sta. 36+00, 5 ft Lt. of Reloc. Shumway Hollow | Date Drilled: 8/25/04

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: None (boring collapsed @ 6.0')

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay | STANDARD PENETRATION (N) / Natural Moisture Content, % / Blows per foot |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 646.3 | 7 10 13 | 18 | 1 | | 4.5+ | Hard brown SANDY SILT (A-4a), trace clay, trace to little gravel; damp. | | | | | | | PL — LL; Blows per foot - 10 20 30 40 |
| | | 8 13 13 | 18 | 2 | | 4.5+ | | | | | | | | |
| 5 | | | | | | | | | | | | | | |
| | | 4 10 50 | 16 | 3 | | 4.5+ | @ 6.0' to 7.5', contains sandstone fragments. | | | | | | | |
| 7.5 | 638.8 | | | | | | Medium hard to hard brown and gray SANDSTONE; very fine to fine grained, slightly to highly weathered, argillaceous, micaceous, massively bedded, slightly fractured. @ 7.5' to 10.0', rust stained. @ 7.8',8.9' and 15.6', low angle fractures. | | | | | | | |
| 10 | | Core 120" | Rec 120" | RQD 98% | R-1 | | | | | | | | | |
| 15 | | | | | | | @ 14.9' to 15.2', high angle fractures. | | | | | | | |
| 17.5 | 628.8 | | | | | | Bottom of Boring - 17.5' | | | | | | | |
| 20 | | | | | | | | | | | | | | |
| 25 | | | | | | | | | | | | | | |
| 30 | | | | | | | | | | | | | | |

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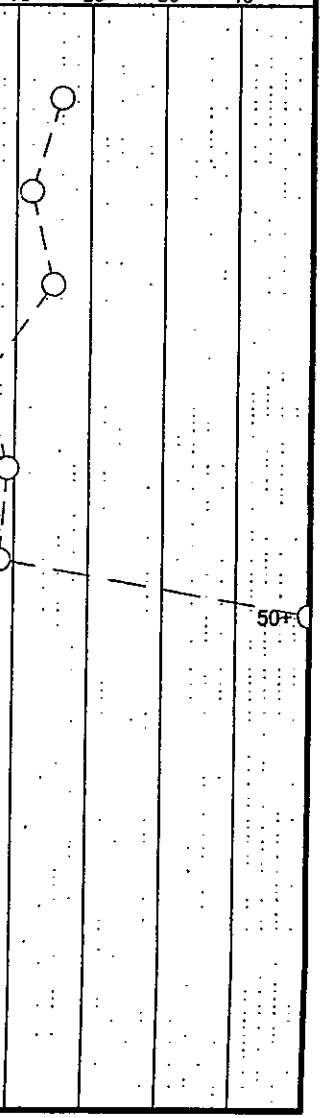
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-28** | Location: Approx. Sta. 38+20, 20 ft Rt. of Reloc. Shumway Hollow | Date Drilled: 02-02-05

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press / Core | Hand Penetrometer (tsf) | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 0 | 659.7 | | | | | | WATER OBSERVATIONS: Water seepage at: 14.0', 18.5'<br>Water level at completion: 10.0' (includes drilling water) |
| 0.7 | 659.0 | | | | | | Asphalt Concrete Pavement - 8" |
| | | 4 8 8 | 16 | 1 | | 4.0 | Very stiff to hard brown SILT AND CLAY (A-6a), trace fine to coarse sand; damp. |
| 3.0 | 656.7 | | | | | | |
| | | 5 5 7 | 15 | 2 | | | Medium dense reddish brown COARSE AND FINE SAND (A-3a); (residual soil); moist. |
| 5 | | 8 8 7 | 18 | 3 | | | |
| | | 6 4 2 | 18 | 4 | | | |
| 10 | | 3 5 4 | 14 | 5 | | | |
| | | 1 4 4 | 13 | 6 | | | |
| 15 | | | | | | | |
| 15.5 | 644.2 | 50/2 | 2 | 7 | | | Severely weathered gray SANDSTONE argillaceous.<br>@ 18.5' to 24.0', broken. |
| 18.5 | 641.2 | | | | | | |
| 20 | | Core 60" | Rec 30" | RQD 12% | R-1 | | Medium hard to hard gray SANDSTONE; very fine to fine grained, moderately to highly weathered, argillaceous, massively bedded, slightly fractured. |
| 25 | | Core 84" | Rec 84" | RQD 100% | R-2 | | |
| 30 | | | | | | | |

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ——— LL
Blows per foot - ○
10 20 30 40

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DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-28** | Location: Approx. Sta. 38+20, 20 ft Rt. of Reloc. Shumway Hollow | Date Drilled: 02-02-05

WATER OBSERVATIONS: Water seepage at: 14.0', 18.5'
Water level at completion: 10.0' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetro-meter (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay | STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL — LL Blows per foot - ○ 10 20 30 40 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 629.7 | | | | | | | | | | | | | |
| 30.5 | 629.2 | | | | | | Bottom of Boring - 30.5' | | | | | | | |
| 35 | | | | | | | | | | | | | | |
| 40 | | | | | | | | | | | | | | |
| 45 | | | | | | | | | | | | | | |
| 50 | | | | | | | | | | | | | | |
| 55 | | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | | |

DRAFT

FILE: 0121-3070-03 [ 4/26/2006 10:27 AM ]

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April 12, 2006

Michael D. Weeks, P.E., P.S.
TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, OH 43017

Re: **Preliminary MSE Wall Evaluations**
**Shumway Hollow Road**
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document # 0009

Dear Mr. Weeks:

This letter includes the findings of preliminary evaluations of mechanically stabilized earth (MSE) retaining walls on the above-referenced project. The findings included in this letter pertain to the MSE walls at the intersection of proposed 823 and Shumway Hollow Road. The findings of other preliminary MSE wall evaluations will be submitted in separate documents at a later date.

It should be noted that the results of these evaluations are based upon the findings of three preliminary structural borings. These borings were drilled for a preliminary bridge plan, essentially consisting of Shumway Hollow Road separating from grade and passing over proposed 823. The current design being considered is proposed 823 separating from grade and passing over an at-grade Shumway Hollow Road. Due to the change, the borings drilled for the previous design are not necessarily representative of soils in the area of the currently proposed structures. After the bridge design is finalized, it will be necessary to drill additional borings in the area of the proposed MSE walls in accordance with ODOT's specifications for subsurface investigations in order to finalize the MSE wall evaluations. Boring logs for borings TR-24, TR-25, and TR-26 are attached.

An MSE retaining wall essentially consists of good quality backfill material with layers of metal or plastic reinforcing that are attached to concrete facing panels. The MSE wall and associated backfill should be constructed in accordance with the specifications of the manufacturer of the MSE wall.

At the time this letter was prepared, it was understood that the plan location of the bridge structure for proposed 823 over Shumway Hollow Road is significantly different than the configuration shown on the plan and profile drawings dated 07/11/05. See attached plan and profile drawing. It is understood that the planned structure is being modified as follows: Shumway Hollow Road will be realigned essentially at existing grade; MSE walls will be placed

at approximately stations 383+75 and 384+69 to contain the abutments and hold back the roadway embankment for proposed 823. Furthermore, it is assumed that the maximum height of the MSE wall at station 383+75 (Rear Abutment) and station 384+69 (Forward Abutment) will be approximately 28.8 feet high. This height is based upon the maximum difference between the proposed grade, and the approximate existing grade over the cross-section at station 384+69. See attached cross-section drawing. Profile of Shumway Hollow is being lowered H ≤ 35'

A preliminary global stability analysis and preliminary bearing capacity analysis were performed for the MSE walls at this bridge location in accordance with ODOT and AASHTO guidelines. The MSE walls were also analyzed for sliding, overturning and settlement. At the time this letter was prepared, it was not known what foundation type was to be used at this site to support the bridge abutments. However, the use of MSE walls at this site does not preclude the use of most common foundation types. Once a foundation type has been selected, DLZ should be informed so that the analyses may be revised as necessary.

Preliminary calculations for bearing capacity, sliding, and overturning as well as the results of the global stability analyses are attached. Other external and internal stability analyses are required for the design of an MSE wall, but are considered outside the scope of this report. The parameters required to perform the stability analyses are presented below.

In accordance with ODOT guidelines, a unit weight of 120 pcf and a friction angle of 34 degrees were selected for the backfill material in the reinforced zone. Similarly, the fill material used to construct the roadway embankments is assumed to have a unit weight of 120 pcf and a friction angle of 30 degrees. If the embankment fill material or backfill material for the reinforcing zone has properties significantly different from these values, DLZ should be informed so that the analyses may be revised as necessary.

Due to similarities in the soil profiles at this location, the results of the analyses of the MSE wall at the forward abutment are considered representative of both walls at this site. It should be noted, variations may be found in borings drilled for the final design that may change the results of these analyses. The results of preliminary analyses and recommendations for both wall locations will be presented jointly in this letter.

**MSE Wall Evaluation at Station 383+75 (Rear Abutment) and Station 384+69 (Forward Abutment)**

In the area of the proposed MSE walls, boring TR-25 generally encountered 12 inches of topsoil at the surface. Below the topsoil layer, primarily very stiff to hard silt and clay (A-6a) was encountered to a depth of 5.5 feet below ground surface. Below 5.5 feet,

primarily stiff to very stiff clay (A-7-6) was encountered to a depth of approximately 18.0 feet below ground surface. Below 18.0 feet, primarily loose fine sand (A-3) was encountered to a depth of approximately 30.0 feet, at the top of bedrock. Underlying the soil, this boring encountered hard, slightly to moderately weathered sandstone to the bottom of the boring, at a depth of 42.0 feet.

