TranSystems

SCI-823-0.00 PID 77366

SR 823 Ramp B (SB) over US 52 and Ohio River Road (CR-503)

Ohio Department of Transportation
District 9
November 20, 2006

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BRIDGE TYPE STUDY NARRATIVE

1. Introduction

TranSystems is providing engineering services to the Ohio Department of Transportation for the design of new overpass structures for the proposed S.R. 823 ramps at the U.S. 52 interchange over Ohio River Road. This bridge type study will address the overpass structure on Ramp B, which carries southbound traffic from S.R. 823 to eastbound U.S. 52. As requested by the Scope of Services, a Bridge Type Study report is to be submitted before any plan development. The purpose of this report is to investigate various span arrangements, superstructure and substructure types in order to determine the most appropriate and economical structure type that will meet the project requirements. Initial Structure Type Study reports for two separate structures carrying proposed Ramp B over US 52 and Ramp B over Ohio River Road, dated 7/15/2005, were submitted to the Department. Comments, dated 9/8/2005 and 9/20/2005, were in turn received by TranSystems. In the comments provided by ODOT the reviewer recommended that the structures be combined by eliminating a narrow section of embankment between the bridges. Since the PAVR submittal the alignment and profile of Ramp B has been revised. The revised horizontal alignment of the ramp was shifted east to provide more clearance for future Norfolk Southern tracks and also eliminates a superelevation transition on the structures. The revised profile raises the elevations of the proposed Ramp B over US 52 from the elevations specified in the July 2005 PAVR to provide additional depth for the structure. This follow-up Structure Type Study presents the changes in alignment and profile as well as alternative bridge types that are investigated in accordance with the 9/8/2005 and 9/20/2005 ODOT comments. As a result, three (3) alternatives for construction of the proposed Ramp B structure over US 52 and Ohio River Road are evaluated in this study and are designated as Alternatives 1, 2A and 2B. 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 current version of the Ohio Department of Transportation Bridge Design Manual (BDM) and the 2002 AASHTO Standard Specifications for Highway Bridges. Horizontal and vertical clearances are based on the Ohio Department of Transportation Location and Design Manual (L&D), Volume One – Roadway Design.

3. Subsurface Conditions and Foundation Recommendation

DLZ Ohio, Inc. performed the subsurface exploration for the proposed Ramp B and prepared preliminary bridge foundation recommendations which were presented in Section 3 and Appendix E of the original 7/15/2005 Structure Type Study report. An updated Subsurface Exploration report, dated 10/24/2006, has since been prepared by DLZ Ohio, Inc. and is presented in Appendix E of this Type Study. Five test borings (TR-62, TR-64, TR-66, TR-73A and TR-71A) were drilled and all of them encountered bedrock at depths between 6 and 17 feet. Overburden consisted of natural granular and cohesive materials except at boring TR-64 that only encountered granular materials.

DLZ recommends the following three possible solutions for supporting the Ramp B overpass abutments:

1) pipe piles placed in prebored holes 12 inches larger than the diameter of the pile and a minimum of 5' deep into bedrock;
2) drilled shafts socketed a minimum of 5' into competent bedrock; and,
3) spread footings bearing in MSE fill.

To support the proposed piers, DLZ recommends using drilled shafts socketed 5' minimum into bedrock or spread footings bearing on the bed rock, each with an allowable bearing capacity of 80ksf. Additional discussion of the selection of the foundation types for each substructure can be found in the alternatives discussion. Please refer to Appendix E for further information and details regarding the foundation recommendations.

Preliminary MSE wall evaluations were performed by DLZ Ohio, Inc. as well and are presented in the Preliminary Subsurface Exploration report of Appendix E. These wall evaluations reveal that MSE walls can be used at the rear and forward abutment locations for all Alternatives. DLZ anticipates that the MSE wall at the forward abutment will bear on or near bedrock whereas the MSE wall at the rear abutment will bear on either native soils or compacted granular fill (CMS Item 304) if loose, soft, or compressible soils are encountered at this location. Please refer to Appendix E for further information and details regarding MSE wall evaluations.

4. Roadway

The purpose of this project is to construct a new bypass state route – S.R. 823 – 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 the town to another interchange with US 23 north of the town in Valley Township. As part of the US 52 and SR 823 interchange on the south terminus of the proposed bypass, Ramp B carries southbound traffic from S.R. 823 to eastbound U.S. 52. The proposed Ramp B bridge will consist of one 16'-0" travel lane with a 6'-0" left shoulder and a 8'-0" right shoulder with 1'-6" straight face deflector parapets. Thus the bridge deck width will be 33'-0" out to out.

Vertical and Horizontal Clearances - The vertical profile of the ramp is dictated by the depth required for the structure. Vertical clearance was considered critical at this structure location. Ohio River Road is classified as an Urban Minor Arterial roadway and US 52 is classified as an Urban Principal Arterial. According to the ODOT Location and Design Manual, Volume One – Roadway Design, Figure 302-1E, a preferred vertical clearance of 17'-0" (minimum of 16'-6") should be provided over Arterial roadways such as the ones at this site. More than 16'-6" of required vertical clearance could be provided for the alternatives considered for this study with more than 17'-0" vertical clearance for the preferred alternative.

Horizontal clearances will use guardrail or concrete barrier due to the skew of the crossing and the impact on span lengths. The minimum horizontal clearances under the structures will be in accordance with Figure 302-1E and the other sections it references. A description of the horizontal clearances follows:

US 52- The design designation of US 52 is an Urban Principal Arterial road with a 2030 ADT of 39,400 as shown in the PAVR submittal and as given by ODOT Office of Technical Services letter of 6/2/05. US 52 currently has uncurbed outside shoulder with drainage ditches. Using this roadway classification in Figure 301-3E gives a guardrail offset of 12'-0" and a concrete barrier offset at the edge of the treated shoulder of 10'-0". Improvements are not planned on US 52; therefore, the proposed guardrail offsets along US 52 will match the existing guardrail offset of 10'-0" to the outside right shoulder. This offset will be used for proposed guardrail or concrete barrier along with the barrier clearances in Figure 603-2E behind the face of the barrier. All alternatives include a pier in the median of US 52, thus, reducing the width of the existing median shoulders. The shoulder width proposed is 4'-0" which is below the minimum design standards. TranSystems is preparing a design exception for the median shoulder width at US 52.

Ohio River Road (CR-503)- The design designation of Ohio River Road is an Urban Minor Arterial and the ADT is unknown but it is assumed to be greater than 4000. The design speed is obtained from Figure 104-2E of the ODOT Location and Design Manual, Volume One – Roadway Design, recommending a design speed of 40-50 mph. The posted speed on Ohio River Road is 45mph and therefore a 50mph design speed selected. Using this information in Figures 301-4E of the L&D manual the offset to the concrete barrier is at the edge of treated width of 10'-0". The concrete barrier will be Type D per standard drawing RM-4.5.

Alignment & Profile - The proposed horizontal geometry is along a curved alignment across the entire length of the ramp structure. The curve alignment may be defined by the following parameters: PC = Station 31+94.17, PT = Station 52+11.25, Δ = 32°16'24", D_c (degree of curve) = 1°36'00", R (radius) = 3580.99', L_c = 2017.08', T = 1036.08', and E = 146.87'. The proposed Ramp B structure is positioned within a horizontal curve, therefore the deck is superelevated. The superelevation rate and layout are based on Figure 202-7E of the ODOT Location and Design Manual, Volume One – Roadway Design (using a degree of curve of 1°36'00" and design speed of 60 mph) and Figure 205 of the ODOT Bridge Design Manual, respectively. Using these design references results in a superelevation rate of 0.043 ft/ft (4.3%) across the ramp travel lane. The proposed ramp profile is located on the right edge of the traveled lane and is along a vertical curve beginning at 37+50 with PVI at Station 41+50.00, PVI Elevation = 573.47, g_1 = 3.70% and g_2 = -0.87%. The horizontal and vertical geometry for all alternatives considered are the same. Horizontal and vertical sight distances, in accordance with the design standards, have been provided for all alternatives.

Several roadways, properties and two Norfolk Southern tracks are closely aligned in the proposed U.S. 52-S.R. 823 interchange; necessitating the investigation into the use of retaining walls. The limits of the retaining wall along Ramp B have been determined in the Retaining Wall Justification and included in the cost comparisons. Please refer to Appendix F for further information and details regarding retaining wall justification.