The MSE walls at the rear and forward abutments are assumed to have a maximum height of approximately 28.8 feet. The minimum required embedment depth for this wall is 3.0 feet.

Analyses for the MSE walls bearing on natural soils at this location yielded inadequate factors of safety for undrained and drained bearing capacity. Analyses were then performed assuming a five-foot undercut backfilled with compacted, granular fill. These analyses yielded an inadequate factor of safety for drained global stability. Consequently, analyses were performed assuming a seven-foot undercut backfilled with compacted, granular fill. These analyses indicated adequate safety factors for both undrained and drained conditions. As a result, it is recommended that soils beneath the proposed MSE walls be undercut seven feet in addition to the minimum embedment, and replaced with compacted granular fill. If soft soils are encountered while excavating for the MSE wall, these soils should also be removed and replaced with compacted granular fill.

For stability, preliminary calculations have shown that a minimum reinforcement length of 0.9(H+D) or 28.6 feet is required for stability.

The total maximum settlement of the MSE wall volumes at this location was estimated to be approximately 18 inches at the centerline of the wall. Differential settlement at this location was estimated to be approximately 1.0%. MSE retaining walls are able to withstand relatively large amounts of differential settlement, typically up to 100 millimeters per 10 meters of wall length (1/100). The estimated amount of differential settlement at this site is approximately equal to the typical recommended maximum value of 1/100. Consequently, it is recommended that a wire-faced MSE wall be considered to construct the embankments at the Shumway Hollow Road crossing. Using a wire-faced MSE wall results in the internal reinforcing strips being attached to a wire facing. The advantage to using a wire-faced MSE wall is that it can tolerate significant settlement and that it can be constructed in phases. After the consolidation period is over, the final wall facing can be installed. The final wall facing is set on a leveling pad about 1 foot from the wire facing and the void between the wire facing and the final wall facing can remain open or be filled. The final wall facing can be pre-cast panels or cast-in-place.

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Preliminary time-rate consolidation calculations have indicated that approximately 2.7 years will be required to achieve 90 percent consolidation of foundational soils without using wick drains or other methods. It is recommended that equipment for monitoring settlement and pore water pressures be installed prior to construction to determine when sufficient consolidation has been achieved. If the previously mentioned consolidation period is of significant concern, the use of wick drains or other methods may be explored to accelerate the consolidation of foundation soils. These alternatives can be evaluated for this site upon request.

how?

Calculations for bearing capacity, overturning, sliding, and settlement are attached for the MSE wall at the forward abutment. A drawing showing the results of the global stability analyses is also attached.

A summary of soil properties, summary of the results of calculations, and results of global stability analyses are attached.

We appreciate having the opportunity to be of service to you on this project. Please do not hesitate to call if you have any questions concerning our preliminary findings.

Respectfully submitted,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

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

Encl: As noted

cc: file

M:\proj\0121\3070.03\Stability Analyses\Documents\MSE Wall letters\07 Shumway Hollow Road\MSE Wall Findings - Shumway Hollow Rd 04-12-06 SJR.doc

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-24** | Location: | Date Drilled: 8/20/04 to 8/23/04

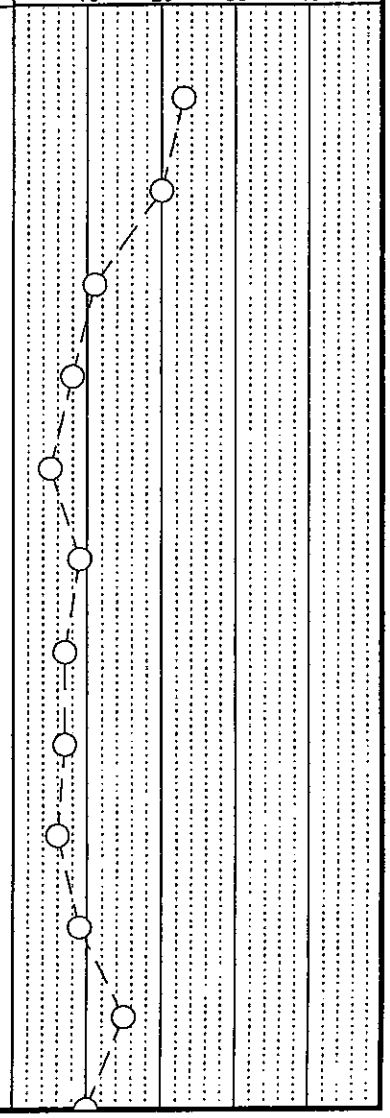
WATER OBSERVATIONS: Water seepage at: 6.0'
Water level at completion: 29.8' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION | % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 686.2 | | | | | | Topsoil - 12" | | | | | | |
| 1.0 | 685.2 | 6 10 13 | 18 | 1 | | 4.5+ | Hard brown SILT AND CLAY (A-6a), little fine to coarse sand; damp. | | | | | | |
| 5 | | 13 10 10 | 18 | 2 | | 4.5+ | | | | | | | |
| 6.0 | 680.2 | 3 3 8 | 12 | 3 | | 2.75 | Stiff to very stiff brown CLAY (A-7-6), little fine to coarse sand, little silt; varved; moist. | | | | | | |
| 10 | | 2 3 5 | 18 | 4 | | 2.0 | | | | | | | |
| | | 2 2 3 | 18 | 5 | | 2.0 | | | | | | | |
| 15 | | 2 4 5 | 18 | 6 | | 2.25 | | | | | | | |
| | | 2 3 4 | 18 | 7 | | 1.25 | | | | | | | |
| 20 | | 1 3 4 | 18 | 8 | | 3.75 | | | | | | | |
| | | 2 3 3 | 18 | 9 | | 1.0 | | | | | | | |
| 25 | | 3 4 5 | 18 | 10 | | 1.5 | | | | | | | |
| 27.0 | 659.2 | 4 3 12 | 18 | 11 | | 1.75 | Medium dense brown FINE SAND (A-3), trace gravel; damp. | | | | | | |
| 30 | | 5 5 5 | 18 | 12 | | | | | | | | | |



GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40



FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-24** | Location: | Date Drilled: 8/20/04 to 8/23/04

WATER OBSERVATIONS: Water seepage at: 6.0'
Water level at completion: 29.8' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION | % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 | 656.2 | | | | | | Medium dense brown FINE SAND (A-3), trace gravel; damp. | | | | | | |
| 34.0 | 652.2 | 4<br>2<br>2 | 18 | 13 | | 0.5 | Soft gray SILTY CLAY (A-6b), little fine to coarse sand, trace gravel; moist. | | | | | | |
| 37.0 | 649.2 | | | | | | Severely weathered gray SANDSTONE argillaceous. | | | | | | |
| 40 | | 10<br>17<br>22 | 18 | 14 | | | DRAFT<br>@ 43.0', augers encountered difficult drilling. | | | | | | |
| 43.5 | 642.7 | | | | | | Medium hard to hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, argillaceous, micaceous, moderately to highly fractured.<br>@ 44.8' to 44.9',45.2',45.4',47.0' contains argillaceous laminations and fractures.<br>@ 47.0', slightly weathered, unfractured to slightly fractured. | | | | | | |
| 45 | | Core 120" | Rec 118" | RQD 77% | R-1 | | | | | | | | |
| 50 | | | | | | | | | | | | | |
| 53.5 | 632.7 | | | | | | Bottom of Boring - 53.5' | | | | | | |
| 55 | | | | | | | | | | | | | |
| 60 | | | | | | | | | | | | | |

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-25** | Location: | Date Drilled: 8/19/04 to 8/20/04

WATER OBSERVATIONS: Water seepage at: 16.0', 21.0'
Water level at completion: 16.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 674.6 | 4 7 6 | 18 | 1 | | 4.0 | Hard brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp. | | | | | | |
| 5 | | 6 8 9 | 18 | 2 | | 4.5 | | 4 | 6 | – | 13 | 37 | 40 |
| 5.5 | 669.1 | 2 3 5 | 18 | 3 | | 2.0 | Stiff to very stiff brown CLAY (A-7-6), trace fine sand; varved; damp to moist. | 0 | 0 | – | 1 | 11 | 88 |
| 10 | | 2 3 5 | 18 | 4 | | 1.25 | | | | | | | |
| | | 2 4 4 | 18 | 5 | | 1.75 | | | | | | | |
| 15 | | 3 3 5 | 18 | 6 | | 2.5 | | | | | | | |
| | | 2 3 5 | 18 | 7 | | 2.25 | | | | | | | |
| 18.0 | 656.6 | 4 3 4 | 18 | 8 | | | Loose brown FINE SAND (A-3), trace silt; damp. | | | | | | |
| 20 | | 1 1 3 | 18 | 9 | | | @ 21.0', moist to wet. | | | | | | |
| 25 | | 9 11 12 | 18 | 10 | | | | | | | | | |
| | | 7 3 7 | 18 | 11 | | | | | | | | | |
| 28.0 | 646.6 | 2 14 16 | 18 | 12 | | | Dense brown GRAVEL WITH SAND (A-1-b); contains sandstone fragments; moist. | | | | | | |
| 30 | | | | | | | | | | | | | |

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢ LL
Blows per foot - ○
10 20 30 40

66



FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-25** | Location: | Date Drilled: 8/19/04 to 8/20/04

WATER OBSERVATIONS: Water seepage at: 16.0', 21.0'
Water level at completion: 16.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetrometer (tsf) | DESCRIPTION |
|---|---|---|---|---|---|---|---|
| 30.0 | 644.6 | | | | | | Severely weathered brown and gray SANDSTONE. |
| | | 27 50/5 | 6 | 13 | | | |
| 32.0 | 642.6 | | | | | | Hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, micaceous, argillaceous, massively bedded, slightly fractured. @ 32.0' to 37.0', highly fractured. |
| | | Core 48" | Rec 46" | RQD 42% | R-1 | | |
| 35 | | | | | | | |
| | | Core 72" | Rec 72" | RQD 90% | R-2 | | |
| 40 | | | | | | | |
| 42.0 | 632.6 | | | | | | Bottom of Boring - 42.0' |
| 45 | | | | | | | |
| 50 | | | | | | | |
| 55 | | | | | | | |
| 60 | | | | | | | |

GRADATION: % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40 50+

DRAFT

FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

**LOG OF: Boring TR-26** | Location: | Date Drilled: 8/19/04

WATER OBSERVATIONS: Water seepage at: 8.5'
Water level at completion: 8.4' (includes drilling water)

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press / Core | Hand Penetrometer (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 665.2 | | | | | | | | | | | | |
| 1.0 | 664.2 | 5 5 8 | 18 | 1 | | 4.5 | Topsoil - 12"<br>Hard brown CLAY (A-7-6), some to "and" fine to coarse sand; damp to moist. | | | | | | |
| | | 8 9 11 | 18 | 2 | | 4.5+ | | 0 | 2 | – | 38 | 12 | 48 |
| 5.5 | 659.7 | 7 7 8 | 18 | 3 | | | Loose to medium dense orangish brown COARSE AND FINE SAND (A-3a), little silt; damp to moist. | 0 | 0 | – | 81 | 19 | |
| | | 4 9 7 | 18 | 4 | | | | | | | | | |
| 10 | | 3 4 6 | 18 | 5 | | | DRAFT | | | | | | |
| | | 4 5 10 | 18 | 6 | | | | | | | | | |
| 15 | | 5 4 3 | 18 | 7 | | | @ 16.0', wet. | | | | | | |
| | | 2 3 4 | 18 | 8 | | | | | | | | | |
| 20 | | | | | | | | | | | | | |
| 20.5 | 644.7 | 4 8 13 | 18 | 9 | | | Medium dense gray GRAVEL WITH SAND (A-1-b); contains sandstone fragments; moist. | | | | | | |
| 23.0 | 642.2 | | | | | | @ 23.0' to 25.5', moderately fractured. | | | | | | |
| 25 | | Core 120" | Rec 111" | RQD 73% | R-1 | | Hard gray SANDSTONE; very fine to fine grained, argillaceous, micaceous, slightly to moderately weathered, massively bedded, slightly fractured.<br>@ 23.1', 23.5', thin clay seams. | | | | | | |
| 30 | | | | | | | | | | | | | |

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

Non-Plastic

FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]

DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

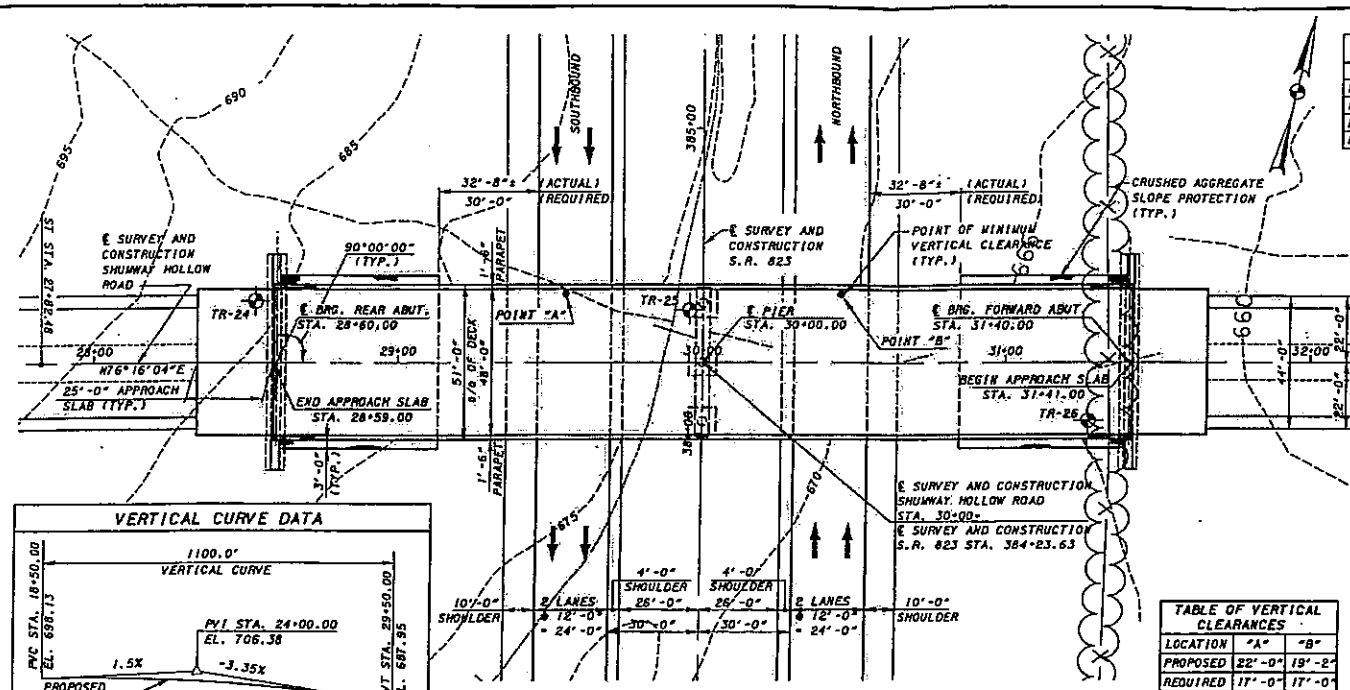
**LOG OF: Boring TR-26** | Location: | Date Drilled: 8/19/04

| Depth (ft) | Elev. (ft) | Blows per 6" | Recovery (in) | Sample No. Drive | Sample No. Press /Core | Hand Penetro-meter (tsf) | DESCRIPTION | GRADATION % Aggregate | % C. Sand | % M. Sand | % F. Sand | % Silt | % Clay |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30.0 | 635.2 | | | | | | WATER OBSERVATIONS: Water seepage at: 8.5'<br>Water level at completion: 8.4' (includes drilling water)<br>Hard gray SANDSTONE; very fine to fine grained, argillaceous, micaceous, slightly to moderately weathered, massively bedded, slightly fractured. | | | | | | |
| 33.0 | 632.2 | | | | | | Bottom of Boring - 33.0' | | | | | | |

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40

DRAFT

FILE: 0121-3070-03 [ 3/27/2006 1:18 PM ]




## VERTICAL CURVE DATA

1100.0' VERTICAL CURVE

PVC STA. 18+50.00
EL. 698.13

PVI STA. 24+00.00
EL. 706.38

PVT STA. 29+50.00
EL. 687.95

1.5%
-3.35%
PROPOSED GRADE

## FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS

| LOCATION | STATION | SIDE |
|---|---|---|
| REAR ABUT. | x | RT. |
| REAR ABUT. | x | LT. |
| FWD. ABUT. | x | RT. |
| FWD. ABUT. | x | LT. |

## BORING LOCATIONS

| BORING No. | STATION | OFFSET |
|---|---|---|
| TR-24 | 28+52.92 | 20.23' LT. |
| TR-25 | 29+95.64 | 17.40' LT. |
| TR-26 | 31+26.84 | 19.37' RT. |

| BENCHMARK 1 | BENCHMARK 2 |
|---|---|
| (TO BE PROVIDED LATER) | (TO BE PROVIDED LATER) |

## TRAFFIC DATA

SHUMWAY HOLLOW

| | |
|---|---|
| CURRENT YEAR ADT (2010) | = 3,800 |
| DESIGN YEAR ADT (2030) | = 7,800 |
| CURRENT YEAR ADTT (2010) | = 228 |
| DESIGN YEAR ADTT (2030) | = 468 |

## TABLE OF VERTICAL CLEARANCES

| LOCATION | "A" | "B" |
|---|---|---|
| PROPOSED | 22'-0" | 19'-2" |
| REQUIRED | 17'-0" | 17'-0" |

## PROPOSED STRUCTURE

TYPE: 2 SPAN CONTINUOUS 72" PRESTRESSED CONCRETE I-BEAM WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY REINFORCED CONCRETE SUBSTRUCTURES ON PILES.

SPANS: 140'-0" - 140'-0" CENTER TO CENTER OF BEARINGS

ROADWAY: 48'-0" TOE TO TOE OF PARAPETS

LOADING: HS-25 AND ALTERNATE MILITARY LOADING. FWS = 60 PSF

SKEW: NONE

CROWN: NORMAL 0.016 FT./FT.