Drainage Design –The profile on the structure is in a positive grade of 3.70% leading into an 800' vertical curve starting at station 37+50. The high point of the vertical curve is just beyond the forward abutment at station 43+98, thereby draining the pavement towards the rear abutment. Pavement spread calculations indicate that the spread will be contained in the shoulder for the length of the bridge beginning from the high point. In accordance with Section 209.3 of the BDM, it is recommended that the collection of storm water runoff will be addressed off the bridge requiring an inlet and longitudinal storm system in the MSE embankment off the bridge. Also discussed in Section 209.3 are MSE walls and expansion joints, which are both items in use on the structures investigated for Ramp B. Therefore, additional consideration maybe given to placing scuppers on this structure to reduce the maintenance that can be associated with the modular expansion joint at the rear abutment as well as the MSE supported ramp embankment. At the request of ODOT, scuppers could be incorporated into Alternative 1 at approximately station 35+25 and 40+50 to minimize the amount of water that would traverse the modular expansion joint and MSE embankment. If scuppers are to be given additional consideration for Alternative 1, consideration should also be given to the deck overhang used as well as the associated pier overhangs.

Utilities - No utilities will be placed on the bridge. However, lighting and ITS conduits will be provided if necessary. Alternative 1 requires the relocation of a waterline that runs parallel to Ohio River Road.

Maintenance of Traffic - While the new bridge is under construction, traffic will be maintained on US 52. Alternative 1 will use portable concrete barriers along the median and outside shoulders of US 52 placed such that 2~10' lanes with 1' clearance to the barrier can be maintained through construction of the pier foundations. The placement of the barriers will allow for a minimum clearance of 6'± to nearest foundation element. Alternatives 2A & 2B will require the placement of portable concrete barrier along the median shoulders to provide for the construction of the median pier. The close proximity of the rear abutment and MSE wall to US 52 eastbound will not allow adequate clearances to permit simultaneous work on the pier foundation and MSE wall. Construction of the two substructures will need to be phased. It is anticipated that there will be additional limited closures during construction of the new structure for significant construction events. Cost is included in each of the alternatives.

5. Proposed Structure Configurations

Alternative Discussion - The location of US 52 and Ohio River Road and their associated horizontal/vertical clearances dictated most elements of the structure configurations. The proposed crossings with each road are at skew angles of approximately 70° and 60°. The excessive skew angles will create construction issues with the turn-back MSE walls as well as structural steel, as noted in the 9/20/2005 review comments. Due to the potential construction issues associated with the high skew, it is recommended that the skew (between the reference chord and substructure units) for the proposed crossing be limited to 30° maximum. The high skews create approximately a 275' clear span between the guardrails of US 52, as measured along the baseline. Therefore, the placement of a pier in the median of US 52 is considered for all of the options. A straddle bent over US 52 was considered to eliminate the median pier. However, the straddle bent must span approximately 100' over US 52. The use of a 100' long non-redundant element was considered unacceptable and not carried forward as a feasible pier type. Using a 2 span straddle bent did not eliminate the pier column in the median of US 52, and was not considered.

The span arrangements investigated began from the median pier and placed piers or abutments at appropriate locations and skews (up to 30°) to meet the minimum horizontal clearances and other design constraints. The span configurations were refined to the layouts discussed below (and shown in the Structure Type Alternative Table).

One span configuration dismissed and not included in the detailed discussions is a four span configuration of approximately 230'-230'-140'-140'. The end spans are over US 52 EB and Ohio River Road. The four span alternative was dismissed due to the unbalanced span arrangement and the corresponding steel weight of the preliminary design trials did not indicate any savings over the other options.

Structure Types - Three alternatives have been evaluated in this Structure Type Study, and are designated as Alternative 1, 2A and 2B. The appropriate structure types that were considered are outlined in the Structure Type Alternative Table.

A preliminary bridge construction cost has been prepared for the three (3) 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.

STRUCTURE TYPE ALTERNATIVE TABLE			
Structure Type Alternative	1	2A	2B
Superstructure Type Description	5 Span Continuous Dog Legged Steel Plate Girders	3 Span Dog Legged Continuous Steel Plate Girders	3 Span Continuous Curved Steel Plate Girders
Proposed Beam Spacing	3 Spaces @ 8'-7" to 8'-7 1/2"	3 Spaces @ 8'-7 1/2" to 9'-5 3/8"	3 Spaces @ 9'-0"
No. of Spans	5 (130.0'-193.08'-193.08'-170.83'-141.5')	3 (216.0'278.92'-216.0')	3 (216.0'278.92'-216.0')
Abutment Type	Stub Type Abutments with MSE Walls	Stub Type Abutments with MSE Walls	Stub Type Abutments with MSE Walls
No. of Piers	4	2	2
Pier Type	Single Column and T-Type	Single Column and T-Type	Single Column and T-Type
Substructure Orientation	90°00'00" (to Ref Chord)	30°00'00" (to Ref. Chord)	30°00'00" (to Ref. Chord)
Approximate Bridge Length	828.50'	710.92'	710.92'
Approximate Structure Depth			
Slab	8.5"	8.75"	8.5"
Haunch	2"	2"	2"
Girder	70"	117"	117"
Total	80.5"(6.7083')	127.75"(10.64583')	127.5"(10.625')

Alternative 1

Span configuration: Alternative 1 is a 5-span bridge with spans of 130'-0", 193"-1", 193'-1", 170'-10", 141'-6". The bridge overall length is 828.50' from centerline of bearing to centerline of bearing (measured along the curve). This span arrangement was investigated in direct response to the 9/20/05 comments recommending a 5 span structure. The span arrangement meets the horizontal clearances required and as close as practical to the span ratios of ODOT BDM 205.6. The substructures are oriented normal to the reference chord between the centerlines of the bearings to minimize the excessive skews. The span layout began at the median of US 52 where a single column pier 5'-6" in diameter will be placed as discussed earlier in the Alternative discussion. Working towards the rear from the pier at US 52 (Pier-2) a T-Type pier (Pier-1) was located to provide the minimum horizontal clearance from US 52 when using Type 5 guardrail and a span length (span 2) of 193'-1". The cap of the T-Type pier will overhang the shoulder of US 52 but provide adequate clearance. Continuing toward the rear, the rear abutment is positioned to avoid an existing storm outlet. The position of the rear abutment creates an end span of 130'-0" and also provides for a span ratio of 0.67 to preclude uplift. Working forward from Pier-2, Pier-3 was located to provide for the same span length (193'-1") as the previous span. Pier-4 was located similarly to Pier-1 to overhang the shoulder of Ohio River Road. The location of Pier-4 and dimensions of the pier provide for the minimum horizontal clearance and a 170'-10" span. Continuing forward, the forward abutment was positioned to provide the minimum horizontal clearance using concrete barrier cast against the proposed MSE wall.

Substructure:

I. *Abutments:* The abutments will be stub type abutments (A-1-69) with MSE walls. DLZ recommends three different foundation options for the proposed abutments. Spread foundations bearing in the MSE wall fill were not considered for this location due to the high axial loads anticipated and also consistent with BDM section 204.4. High axial loads are anticipated however high lateral loads of uplift loads are not anticipated at the abutments allowing for the use of pipe piles. Based on this information, DLZ's recommendations, and cost estimates, TranSystems consequently believes pipe piles are the best foundation type for the abutments. The details of the abutments and MSE walls will follow ODOT Standard Construction drawings.

II. *Piers:* Three piers outside of the US 52 median (Piers 1, 3 and 4) will be T-Type piers and the pier in the median of US 52 a single column pier with a reinforced concrete cap. Due to the high skew angle it was advantageous to allow the cap of the T-Type piers to overhang the adjacent road (Piers 1 and 4) to minimize span lengths. The proximity of the road also was an important factor in the selection of the foundations for the piers. The use of drilled shafts at this location meets many of the considerations listed in Section 202.2.3.of the BDM and also allows for additional clearance for maintaining traffic. Utilizing a spread footing to support Piers 1 and 4 required temporary shoring to protect the adjacent roadways during excavation. The preliminary cost of the spread footing supported pier and temporary shoring was compared to the cost for a drilled shaft supported pier and found to be greater for the spread footing. The cost of the spread footing supported pier was approximately $10,000/pier more expensive because of the high cost of the temporary shoring. A preliminary design using a gross allowable end bearing capacity of 80 tsf results in 4 drilled shafts with 3'-6" diameter above rock and 3'-0" diameter within the rock socket. Similarly, this was investigated for Pier 3 and found that minimal temporary shoring was required for the construction of this pier when founded on a spread footing. Therefore, a spread footing is recommended at Pier 3. Utilizing a spread footing to support Pier 2 was investigated and compared to the 4 drilled shafts, however, the construction cost, including shoring, was higher. A preliminary design using a single drilled shaft with 8'-6" diameter above rock and 8'-0" diameter within the rock socket was comparable in construction cost. However, discussions with OSE staff indicated the preference for more redundancy. Analysis of the single column pier was performed for Alternative 2A, which had longer spans, and additional discussion of the preliminary design is included with that respective alternative.

Superstructure:

I. *Deck and Girders:* The preliminary design is 4 continuous welded steel plate girders, Grade 50W, with 70" deep webs. The plate girders are dog-legged to accommodate the horizontal curvature of the bridge and to permit fabrication of straight girder segments which is easier and less costly than the fabrication of curved girder segments. The straight girder segments are dog-legged at splice points and placed parallel to one another between splices. A nominal center-to-center girder spacing of 8'-7"± results in overhangs that vary from 3'-2 3/4" to 3'-11 5/8" (spacing between splice points actually varies from 8'-7" to 8'-7 1/2"± refer to the framing plan for Alternative 1). With such spacing, the 4-continuous welded steel plate girders discussed above will satisfy the HS-25 (Case I) and Alternate Military Loading as well as a Future Wearing Surface loading of 60 psf.

The bridge width is 30'-0" from toe to toe of parapets with an overall bridge deck width of 33'-0". The deck thickness is 8 1/2" including a 1" monolithic wearing surface.

Hybrid girders with Grade 70W flanges were considered for this alternative. The hybrid girder investigated had a 62" Grade 50W web with Grade 70W flanges varying form 20"x7/8" to 24"x2". The hybrid girder was inherently more flexible than the homogeneous section and required additional stiffening to satisfy fatigue and live load deflection in the positive moment regions. The AASHTO *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges* does not recommend the use of yield stresses greater than 50ksi due to a lack of research. Although the proposed structure meets the requirements in section 4.2 of the *Guide Spec* to neglect the effect of curvature we recommend that hybrid girders not be used on this structure as the applied loads will be similar to structures with more curvature.

II. *Bearings and Expansion Devices:* A preliminary evaluation of expansion devices involved designating Pier 3 as a "fixed" pier. Pier 3 was selected as the fixed pier over Pier 2 due to its ability to more efficiently support the additional loads transferred at the fixed pier. This resulted in a rear abutment expansion length of 516'-2" and a forward abutment expansion length of 312'-4". Section 306.3.3 of the ODOT Bridge Design Manual and ODOT Standard Drawing EXJ-4-87 reveal that a 4" strip seal expansion joint can be used at the forward abutment whereas a modular expansion device is needed at the rear abutment. To accommodate the large vertical reactions at the piers and abutments as well as the large horizontal displacements due to thermal expansion/contraction, pot bearings should be used and are recommended as the bearing type for Alternative 1. Pot bearings can support high vertical loads and multi-directional displacements/rotations which will occur due to the horizontal curvature of these bridges.

The initial bridge construction cost for Alternative 1 is estimated to be $6,460,000 in year 2008 dollars. The present life cycle maintenance costs for this alternative are estimated to be $3,355,000, resulting in a total estimated ownership cost of $9,815,000 in year 2008 dollars.

Alternative 2A

Span configuration: Alternative 2A is a 3-span bridge with spans of 216'-0" - 278"-11" - 216'-0". The overall bridge length is 710.92' from centerline of bearing to centerline of bearing (measured along the curve). The span arrangement meets the horizontal clearances required and the span ratios of ODOT BDM 205.6. The substructures are oriented at a 30°00'00" skew measured to the reference chord between the centerlines of the bearings to minimize the skews. The rear and forward abutments are located to provide the minimum horizontal clearance(s) using a concrete barrier. Pier-1 was located in the median of US 52 requiring the use of a single column pier, 5'-6" in diameter. Pier-2 was located in the area between US 52 and Ohio River Road to provide for the same span length for each of the end spans.

Substructure:

I. *Abutments:* The abutments for this alternative will be stub abutments, similar to Alternative 1.

II. *Piers:* At Pier 2, in the area between US 52 and Ohio River Road, a T-Type pier founded on a spread footing that bears on bedrock is recommended. A cap and column pier with 3 columns as required by the ODOT BDM Section 204.5, had slightly higher construction cost and the T-Type pier was preferred due to its common use on other structures on the bypass. Pier 1 at the median of US 52 is single column type with reinforced concrete cap and will be founded on drilled shafts embedded into bedrock. Utilizing a spread footing to support the single column pier was investigated. However, the construction cost, including shoring, was higher and required temporary paving to maintain traffic. Preliminary analysis of the single column pier using P-Delta calculation methods indicates that the use of 4500psi (Class S) concrete reinforced with bundled bars will satisfy the applied loading. Checks of the cap indicate that the applied loading can be supported without post-tensioning.

Superstructure:

I. Girders and Deck: The superstructure for this alternative consists of 4-continuous welded steel plate girders, Grade 50W, with 117" deep webs. The design loading applied was HS-25 (Case I) and Alternate Military Loading as well as a Future Wearing Surface loading of 60 psf. As with Alternative 1, straight girder segments are placed parallel to one another between splice points and the girders are dog-legged at the splices to accommodate the horizontal curvature. Splices have been positioned in an effort to shorten, as best as possible, the length of straight girder segments, thus allowing a larger number of fabricators to bid on the steel superstructure (shorter length sections permit truck transportation to the site and are thus not strictly dependent on barge transportation). A nominal center-to-center girder spacing of 9'-0"± results in overhangs that vary from 4'-0" to 1'-7 13/16" (spacing between splice points actually varies from 8'-7 1/2" to 9'-5 3/8"± refer to the framing plan for Alternative 2A). Due to the increased span lengths and skew of this structure the deflection angles at the splice points are greater and the beam spacing or overhangs more variable when compared to the layout of Alternative 1. The differential deflections due to the total slab weight were investigated in accordance with Section 302.2.7 of the BDM. The preliminary analysis indicates that a girder design that satisfies the strength requirements has adequate stiffness to minimize differential deflections between adjacent girder points to less than ½". The preliminary analysis only considered the weight of the concrete applied to the whole structure and not the pour sequence, which could cause higher deflections. It is recommended that the pour sequence also be given consideration in the final girder design. It is also recommended that checks of the lateral bending stress in the flanges due to the overhang/construction loads at the exterior girder be performed and incorporated in the cross frame and girder design in accordance with Section 13.8 of the AASHTO *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges*. Hybrid girders were not considered due to the curvature and lower stiffness of a hybrid girder that would result in greater cross frame forces and more lateral bending in the flanges.

The bridge has a 30'-0" width from toe-to-toe of parapet with an overall bridge deck width of 33'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 3/4".

II. Bearings and Expansion Devices: A preliminary evaluation of expansion devices involved designating Pier 2 as a "fixed" pier. Pier 2 was selected as the fixed pier over Pier 1 due to its ability to more efficiently support the additional loads transferred at the fixed pier. This resulted in a rear abutment expansion length of 494'-11" and a forward abutment expansion length of 216'-0". Section 306.3.3 of the ODOT Bridge Design Manual and ODOT Standard Drawing EXJ-4-87 reveal that a 4" strip seal expansion joint can be used at the forward abutment whereas a modular expansion device is needed at the rear abutment. Note that these results are based on a simple preliminary evaluation of the bridge system and ignore, for now, the effects of horizontal curvature. To accommodate the large vertical reactions at the piers and abutments as well as the large horizontal displacements due to thermal expansion/contraction, pot bearings should be used, and are recommended, as the bearing type for Alternative 2A. Pot bearings can support high vertical loads and multi-directional displacements/rotations which will occur due to the horizontal curvature of these bridges.

The initial bridge construction cost for Alternative 2A is estimated to be $7,780,000 in year 2008 dollars. The present life cycle maintenance costs for this alternative are estimated to be $4,066,000, resulting in a total estimated ownership cost of $11,846,000 in year 2008 dollars.