ALIGNMENT: TANGENT

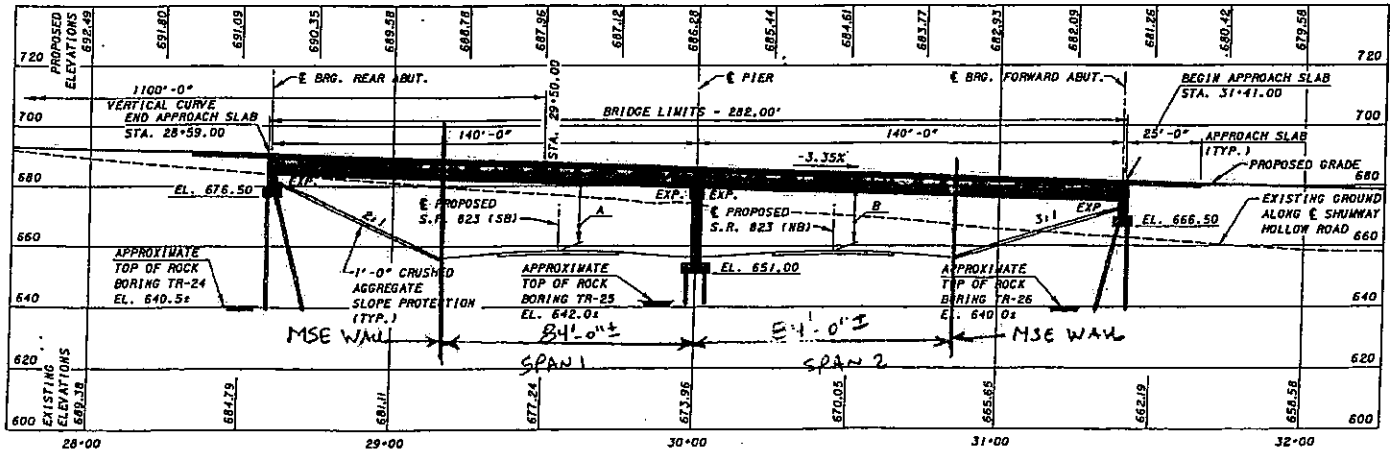
WEARING SURFACE: 1" MONOLITHIC CONCRETE

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

STRUCTURE FILE NUMBER:

LATITUDE:

LONGITUDE:




ELEVATION ALONG ℄ SURVEY AND CONSTRUCTION SHUMWAY HOLLOW ROAD

## NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.
3. THE PROPOSED PROFILE GRADE IS WITHIN BRIDGE LIMITS. SEE ROADWAY PLANS FOR PAVEMENT ELEVATIONS BEYOND BRIDGE LIMITS.

## FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 14x73 PILES AND HAVE A MAXIMUM CAPACITY OF 90 TONS PER PILE.

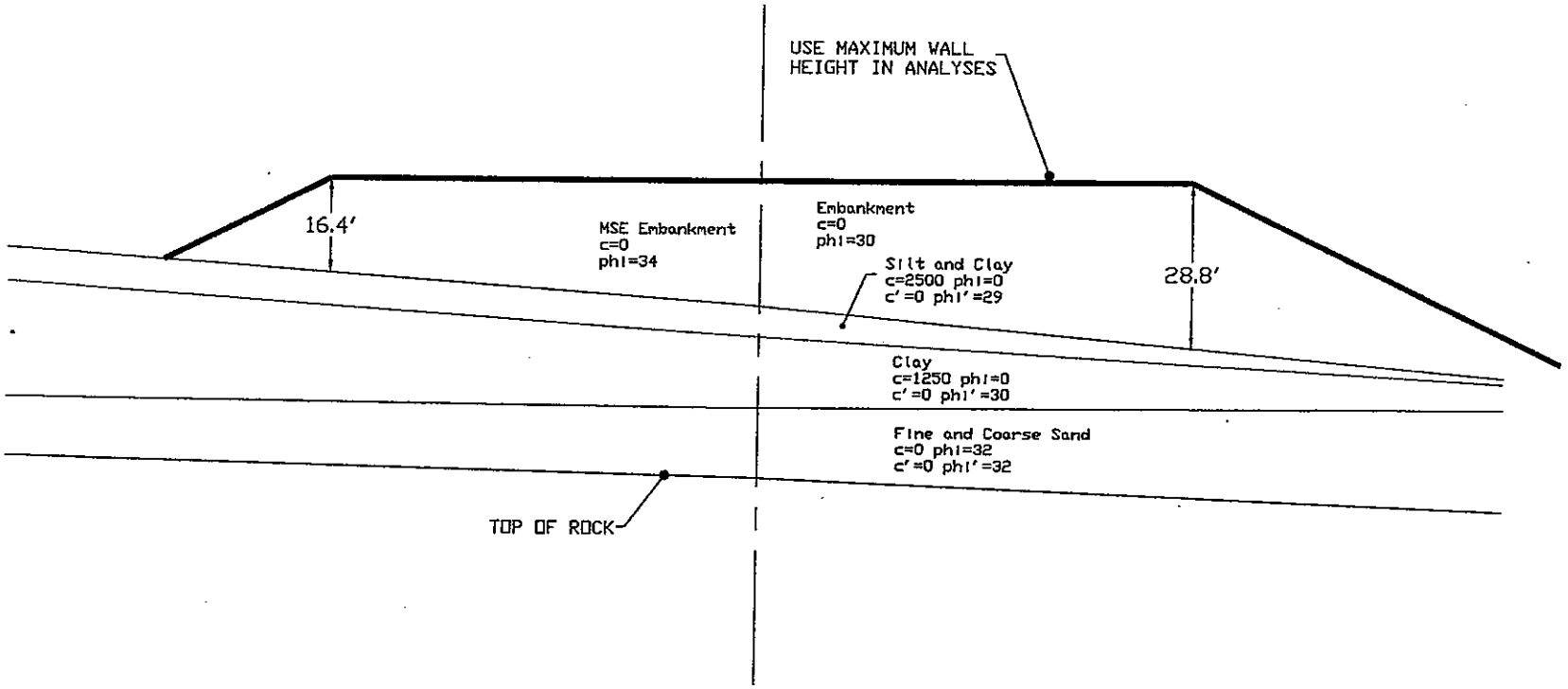
DESIGNED RER 7/11/05
DRAWN RCK
CHECKED JDH

SCIOTO COUNTY
STA. 28+59.00
STA. 31+41.00

PRELIMINARY SITE PLAN - ALTERNATIVE 2
BRIDGE NO. SCI-823-XXXX
S.R. 823 UNDER SHUMWAY HOLLOW ROAD

SCI-823-0.00
PID 19415

1 / 2




SHUMWAY HOLLOW ROAD

CROSS SECTION: STATION 384+69
VIEW LOOKING UPSTATION

MSE WALL STABILITY ANALYSIS
USE MAXIMUM WALL HEIGHT
SCI-823-0.00

| PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 03-27-06 |
|---|---|---|

M:\proj\0121\3070.03\Stability Analyses\Drawings\MSE Wall and Embankment Profiles.dwg, 4/12/2006 2:46:35 PM, \\COLS1\Q_MARKETING_XDC50

**Soil Parameters Used in MSE Wall Stability Analyses**
**Shumway Hollow Road**

| Zone | Soil Type | Unit Weight (pcf) | Strength Parameters | | | |
|---|---|---|---|---|---|---|
| | | | Undrained | | Drained | |
| | | | c | $\phi$ | c' | $\phi'$ |
| Reinforced Fill | Compacted Granular Fill | 120 | 0 | 34 | 0 | 34 |
| Retained Soil | Compacted Embankment Fill | 120 | 0 | 30 | 0 | 30 |
| Foundation Soil (Rear and Forward Abutments) (Borings TR-24,25,26) | Loose to Medium Dense Sandy Silt | 125 | 1250 | 0 | 0 | 29 |
| Foundation Soil (Rear and Forward Abutments) | Compacted Granular Fill | 125 | 0 | 36 | 0 | 36 |

**MSE Retaining Wall Parameters and Analyses Results**
**Portsmouth – Minford Road (Rear and Forward Abutments)**
***Compacted Granular Fill Foundation***

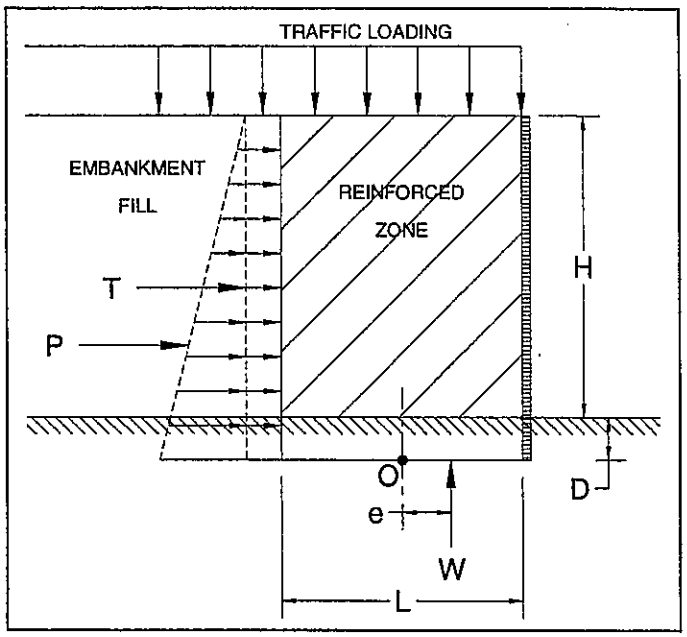
| |
|---|
| Retained Soil (New Embankment)<br>Unit Weight = 120 pcf<br>Coefficient of Active Earth Pressure ($K_a$) = 0.33<br>(Based on $\Phi = 30^o$) |
| Sliding along base of MSE wall<br>Sliding Coefficient ($\mu$)(0.67) = tan 36º(0.67) = 0.49 Use ($\mu$)(0.67)<br>Use ($\mu$)(0.67) =0.55 as a maximum value as per AASHTO, BDM,303.4.1.1 |
| Allowable Bearing Capacity – Undrained Condition<br>$q_{all}$ = 18,360 psf<br>For MSE wall with minimum 28.6-foot long reinforcing |
| Allowable Bearing Capacity – Drained Condition<br>$q_{all}$ = 18,360 psf<br>For MSE wall with minimum 28.6-foot long reinforcing |
| Global Stability<br>Factor of Safety – Undrained Condition = 1.9<br>Factor of Safety – Drained Condition = 1.5<br>Factor of Safety – Seismic Condition = 1.4<br>For MSE wall with 28.6-foot long reinforcing |
| Estimated Settlement of MSE volume<br>Total settlement = 18 inches<br>**Differential settlement = 1.0% = 1/100** |
| Full Height of MSE Wall = 28.8 feet<br>Minimum Embedment Depth = 3.0 feet<br>Minimum Length of Reinforcement for External Stability = 28.6 feet |