Alternative 2B

Span configuration and Substructure: Alternative 2B is a 3-span bridge with spans of 216'-0" - 278"-11" - 216'-0" identical to that of Alternative 2A. The substructures will also be the same as described for Alternative 2A.

Superstructure:

I. *Girders and Deck:* The superstructure for this alternative consists of 4-continuous welded steel plate girders, Grade 50W, with 117" deep webs. The design loading applied was HS-25 (Case I) and Alternate Military Loading as well as a Future Wearing Surface loading of 60 psf. This alternative is differs from Alternative 2A in that curved girders are recommended with uniform overhang widths. The girders were spaced at 9'-0", with 3'-0" overhangs. The preliminary analysis indicates that a girder design that satisfies the strength requirements has adequate stiffness to minimize differential deflections between adjacent girder points to less than ½". The preliminary analysis only considered the weight of the concrete applied to the whole structure and not the pour sequence, which could cause higher deflections. It is recommended that the pour sequence also be given consideration in the final girder design. It is also recommended that checks of the lateral bending stress in the flanges due to the overhang/construction loads at the exterior girder be preformed and incorporated in the cross frame and girder design in accordance with Section 13.8 of the AASHTO *Guide Specifications for Horizontally Curved Steel Girder Highway Bridges*. Hybrid girders were not considered due to the curvature.

The bridge has a 30'-0" width from toe-to-toe of parapet with an overall bridge deck width of 33'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2".

The initial bridge construction cost for Alternative 2Bis estimated to be $7,910,000 in year 2008 dollars. The present life cycle maintenance costs for this alternative are estimated to be $4,049,000, resulting in a total estimated ownership cost of $11,959,000 in year 2008 dollars.

6. Recommendations:

Based upon the above information and discussions, we recommend Structure Type Alternative 1, a 5-span, 70" dog legged steel girder with T-Type pier at 1,3&4, single column pier with reinforced concrete cap at Pier 2, and stub type abutments supported on piles with MSE walls. See Appendix B for the Site Plan and Structure Details.

Our recommendation for Alternative 1 is based on the following items:

- Lowest construction and total ownership cost of the alternatives investigated.
- Lower construction complexity due to lower skew angle and shorter span lengths.
- Less complex maintenance of traffic due to larger horizontal clearances at the eastbound lanes of US 52.
- Improved serviceability due to lower skew angle (such as girder distortions, out-of-plane bending, etc.)

APPENDIX A

Cost Comparison Summary

TranSystems

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY

By: PJP Date: 10/13/2006
Checked: JRC Date: 11/15/2006

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	5	130'-0" - 193'-1" - 193'-1" - 170'-10" - 141'-6"	828.50	4 Dog-Legged Steel Plate Girders	70" Web Grade 50W	$2,781,000	$1,863,000	$743,000	$1,077,400	$6,460,000	$3,355,000	$9,815,000
2A	3	216'-0" - 278'-11" - 216'-0"	710.92	4 Dog-Legged Steel Plate Girders	117" Web Grade 50W	$3,327,000	$2,265,000	$894,700	$1,297,300	$7,780,000	$4,066,000	$11,846,000
2B	3	216'-0" - 278'-11" - 216'-0"	710.92	4 Curved Steel Plate Girders	117" Web Grade 50W	$3,416,000	$2,265,000	$909,000	$1,318,000	$7,910,000	$4,049,000	$11,959,000

NOTES:

1. Structure incidental cost allowance includes provision for structure excavation, porous backfill, sealing of concrete surfaces, 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.

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 1 - SUPERSTRUCTURE

By: PJP
Checked: JRC

Date: 10/13/2006
Date: 11/15/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement 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)	Structural Steel Cost	Expansion Joint Cost	Subtotal Superstructure Cost
1	5	130'-0" - 193'-1" - 193'-1" - 170'-10" - 141'-6"	828.50	830.50	1053	$630,700	$264,100	$41,600	$0	4 Dog-Legged Steel Plate Girders	70" Web Grade 50W	1,411,800	$1,800,100	$44,500	**$2,781,000**

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.)
Bridge	0.71	33.00	23.4	2.3	34.2

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

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2008	
Rolled Beams - Grade 50	n/a	$0.95	3.5%	$1.05	
Level 4 Plate Girders - Grade 50W	n/a	$1.05	3.5%	$1.16	Straight Girders
Level 4 Plate Girders - Grade 50W	n/a	$1.15	3.5%	$1.28	Dog Legged Girders
Level 4 Plate Girders - Grade 70W	n/a	$1.30	3.5%	$1.44	Dog Legged Girders
			Weighted Average =	$1.38	

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 =			$599.00

Based on parapet and slab percentages
of total concrete area

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

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

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):
Length = 30 ft. Width = 33 ft
Area = 220 sq. yd.

	Year 2004	Annual Escalation	Year 2008
Approach Slabs	$165.00	3.5%	$189.00

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

	Cost Ratio	Year 2005	Annual Escalation	Year 2008
Modular Expansion Joint	1.0	$907.42	3.5%	#######
Strip Seal Expansion Joints	1.0	$306.27	3.5%	$339.57

Modular Expansion Joints Length 33 ft.
Strip Seal Expansion Joints Length 33 ft.

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

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 1 - SUBSTRUCTURE

By: PJP Date: 10/13/2006
Checked: JRC Date: 11/15/2006

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	Drilled Shaft Foundation Cost	MOT and Shoring Cost	Subtotal Substructure Cost
1	5	130'-0" - 193'-1" - 193'-1" - 170'-10" - 141'-6"	4 Dog-Legged Steel Plate Girders	70" Web Grade 50W	$197,100	$44,900	$53,600	$8,800	$43,800	$1,421,300	$34,800	$59,100	**$1,863,000**

COST SUPPORT CALCULATIONS

Pier QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Cap	126	$421.00	3.5%	$483.00	$60,860
Stem	156	$421.00	3.5%	$483.00	$75,350
Footings	126	$421.00	3.5%	$483.00	$60,860
Total	408				$197,100

Pier QC/QA Concrete, Class QSC1 Cost:

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	111	$421.00	3.5%	$483.00	$53,600
Wingwalls	0	$421.00	3.5%	$483.00	$0

Note: Turn back MSE walls used

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

Pile Foundation Unit Cost ($/ft.): *14" Dia. CIP Piles, Furnished & Driven*

Number of Piles		Total Pile Length
24	SEE QUANTITY CALCULATIONS	960

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$13.05	3.5%	$15.00
Driven	$26.70	3.5%	$30.60
Total			$45.60

Shaft Foundation Unit Cost ($/ft.): Pier Foundations

	Number of Shafts		Total Shaft Length
36" into Bedrock	8		40
42" above Bedrock	8		56
36" into bedrock	4	SEE QUANTITY CALCULATIONS	20
42" above bedrock	4		56

Shaft Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008	Total Cost
36" into Bedrock	$175.00	3.5%	$201.00	$8,100.00
42" above Bedrock	$175.00	3.5%	$201.00	$11,300.00
36" into bedrock	$175.00	3.5%	$201.00	$4,100.00
42" above bedrock	$175.00	3.5%	$201.00	$11,300.00
Cost of Shafts:				**$34,800.00**

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

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 1	23,300	$55.00	3.5%	$61.00

Note: MSE wingwall lengths include full length required for ramp

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

Maintenance of Traffic Cost

$ 25,000

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

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

By: PJP
Checked: JRC

Date: 10/13/2006
Date: 11/15/2006

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	Depth	Area	Volume	Width	Height	Length		Volume	Width	Depth	Length		Volume	
Pier 1 (DS)	31	4	6.08	24.32	754	4	21	11.0		924	15	3.5	15.00		788	2465
Pier 2 (DS)	31	5	7.35	36.75	1139	4.9	23	4.9		552	15	3.5	15.00		788	2479
Pier 3 (Spr. Ftg.	31	4	6.08	24.32	754	4	37.5	11.0		1650	15	3.5	20.00		1050	3454
Pier 4 (DS)	31	4	6.08	24.32	754	4	24.5	11.0		1078	15	3.5	15.00		788	2619
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					**3401**					**4204**					**3413**	**11018**
Total (Cu.Yd.)					**126**					**156**					**126**	**408**

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	12	561.9	523.1	40.0	480
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	12	584.6	548.1	40.0	480
Total								24				960

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	33.3	1.75	7	12.25	408	3.75	1.5	5.63		187	9	3	27	1	899	1494
Fwd. Abut	33.3	1.75	7	12.25	408	3.75	1.5	5.63		187	9	3	27	1	899	1494
Total (Cu.Ft.)					**816**					**375**					**1798**	**2989**
Total (Cu.Yd.)					**30**					**14**					**67**	**111**

Drilled Shafts

Location	Drilled Shafts Into Bedrock: Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Shaft Length Into Rock (Ft)		Drilled Shafts Above Bedrock: Top Elev.	Bot Elev.	Shaft Length	Shaft Length Above Rock (Ft)
Rear Abut.	0	0	0	0.0	0		0	0	0.0	0
Pier 1	4	530.9	525.9	5.0	20		540.8	530.9	10.0	40
Pier 2	4	532.8	527.8	5.0	20		546.5	532.8	14.0	56
Pier 3	0	0	0	0.0	0		0	0	0.0	0
Pier 4	4	549.5	544.5	5.0	20		553.5	549.5	4.0	16
Pier 5	0	0	0	0.0	0		0	0	0.0	0
Pier 6	0	0	0	0.0	0		0	0	0.0	0
Pier 7	0	0	0	0.0	0		0	0	0.0	0
Fwd. Abut.	0	0	0	0.0	0		0	0	0.0	0
Total	12				60					112

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	Length	Area	Volume
Rear Abut		25.1	34	853	
RA Wing (L)		26.425	432	11416	
RA Wing (R)		29.425	203	5973	
Fwd Abut		29.6	34	1006	
FA Wing (L)		22.7	105	2381	
FA Wing (R)		40.35	40	1614	
Total (Sq.Ft.)				**23300**	

Temporary Cofferdams

Location		Wall			
		Height	Length	width	Area
Pier 1		12	20	0	240
Pier 2		15	52	0	780
Pier 4		10	30	0	300
Total (Sq.Ft.)					1320

Superstructure Steel Quantities

Location	Wt.of girder (lb)/ft	# Girders	Span Length	Total Weight
Span 1	426	4	130.00	221520
Span 2	426	4	193.08	329014
Span 3	426	4	193.08	329014
Span 4	426	4	170.83	291100
Span 5	426	4	141.50	241116
Span 6		0	0.00	0
Span 7		0	0.00	0
Span 8		0	0.00	0
Total			828.50	1411800

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2A AND 2B - SUPERSTRUCTURE

By: PJP Date: 10/13/2006
Checked: JRC Date: 11/15/2006

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	Structural Steel Weight (pounds)	Structural Steel Cost	Expansion Joint Cost	Subtotal Superstructure Cost
2A	3	216'-0" - 278'-11" - 216'-0"	710.92	712.92	924	$552,500	$231,700	$41,600	$24,300	4 Dog-Legged Steel Plate Girders	117" Web Grade 50W	1,902,500	$2,425,700	$51,200	**$3,327,000**
2B	3	216'-0" - 278'-11" - 216'-0"	710.92	712.92	904	$540,500	$226,700	$41,600	$24,300	4 Curved Steel Plate Girders	117" Web Grade 50W	1,902,500	$2,531,200	$51,200	**$3,416,000**

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.)
Alt. 2A	0.73	33.00	24.1	2.4	35.0
Alt. 2B	0.71	33.00	23.4	2.3	34.2

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 =			$598.00

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	$0.95	3.5%	$1.05	
Level 4 Plate Girders - Grade 50W	n/a	$1.15	3.5%	$1.28	Dog-Legged Girders
Level 5 Plate Girders - Grade - 50W	n/a	$1.20	3.5%	$1.33	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 = 33 ft
Area = 220 sq. yd.

	Year 2004	Annual Escalation	Year 2008
Approach Slabs	$165.00	3.5%	$189.00

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

	Cost Ratio	Year 2005	Annual Escalation	Year 2008
Modular Expansion Joint	1.0	$907.42	3.5%	$1,006.07
Strip Seal Expansion Joints	1.0	$306.27	3.5%	$339.57

Modular Expansion Joints Length 38 ft.
Strip Seal Expansion Joints Length 38 ft.

Approach Roadway

	Quantity	Year 2005	Annual Escalation	Year 2008	
Embankment fill	0.00 cu.yd.	$4.00	3.5%	$4.43	Included in MSE wall estimate
Roadway incl. base	391.93 sq.yd.	$26.00	3.5%	$28.83	
Barrier (single faced)	235.16 ft.	$50.00	3.5%	$55.44	
Barrier (dble faced)	0 ft.	$80.00	3.5%	$88.70	

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2A AND 2B - SUBSTRUCTURE

By: PJP
Checked: JRC

Date: 10/13/2006
Date: 11/15/2006

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	MOT and Shoring Cost	Drilled Shaft Foundation Cost	Subtotal Substructure Cost
2A	3	216'-0" - 278'-11" - 216'-0"	4 Dog-Legged Steel Plate Girders	117" Web Grade 50W	$117,900	$26,800	$58,000	$9,500	$41,000	$1,933,700	$35,200	$42,700	**$2,265,000**
2B	3	216'-0" - 278'-11" - 216'-0"	4 Curved Steel Plate Girders	117" Web Grade 50W	$117,900	$26,800	$58,000	$9,500	$41,000	$1,933,700	$35,200	$42,700	**$2,265,000**

COST SUPPORT CALCULATIONS

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

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Alt 2A & 2B Total Cost
Cap	80	$421.00	3.5%	$483.00	$38,640
Stem	81	$421.00	3.5%	$483.00	$39,120
Footings	83	$421.00	3.5%	$483.00	$40,090
Total	244				$117,900

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

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Alt 2A & 2B 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	120	$421.00	3.5%	$483.00	$58,000
Wingwalls	0	$421.00	3.5%	$483.00	$0

Note: Turn back MSE walls used

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. 2A & 2B	31,700	$55.00	3.5%	$61.00

Note: MSE wingwall lengths include full length required for ramp

Pile Foundation Unit Cost ($/ft.):

14" CIP Piles, Furnished & Driven

	Number of Piles		Total Pile Length
Alt. 2A & 2B	24	SEE QUANTITY CALCULATIONS	900

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$13.05	3.5%	$15.00
Driven	$26.70	3.5%	$30.60
Total			$45.60

Shaft Foundation Unit Cost ($/ft.):

Pier 1 Foundation

	Number of Shafts		Total Shaft Length
48" into bedrock	4		20
54" above bedrock	4	SEE QUANTITY CALCULATIONS	56

Shaft Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008	Total Cost
48" into bedrock	$600.00	3.5%	$689.00	$13,800.00
54" above bedrock	$450.00	3.5%	$516.00	$28,900.00
			Cost of Shafts:	**$42,700.00**

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

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 2A & 2B	0	$ -

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

Maintenance of Traffic Cost

$ 15,000

SCI-823-0.00 - PORTSMOUTH BYPASS

Proposed SR 823 Ramp US 52 B over US 52 and Ohio River Road

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 2A AND 2B - QUANTITY CALCULATIONS

By: PJP Date: 10/13/2006
Checked: JRC Date: 11/15/2006

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Length*		*Volume*	*Width*	*Depth*	*Length*		*Volume*	
Pier 1 (DS)	36	5	6.59	32.95	1186	4.9	20	4.90		480	18.5	3.5	18.50		1198	2864
Pier 2 (Spr. Ftg.	36	4	6.67	26.68	960	4	35.5	12.00		1704	15	3.5	20.00		1050	3714
Pier 3																0
Pier 4																0
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					**2147**					**2184**					**2248**	**6579**
Total (Cu.Yd.)					**80**					**81**					**83**	**244**

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	*12*	561.7	523.1	40.0	*480*
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	*12*	580.5	548.1	35.0	*420*
Total								24				900

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	38.1	1.75	10.4167	18.23	695	3.75	1.5	5.63		214	6.25	3	18.75	1	714	1623
Fwd. Abut	38.1	1.75	10.4167	18.23	695	3.75	1.5	5.63		214	6.25	3	18.75	1	714	1623
Total (Cu.Ft.)					**1389**					**429**					**1429**	**3246**
Total (Cu.Yd.)					**51**					**16**					**53**	**120**