DLZ

| | | | | | |
|---|---|---|---|---|---|
| SUBJECT | Client | TranSystems / ODOT D-9 | JOB NUMBER | 0121-3070.03 | |
| | Project | SCI 823-0.00 Portsmouth Bypass | SHEET NO. | OF | |
| | Item | Bearing Capacity (Forward Abutment) | COMP. BY | SJR DATE | 4/12/06 |
| | 07 - 823 over Shumway Hollow Road | | CHECKED BY | DATE | |
| | Borings TR-24, 25, 26 | | | | |

# BEARING CAPACITY OF A MSE WALL

**Ref: {AASHTO; STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17th Edition, 2002}**




## Soil Properties

| | | | | |
|---|---|---|---|---|
| $\gamma_{EMB}$ | = 120 | pcf | Unit weight | Embankment fill |
| $\phi'_{EMB}$ | = 30 | deg. | Friction ang. | Embankment fill |
| $\gamma_{FDN}$ | = 125 | pcf | Unit weight | Foundation soil |
| $c$ | = 1250 | psf | Cohesion | Foundation soil |
| $\phi$ | = 0 | deg. | Friction ang. | Foundation soil |
| $c'$ | = 0 | psf | Cohesion | Foundation soil |
| $\phi'$ | = 29 | deg. | Friction ang. | Foundation soil |

## Loads and Parameters

| | | | | |
|---|---|---|---|---|
| $\omega_t$ | = 240 | psf | Traffic loading | |
| L=B | = 28.62 | ft | Length of MSE reinforcement | |
| L factor | = 0.9 | | Length factor-range (0.7 - 1.0) | |
| D | = 3 | ft | Embedment depth | |
| Dw | = 0 | ft | Groundwater depth | |
| H+D | = 31.8 | ft | | |
| H | = 28.8 | ft | Height of wall | |
| Ka | = 0.33 | | | |
| ⌜ Pa | = 10.6 | ft | Moment arm | |
| ⌜ Wt | = 15.9 | ft | Moment arm | |
| B' | = 24.28 | ft | | |
| $\gamma'$ | = 57.6 | pcf | | |
| $W_t$ | 6,869 | lb/ft of wall | Weight from traffic | |
| $W_{mse}$ | = 109,214 | lb/ft of wall | Weight from MSE wall | |

## Effective Bearing Pressure

$$\sigma_v = \frac{W_t + W_{MSE}}{L - 2e}$$

$\sigma_v$ = 4,781 psf

## Ultimate undrained bearing capacity, $q_{ult}$

$$q_{ULT} = cN_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

$q_{ULT}$ = 6,598 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

$q_{ALL}$ = 2,639 psf

Factor of Safety = **1.38** **No Good**

## Ultimate drained bearing capacity, $q_{ult}$

$$q_{ULT} = c'N_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

$q_{ULT}$ = 16,365 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

$q_{ALL}$ = 6,546 psf

Factor of Safety = **3.42** **OK**

## Bearing Capacity Factors for Equations

| Undrained | | Drained | |
|---|---|---|---|
| $N_c$ | 5.14 | $N_c$ | 27.86 |
| $N_q$ | 1.00 | $N_q$ | 16.44 |
| $N_\gamma$ | 0.00 | $N_\gamma$ | 19.34 |

## Eccentricity of Resultant Force

e = 2.17 ft

## Kern

e < L/6 = 4.77 ft

DLZ

SUBJECT

| | | | |
|---|---|---|---|
| Client | TranSystems ODOT D-9 | JOB NUMBER | 0121-3070.03 |
| Project | SCI 823-0.00 Portsmouth Bypass | SHEET NO. | OF |
| Item | MSE Wall Stability (Forward Abutment) | COMP. BY SJR | DATE 04/12/06 |
| 07 - 823 over Shumway Hollow Road | | CHECKED BY | DATE |
| Borings TR-24, 25, 26 | | | |

# STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=26'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

| Wall Properties | | | |
|---|---|---|---|
| H+D | = 31.8 | feet | |
| $\gamma_{mse}$ | = 120 | pcf | |
| L | = 28.62 | feet | |
| L factor | = 0.90 | | Length factor-range (0.7 - 1.0) |
| $\phi$ | = 30 | deg | Friction Angle of Embankment Fill |

| Foundational Soil Properties | | | |
|---|---|---|---|
| c | = 1250 | psf | Cohesion |
| $\phi'$ | = 29 | deg | Friction angle |
| $\omega_T$ | = 240 | psf | Traffic loading |

## RESISTANCE AGAINST SLIDING ALONG BASE

Thrust: $P_a = K_a\left[\frac{1}{2}\gamma H^2 + \omega_T H\right]$

where; $K_a = \tan^2(45 - \frac{\phi}{2})$ $K_a$ = 0.33

$P_a$ = 22,541 lbs per foot of wall

Resistance: $P_r = W(0.67)(\mu)$ (Drained)

where; $\mu = \tan(\phi)$ $0.67\mu$ = 0.37

$0.67\mu$ Max. = 0.35 {AASHTO, Bridge Design Manual, 303.4.1.1}

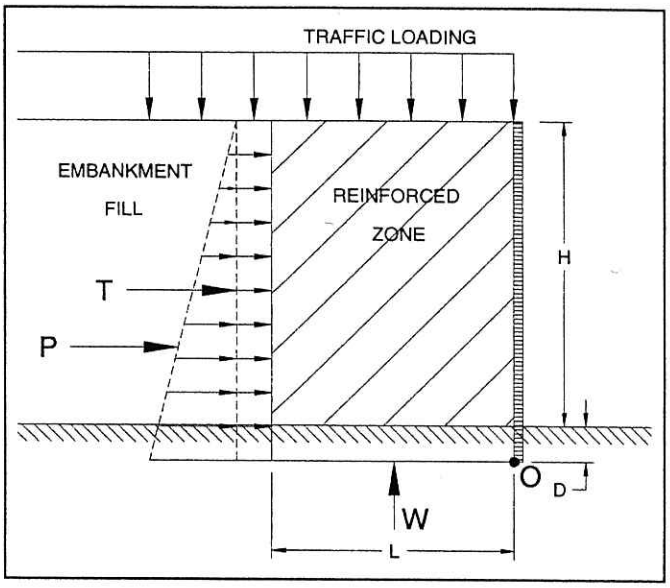
$P_r$ = 38,225 lbs per foot of wall

**Use Undrained Value**

$P_r = L(c)$ (Undrained)

$P_r$ = 35,775 lbs per foot of wall

**USE THIS VALUE**




$FS = \frac{P_r}{P_a}$ Calculated FS = **1.59** Required FS = 1.50 Resistance Against Sliding is **OK**

## RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).
* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 1,562,851 lb-ft $\Sigma M_{resisting} = \gamma H L\left(\frac{L}{2}\right)$

$\Sigma M_{overturning}$ = 252,284 lb-ft $\Sigma M_{overturning} = K_a\left[\frac{1}{2}\gamma H^2\left(\frac{H}{3}\right) + \omega_T H\left(\frac{H}{2}\right)\right]$

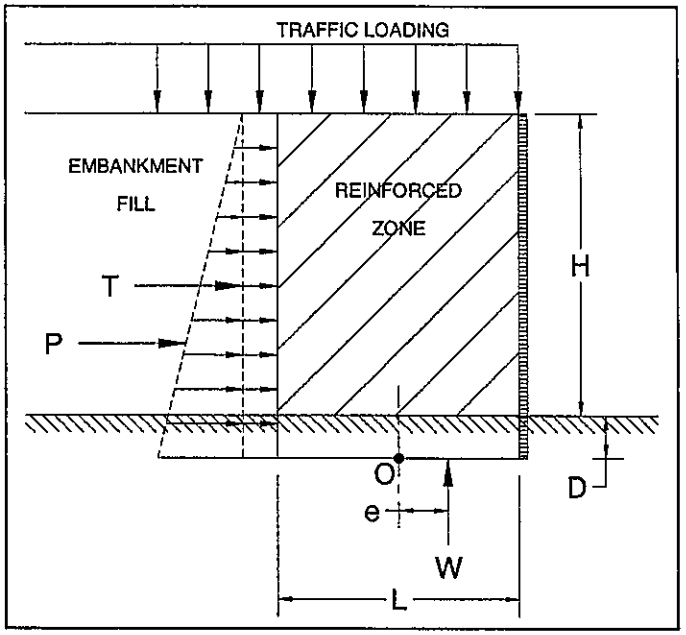
$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturning}}$ Calculated FS = **6.19** Required FS = 2.00 Resistance Against Overturning is **OK**