Drilled Shafts

Drilled Shafts Into Bedrock							Drilled Shafts Above Bedrock			
Location	Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Shaft Length		Top Elev.	Bot Elev.	Shaft Length	Shaft Length Above Rock (Ft)
Rear Abut.	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 1	*4*	532.8	527.8	5.0	*20*		546.5	532.8	14.0	*56*
Pier 2	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 3	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 4	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 5	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 6	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Pier 7	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Fwd. Abut.	*0*	0	0	0.0	*0*		0	0	0.0	*0*
Total	4				20					56

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		21.5	38	817	
RA Wing (L)		26.5	551	14602	
RA Wing (R)		29.5	350	10325	
Fwd Abut		26.5	38	1007	
FA Wing (L)		23.0	104	2392	
FA Wing (R)		41	60	2460	
Total (Sq.Ft.)				**31700**	

Temporary Cofferdams

Location		Wall			
		Height	*Length*	*width*	*Area*
Pier 1		0	0	0	0
Pier 2		15	52	0	780
Pier 4		0	0	0	0
Total (Sq.Ft.)					780

Superstructure Steel Quantities

Location	Wt.of girder (lb)/ft	# Girders	Span Length	Total Weight
Span 1	669	4	216.00	578016
Span 2	669	4	278.92	746381
Span 3	669	4	216.00	578016
Span 4		0	0.00	0
Span 5		0	0.00	0
Span 6		0	0.00	0
Span 7		0	0.00	0
Span 8		0	0.00	0
Total			710.92	1902500

By: PJP Date: 10/13/2006
Checked: JRC Date: 11/15/2006

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	Sealing of Concrete Surfaces 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	5	828.50	4 Dog-Legged Steel Plate Girders	$948,290	2	$1,896,580	$49,217	2	$98,435	$0	10	$0
2A	3	710.92	4 Dog-Legged Steel Plate Girders	$1,191,680	2	$2,383,360	$56,684	2	$113,367	$1,800	10	$18,000
2B	3	710.92	4 Curved Steel Plate Girders	$1,191,680	2	$2,383,360	$56,684	2	$113,367	$1,800	10	$18,000

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	5	828.5	4 Dog-Legged Steel Plate Girders	$82,900	$100,500	$11,125	1	$194,525	$630,700	$264,100	$44,500	$226,400	1	$1,165,700	$3,355,000	$6,460,000	$9,815,000
2A	3	710.92	4 Dog-Legged Steel Plate Girders	$142,200	$172,500	$12,800	1	$327,500	$552,500	$231,700	$51,200	$388,500	1	$1,223,900	$4,066,000	$7,780,000	$11,846,000
2B	3	710.92	4 Curved Steel Plate Girders	$142,200	$172,500	$12,800	1	$327,500	$540,500	$226,700	$51,200	$388,500	1	$1,206,900	$4,049,000	$7,910,000	$11,959,000

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	70	4	828.50	25.00	59,376	20%	71,300
Alt. 2A	117	4	710.92	27.00	74,647	20%	89,600
Alt. 2B	117	4	710.92	27.00	74,647	20%	89,600

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

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
0	0	0.00	0	10%	0

Sealing Cost per sq. yd.:

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

MSE Wall Sealing

	Wall Area (sq.ft.)
Alt. 1	23300
Alt. 2A	31700
Alt. 2B	31700

Bridge Redecking:

Bridge Deck Joint Cost per foot:

	Year 2005	Annual Escalation	Year 2008
Modular Expansion Joint	$907.42	3.5%	$1,006.07
Strip Seal Expansion Joints	$306.27	3.5%	$339.57

	Bridge Width	No. Joints
Alt. 1	33.00	2
Alt. 2	38.11	2

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 1	27,341	$8.28	$226,400
Alt. 2A	46,921	$8.28	$388,500
Alt. 2B	46,921	$8.28	$388,500

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	27,341	3,038	76	69
Alt. 2A	46,921	5,213	130	118
Alt. 2B	46,921	5,213	130	118

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
Modular Expansion Joint Gland	$226.86	3.5%	$251.52
Elastomeric Strip Seal Gland	$76.57	3.5%	$84.89

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. Seals assumed to be replaced at each overlay and complete replacement at redeck.
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:

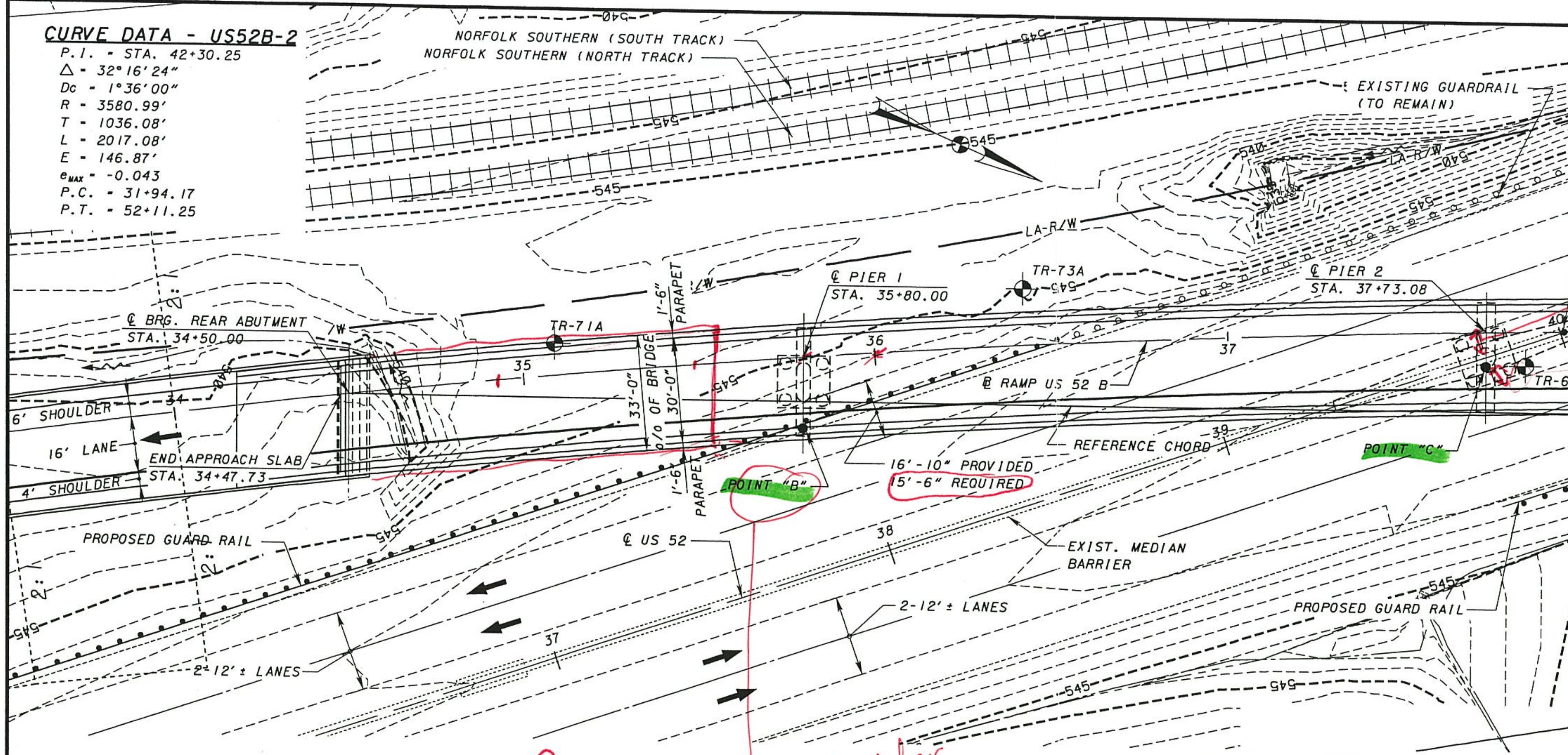
	Year 2004	Annual Escalation	Year 2008
Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254)	$0.98	3.5%	$1.12
Asphalt Concrete Surface Course, per cu. yd.	$72.00	3.5%	$82.62

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	0.0	0	1.50	0.0
Alt. 2A	117.6	30.0	392	1.50	16.3
Alt. 2B	117.6	30.0	392	1.50	16.3

APPENDIX B
Preferred Alternative Site Plan and Details

TranSystems



PLAN

LEGEND

⊕ - BORING LOCATION

NOTES:

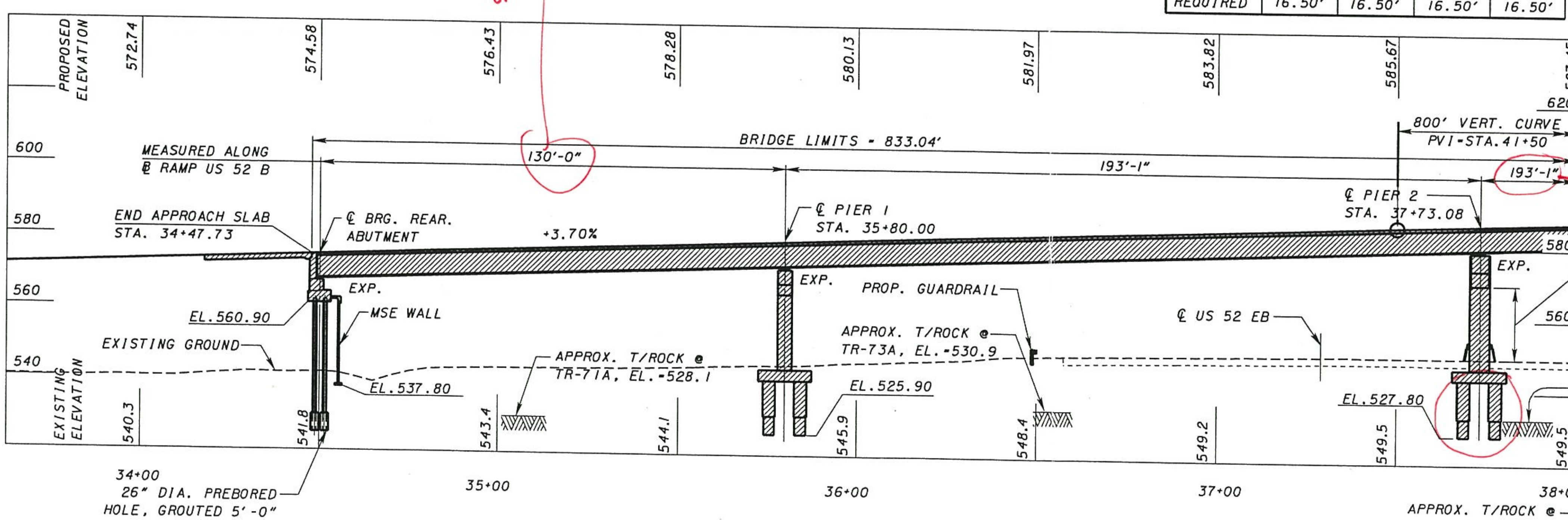
1. ALL SHEETS WITH PLAN DIMENSIONS ARE SHOWN HORIZONTAL.
2. EARTHWORK LIMITS SHOWN ARE APPROXIMATE. ACTUAL SLOPES SHALL CONFORM TO PLAN CROSS SECTIONS.
3. THE PROPOSED PROFILE GRADE IS WITHIN BRIDGE LIMITS. SEE ROADWAY PLANS FOR PAVEMENT ELEVATIONS BEYOND BRIDGE LIMITS.

FOUNDATION DATA:

PILES AT REAR AND FWD. ABUTMENT SHALL BE 14" CIP AND HAVE A MAXIMUM CAPACITY OF 70 TONS PER PILE. ALLOWABLE BEARING CAPACITY FOR SPREAD FOOTINGS ON ROCK, 40 TSF. ALLOWABLE BEARING CAPACITY FOR DRILLED SHAFT, 40 TSF.

TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"	"C"	"D"
PROPOSED	28.59'	17.94'	19.58'	23.10'
REQUIRED	16.50'	16.50'	16.50'	16.50'



PROFILE ALONG ℄ RAMP US 52 B

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

TRAFFIC DATA

(RAMP B)
CURRENT YEAR ADT (2010) - 13400
DESIGN YEAR ADT (2030) - 21000
CURRENT YEAR ADTT (2010) - 1876
DESIGN YEAR ADTT (2030) - 2940

PROPOSED STRUCTURE

TYPE: 5 SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W, DOG LEG AT SPLICES WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS.

SPANS: 130' - 191'-1" - 191'-1" - 170'-10" - 141'-6" (how measured)

ROADWAY: 30'-0" T/T OF PARAPETS

LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING, FWS - 60 PSF

SKEW: NONE (MEASURED TO REFERENCE CHORD)

SUPERELEVATION: 0.043 FT/FT

ALIGNMENT: 1°36'00" CURVE TO THE RIGHT

WEARING SURFACE: MONOLITHIC CONCRETE

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

LATITUDE:

LONGITUDE:

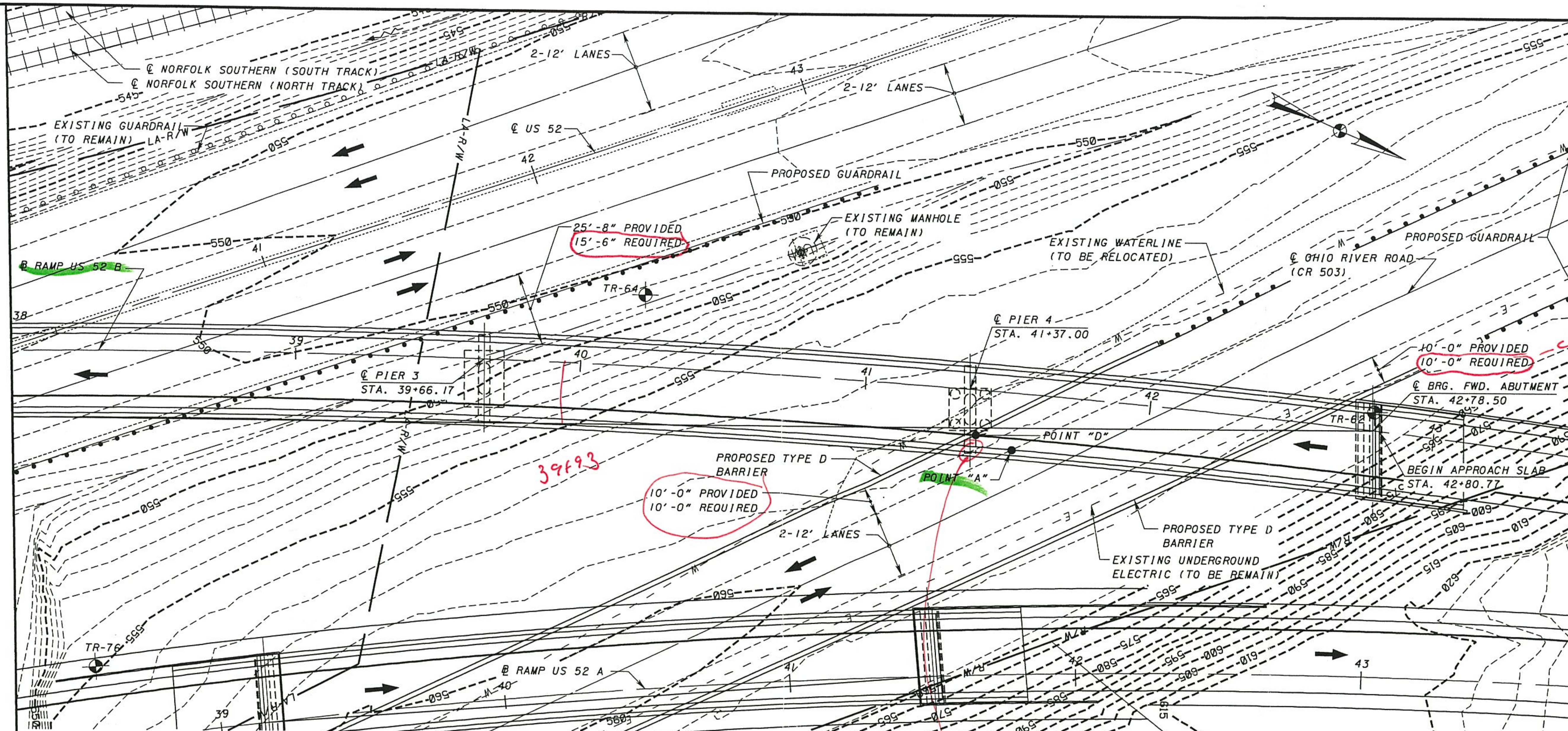
DESIGN AGENCY: TranSystems, 5747 PERIMETER DRIVE, SUITE 240, DUBLIN, OHIO 43017