DLZ

| | | | |
|---|---|---|---|
| SUBJECT | Client | TranSystems / ODOT D-9 | JOB NUMBER 0121-3070.03 |
| | Project | SCI 823-0.00 Portsmouth Bypass | SHEET NO. OF |
| | Item | Bearing Capacity (Forward Abutment) | COMP. BY SJR DATE 3/27/06 |
| | 07 - 823 over Shumway Hollow Road | | CHECKED BY DATE |
| | Borings TR-24, 25, 26 | Granular Fill | |

# BEARING CAPACITY OF A MSE WALL

**Ref: {AASHTO; STANDARD SPECIFICATIONS FOR HIGHWAY BRIDGES, 17th Edition, 2002}**




## Soil Properties

| | | | | |
|---|---|---|---|---|
| $\gamma_{EMB}$ | = 120 | pcf | Unit weight | Embankment fill |
| $\phi'_{EMB}$ | = 30 | deg. | Friction ang. | Embankment fill |
| $\gamma_{FDN}$ | = 125 | pcf | Unit weight | Foundation soil |
| $c$ | = 0 | psf | Cohesion | Foundation soil |
| $\phi$ | = 36 | deg. | Friction ang. | Foundation soil |
| $c'$ | = 0 | psf | Cohesion | Foundation soil |
| $\phi'$ | = 36 | deg. | Friction ang. | Foundation soil |

## Loads and Parameters

| | | | | |
|---|---|---|---|---|
| $\omega_t$ | = 240 | psf | Traffic loading | |
| L=B | = 28.62 | ft | Length of MSE reinforcement | |
| L factor | = 0.9 | | Length factor-range (0.7 - 1.0) | |
| D | = 3 | ft | Embedment depth | |
| Dw | = 0 | ft | Groundwater depth | |
| H+D | = 31.8 | ft | | |
| H | = 28.8 | ft | Height of wall | |
| Ka | = 0.33 | | | |
| Γ Pa | = 10.6 | ft | Moment arm | |
| Γ Wt | = 15.9 | ft | Moment arm | |
| B' | = 24.28 | ft | | |
| $\gamma'$ | = 57.6 | pcf | | |
| $W_t$ | 6,869 | lb/ft of wall | Weight from traffic | |
| $W_{mse}$ | = 109,214 | lb/ft of wall | Weight from MSE wall | |

## Effective Bearing Pressure

$$\sigma_v = \frac{W_t + W_{MSE}}{L - 2e}$$

$\sigma_v$ = 4,781 psf

## Ultimate undrained bearing capacity, $q_{ult}$

$$q_{ULT} = cN_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

$q_{ULT}$ = 45,899 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

$q_{ALL}$ = 18,360 psf

Factor of Safety = **9.60** **OK**

## Ultimate drained bearing capacity, $q_{ult}$

$$q_{ULT} = c'N_c + \sigma'_D N_q + \frac{1}{2}\gamma' B N_\gamma$$

$q_{ULT}$ = 45,899 psf

$$q_{ALL} = \frac{q_{ULT}}{FS}$$

$q_{ALL}$ = 18,360 psf

Factor of Safety = **9.60** **OK**

## Bearing Capacity Factors for Equations

| Undrained | | Drained | |
|---|---|---|---|
| $N_c$ | 50.59 | $N_c$ | 50.59 |
| $N_q$ | 37.75 | $N_q$ | 37.75 |
| $N_\gamma$ | 56.31 | $N_\gamma$ | 56.31 |

## Eccentricity of Resultant Force

e = 2.17 ft

## Kern

e < L/6 = 4.77 ft

DLZ

| | | | |
|---|---|---|---|
| SUBJECT | Client TranSystems ODOT D-9 | JOB NUMBER | 0121-3070.03 |
| | Project SCI 823-0.00 Portsmouth Bypass | SHEET NO. | OF |
| | Item MSE Wall Stability (Forward Abutment) | COMP. BY SJR | DATE 03/27/06 |
| | 07 - 823 over Shumway Hollow Road | CHECKED BY | DATE |
| | Borings TR-24, 25, 26 Granular Fill | | |

## STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=26'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

| Wall Properties | | | | Foundational Soil Properties | | | |
|---|---|---|---|---|---|---|---|
| H+D | = 31.8 | feet | | c = 0 | psf | Cohesion |
| $\gamma_{mse}$ | = 120 | pcf | | $\phi'$ = 36 | deg | Friction angle |
| L | = 28.62 | feet | | $\omega_T$ = 240 | psf | Traffic loading |
| L factor | = 0.90 | | Length factor-range (0.7 - 1.0) | | | |
| $\phi$ | = 30 | deg | Friction Angle of Embankment Fill | | | |

### RESISTANCE AGAINST SLIDING ALONG BASE

Thrust: $P_a = K_a\left[\frac{1}{2}\gamma H^2 + \omega_T H\right]$

where; $K_a = \tan^2(45 - \frac{\phi}{2})$ $K_a$ = 0.33

$P_a$ = 22,541 lbs per foot of wall

Resistance: $P_r = W(0.67)(\mu)$ (Drained)

where; $\mu = \tan(\phi)$ $0.67\mu$ = 0.49

$0.67\mu$ Max. = 0.55 {AASHTO, Bridge Design Manual, 303.4.1.1}

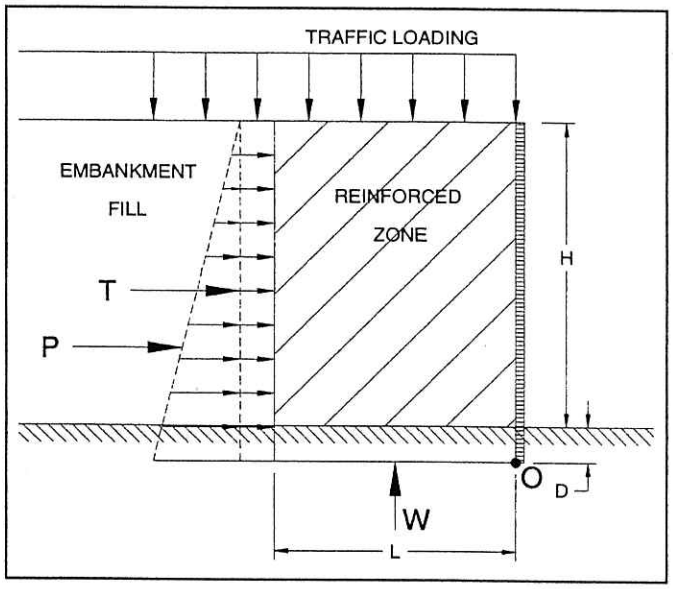
$P_r$ = 53,515 lbs per foot of wall

**USE THIS VALUE**

$P_r = L(c)$ (Undrained)

$P_r$ = 0 lbs per foot of wall

**Use Drained Value**




| | Calculated | Required | |
|---|---|---|---|
| $FS = \frac{P_r}{P_a}$ | FS = **2.37** | FS = 1.50 | Resistance Against Sliding is **OK** |

### RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).
* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 1,562,851 lb-ft

$\Sigma M_{overturning}$ = 252,284 lb-ft

$\Sigma M_{resisting} = \gamma H L\left(\frac{L}{2}\right)$

$\Sigma M_{overturning} = K_a\left[\frac{1}{2}\gamma H^2\left(\frac{H}{3}\right) + \omega_T H\left(\frac{H}{2}\right)\right]$

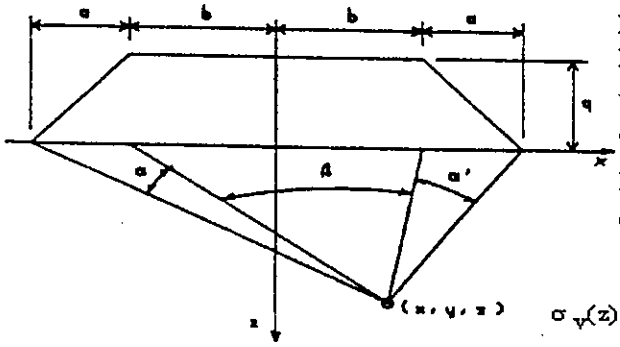
| | Calculated | Required | |
|---|---|---|---|
| $FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturning}}$ | FS = **6.19** | FS = 2.00 | Resistance Against Overturning is **OK** |

DLZ

| | | | |
|---|---|---|---|
| SUBJECT | Client TranSystems / ODOT D-9 | JOB NUMBER | 0121-3070.03 |
| | Project SCI-823 Portsmouth Bypass | SHEET NO. | OF |
| | Item 07 - 823 over Shumway Hollow | COMP. BY | SJR DATE 04/12/06 |
| | MSE wall settlement Based on TR-24 (25) | CHECKED BY | DATE |

# SETTLEMENT ANALYSIS - EMBANKMENT

**Embankment Informaiton:**




| | | | | | |
|---|---|---|---|---|---|
| Groundwater Table: | D= | 5.0 | ft | | |
| Embankment Height: | H = | 28.8 | ft | | |
| Fill Unit Weight: | $\gamma_{emb}$ = | 120 | pcf | q = | 3,456 psf |
| Width of Slope: | a = | 57.6 | | | |
| Top half-width of Emb: | b = | 75 | | | |
| Distance from CL: | x = | 0 | | | |
| Output Range: | z = | 0 | to | 32 | ft |

**See Data output Attached*

$$\sigma_v(z) := \left(\frac{q}{\pi}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \qquad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \qquad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$

*Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1*

**Soil Properites:** *Settlement is calculated at mid-point of layer*

| No. | Bot. of Laye | | Soil Type | $\gamma_{soil}$ (pcf) | $\sigma'_c$ (psf) | $\sigma'_o$ (psf) | $\Delta\sigma z$ (psf) | $\sigma'_f$ (psf) | Cohesionless Soils C' | Cohesive Soils $C_r$ | Cohesive Soils $C_c$ | Cohesive Soils $e_o$ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 7.0 | ft | Granular Fill | 120 | 0 | 420 | 3,456 | 3,876 | 0.0 | 0.00 | 0.00 | 0.000 |
| 2 | 12.0 | ft | Clay | 125 | 4,400 | 872 | 3,455 | 4,326 | 0.0 | 0.27 | 0.00 | 0.743 |
| 3 | 21.4 | ft | Clay | 125 | 4,800 | 1,322 | 3,449 | 4,772 | 0.0 | 0.27 | 0.00 | 0.743 |
| 4 | 32.0 | ft | Fine Sand | 120 | 0 | 1,922 | 3,430 | 5,352 | 43.0 | 0.00 | 0.00 | 0.000 |
| 5 | 0.0 | | | 0 | 0 | | | | | | | |
| 6 | 0.0 | | | 0 | 0 | | | | | | | |
| 7 | 0.0 | | | 0 | 0 | | | | | | | |
| 8 | 0.0 | | | 0 | 0 | | | | | | | |
| 9 | 0.0 | | | 0 | 0 | | | | | | | |
| 10 | 0.0 | | | 0 | 0 | | | | | | | |

| No. | Settlement: | | Total Settlement |
|---|---|---|---|
| 1 | 0.000 | ft | |
| 2 | 0.539 | ft | 1.460 ft |
| 3 | 0.811 | ft | |
| 4 | 0.110 | ft | |
| 5 | | | 17.5 in |
| 6 | | | |
| 7 | | | |
| 8 | | | |
| 9 | | | |
| 10 | | | |

*Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999*

**Overconsolidated Soils - Case I ($\sigma'_o < \sigma'_c$) Eqn:11.24**

$$(\delta_c)_{ult} = \sum \frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_o}\right)$$

**Overconsolidated Soils - Case II ($\sigma'_o < \sigma'_c < \sigma_f$) Eqn:11.25**

$$(\delta_c)_{ult} = \sum\left[\frac{C_r}{1+e_0} H \log\left(\frac{\sigma'_c}{\sigma'_o}\right) + \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

**Normally Consolidated Soils ($\sigma'_o = \sigma'_c$) Eqn: 11.23**

$$(\delta_c)_{ult} = \sum \frac{C_c}{1+e_0} H \log\left(\frac{\sigma'_f}{\sigma'_o}\right)$$

**Cohesionless Soils ($\sigma'_o = \sigma'_c$)**

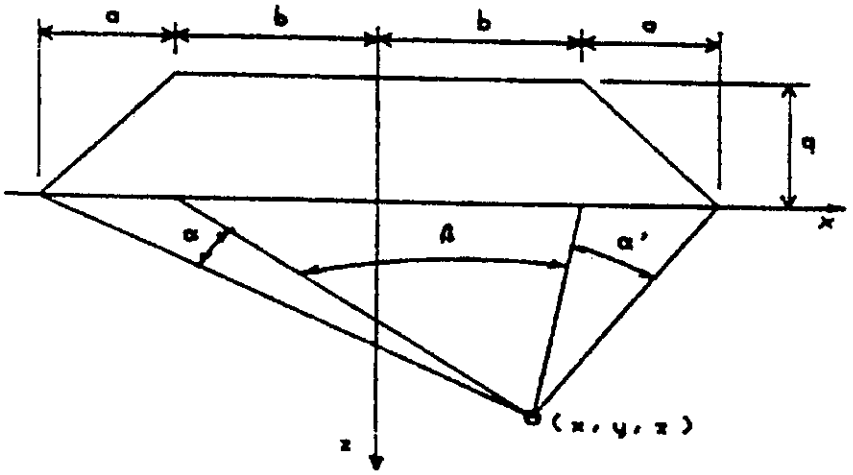
$$(\delta_c)_{ult} = \sum \frac{1}{C'} H \log\left(\frac{\sigma'_f}{\sigma'_o}\right)$$

DLZ

SUBJECT

| | | | |
|---|---|---|---|
| Client | TranSystems / ODOT D-9 | JOB NUMBER | |
| Project | SCI-823 Portsmouth Bypass | SHEET NO. | OF |
| Item | 07 - 823 over Shumway Hollow | COMP. BY | DATE |
| MSE wall settlement Based on TR-24 | | CHECKED BY | DATE |

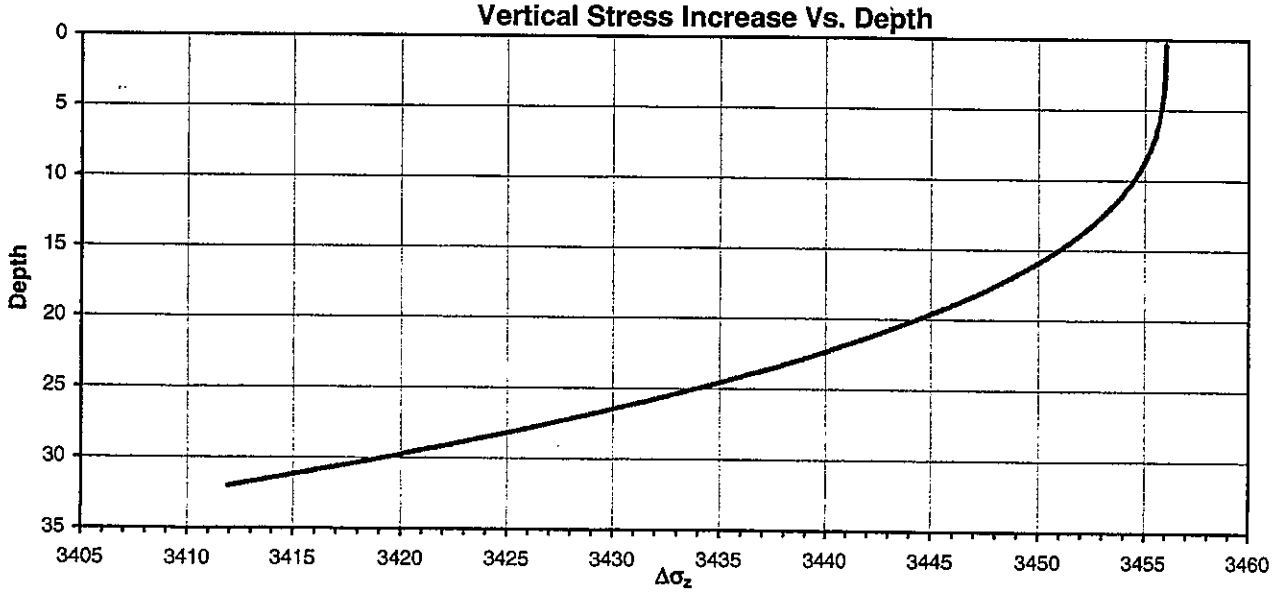
## INCREASE IN VERTICAL STRESS DUE TO EMBANKMENT LOADING




| | | | |
|---|---|---|---|
| q = | 3456 | | load |
| a = | 57.6 | | width of slope |
| b = | 75 | | top half-width of embankment |
| x = | 0 | | distance from CL |
| z = | 0 | to 32 | depth range |

$$\sigma_v(z) := \left(\frac{q}{\pi}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z)) + b\cdot(\alpha(z)+\alpha'(z)) + x\cdot(\alpha(z)-\alpha'(z))\right)$$

$$\beta(z) := \operatorname{atan}\left[\frac{(b-x)}{z}\right] + \operatorname{atan}\left[\frac{(b+x)}{z}\right] \quad ; \quad \alpha'(z) := \operatorname{atan}\left[\frac{(a+b-x)}{z}\right] - \operatorname{atan}\left[\frac{(b-x)}{z}\right] \quad \alpha(z) := \operatorname{atan}\left[\frac{(a+b+x)}{z}\right] - \operatorname{atan}\left[\frac{(b+x)}{z}\right]$$




Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

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PLANNERS • SURVEYORS

CLIENT TranSystems / ODOT D-9
PROJECT SCI-823 Portsmouth Bypass
SUBJECT Shumway Hollow Soil Properties

PROJECT NO. 0121-3070.03
SHEET NO. ____ OF ____
COMP. BY SJK DATE 3-28-06
CHECKED BY ____ DATE ____

- Based on TR-25 * Procedure Adapted From FHWA Soils & Foundations

* Layer 1 Depth 0'- 5.5'

Check Preconsolidation: $\frac{MC - PL}{LL - PL} = \frac{14-22}{35-22} = -0.04 < 0.7$

↳ Overconsolidated

$e_o = \frac{MC\,(2.75)}{100} = 0.385$ $C_r = \frac{MC}{100} = 0.14$

* Layer 2 & 3 Depth 5.5'- 18.0'

Check Preconsolidation: $\frac{MC - PL}{LL - PL} = \frac{27-25}{66-25} = 0.05 < 0.7$

↳ Overconsolidated

$e_o = \frac{MC\,(2.75)}{100} = 0.743$ $C_r = \frac{MC}{100} = 0.27$

$C_c = \frac{MC}{100}$ $C_R = \frac{MC}{1000}$

* Layer 4 Depth 18.0'- 28.0' Sand $C' = 43.0$

---

Differential Settlement * Assuming full heigh width of ≈ 100'

$\delta_{diff} = \frac{1.50}{75+70} = 1.03\% > \frac{1}{100}$

↳ Excessive Differential Settlement

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CLIENT Tran Systems / ODOT D-9 PROJECT NO. 0121-3070.03
PROJECT SCI-823 Portsmouth Bypass SHEET NO. ____ OF ____
SUBJECT Shumway Hollow COMP. BY SJK DATE 4-10-06
Time-Rate Calculations CHECKED BY ____ DATE ____

$U = 90\% \longrightarrow T_v = 0.848$

*Taken from R-33S2
$C_v^* = 0.00014$ in²/sec
$C_v^* = 0.085$ ft²/day

$t_{90\%} = \frac{T H_v^2}{c_v}$

From Profile based on Centerline & Alignment TR-34, TR-25 & TR-26.

$H_v = 18' - (3.0' + 5.0') = 10.0'$ (Embedment; Overexcavate & Replace 7')

$t_{90\%} = \frac{0.848(10.0)^2}{0.085} = 998 \text{ days} = \boxed{2.7 \text{ years}}$

* May want to consider wick drains to accelerate settlement

should be double drainage

$t_{90} = \frac{0.848(5)^2}{0.085} = 249$ days

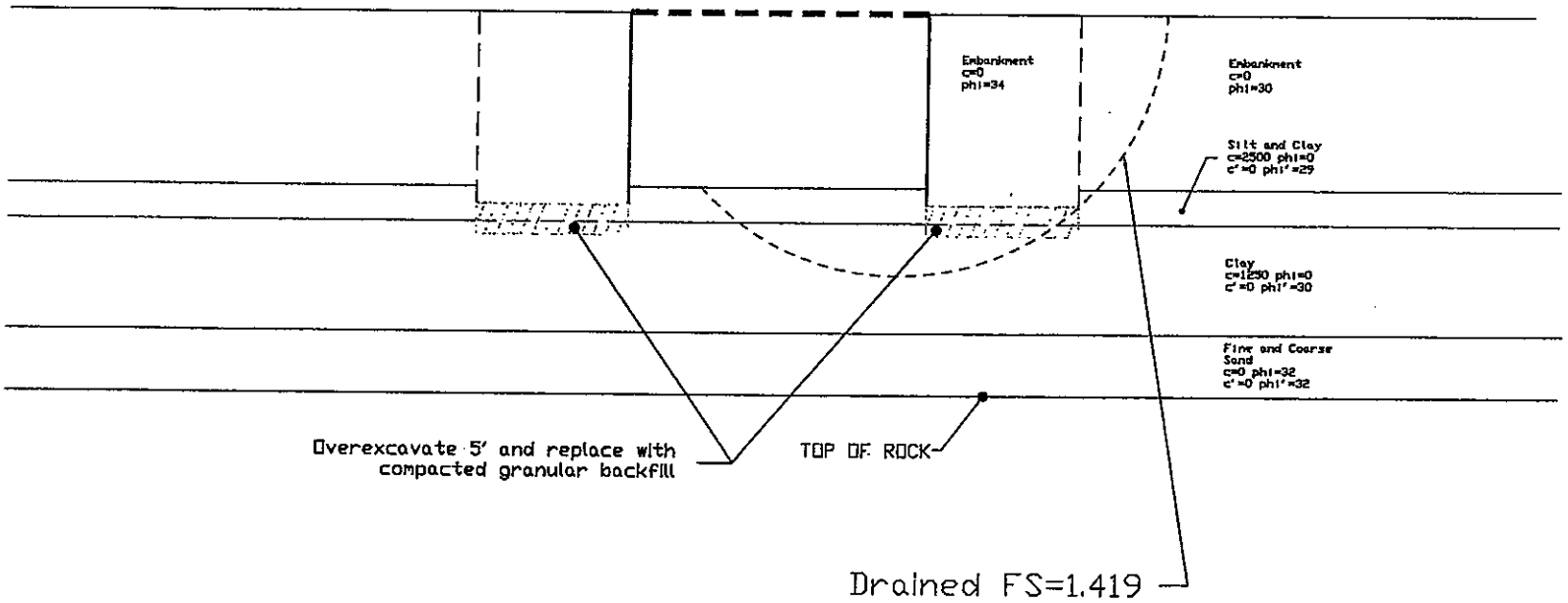
$t_{90} = \frac{0.848(5)^2}{0.2} = 106$ days

if $c_v = 0.2$ ft²/day (as based on Fig 9-5 in FHWA HI-97-021) then

$\frac{0.848(10)^2}{0.2} = 424$ days

MSE Wall Stability
Shumway Hollow Road
Rear Abutment Sta. 383+75.
Based on TR-24
H=28.8' (full height)
Embedment=3.0'
Length=0.8(H+D)=25.5'

MSE Wall Stability
Shumway Hollow Road
Forward Abutment Sta. 384+69
Based on TR-24
H=28.8' (full height)
Embedment=3.0'
Length=0.8(H+D)=25.5'




SHUMWAY HOLLOW ROAD
REAR ABUTMENT STA: 383+75
FORWARD ABUTMENT STA: 384+69

MSE WALL STABILITY ANALYSIS
INITIAL TRIAL
SCI-823-0.00

| PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 04-12-06 |
|---|---|---|

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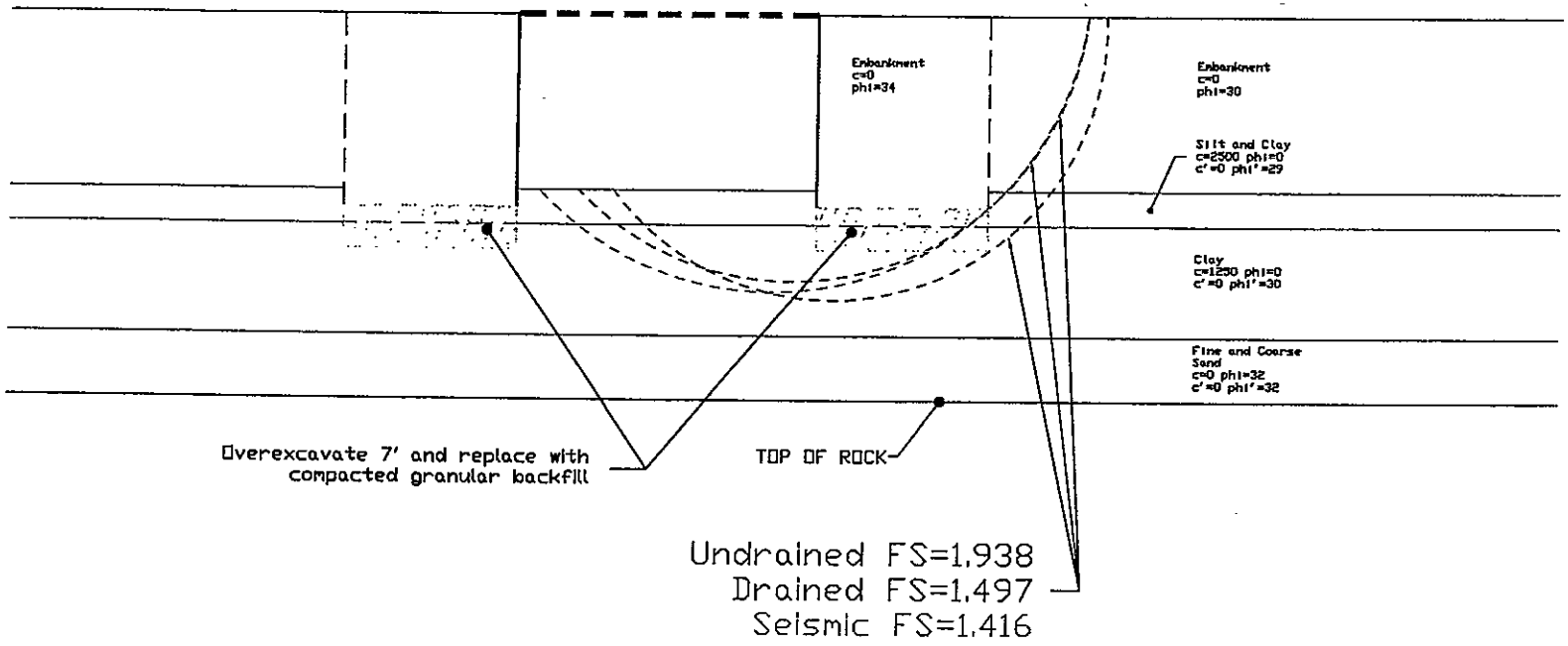
MSE Wall Stability
Shumway Hollow Road
Rear Abutment Sta. 383+75.
Based on TR-24
H=28.8' (full height)
Embedment=3.0'
Length=0.9(H+D)=28.6'

MSE Wall Stability
Shumway Hollow Road
Forward Abutment Sta. 384+69
Based on TR-24
H=28.8' (full height)
Embedment=3.0'
Length=0.9(H+D)=28.6'




Undrained FS=1.938
Drained FS=1.497
Seismic FS=1.416

SHUMWAY HOLLOW ROAD
REAR ABUTMENT STA: 383+75
FORWARD ABUTMENT STA: 384+69

MSE WALL STABILITY ANALYSIS
PRELIMINARY DESIGN ANALYSIS
SCI-823-0.00

| PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 04-12-06 |
|---|---|---|