DESIGNED PJP	DRAWN CAS	REVIEWED JRC	DATE 11/17/06
CHECKED WSL	REVISED	STRUCTURE FILE NUMBER	

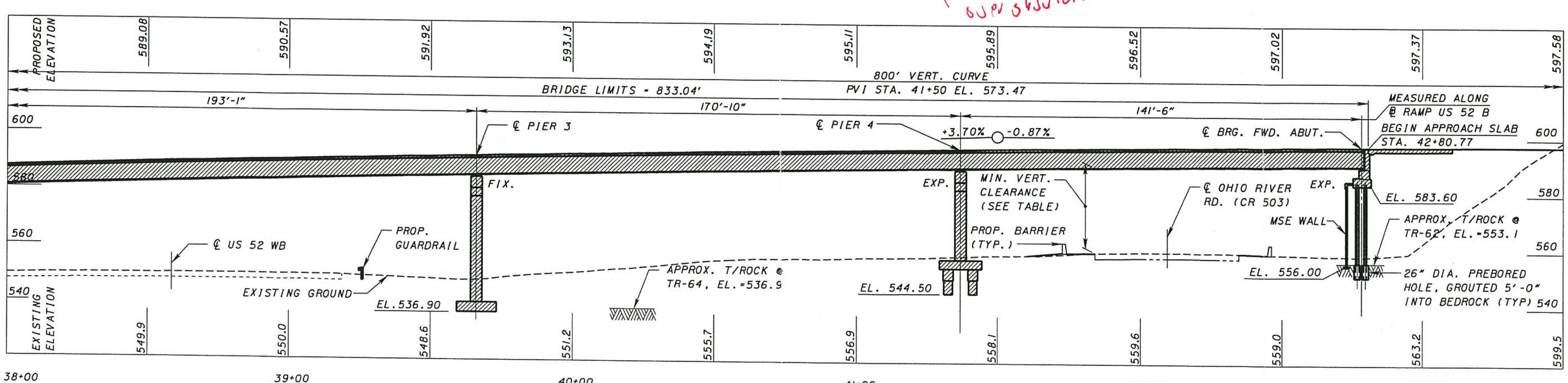
SCIOTO COUNTY STA. 34+47.73 STA. 42+80.77

SITE PLAN - ALTERNATIVE I
BRIDGE NO. SCI-823-XXX
SR 823 RAMP US52 B OVER US 52 AND CR-503

SCI-823-0.00
PID 77366



PLAN



ELEVATION ALONG PROFILE GRADE ℄ RAMP B

DESIGN AGENCY: TranSystems

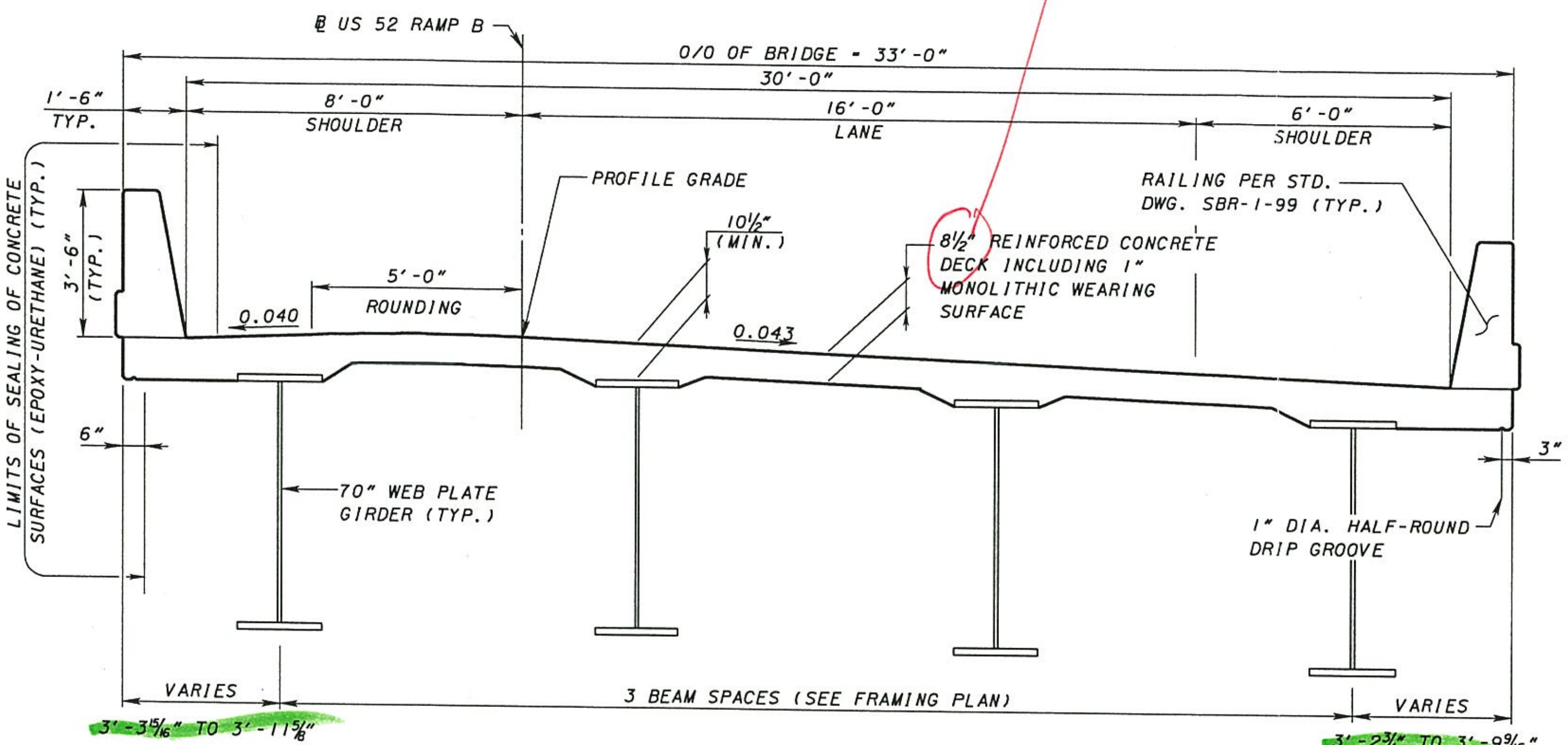
DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	11/17/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	
MSL			

SCIOTO COUNTY
STA. 34+47.73
STA. 42+80.77

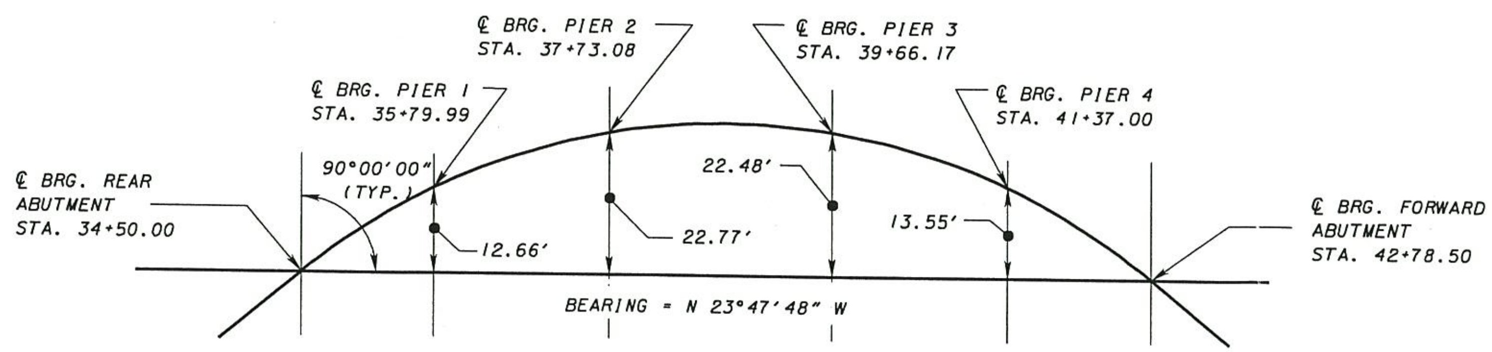
SITE PLAN - ALTERNATIVE I
BRIDGE NO. SCI-823-XXXX
SR 823 RAMP US 52 B OVER US 52 AND CR 503

SCI-823-0.00
PID 77366

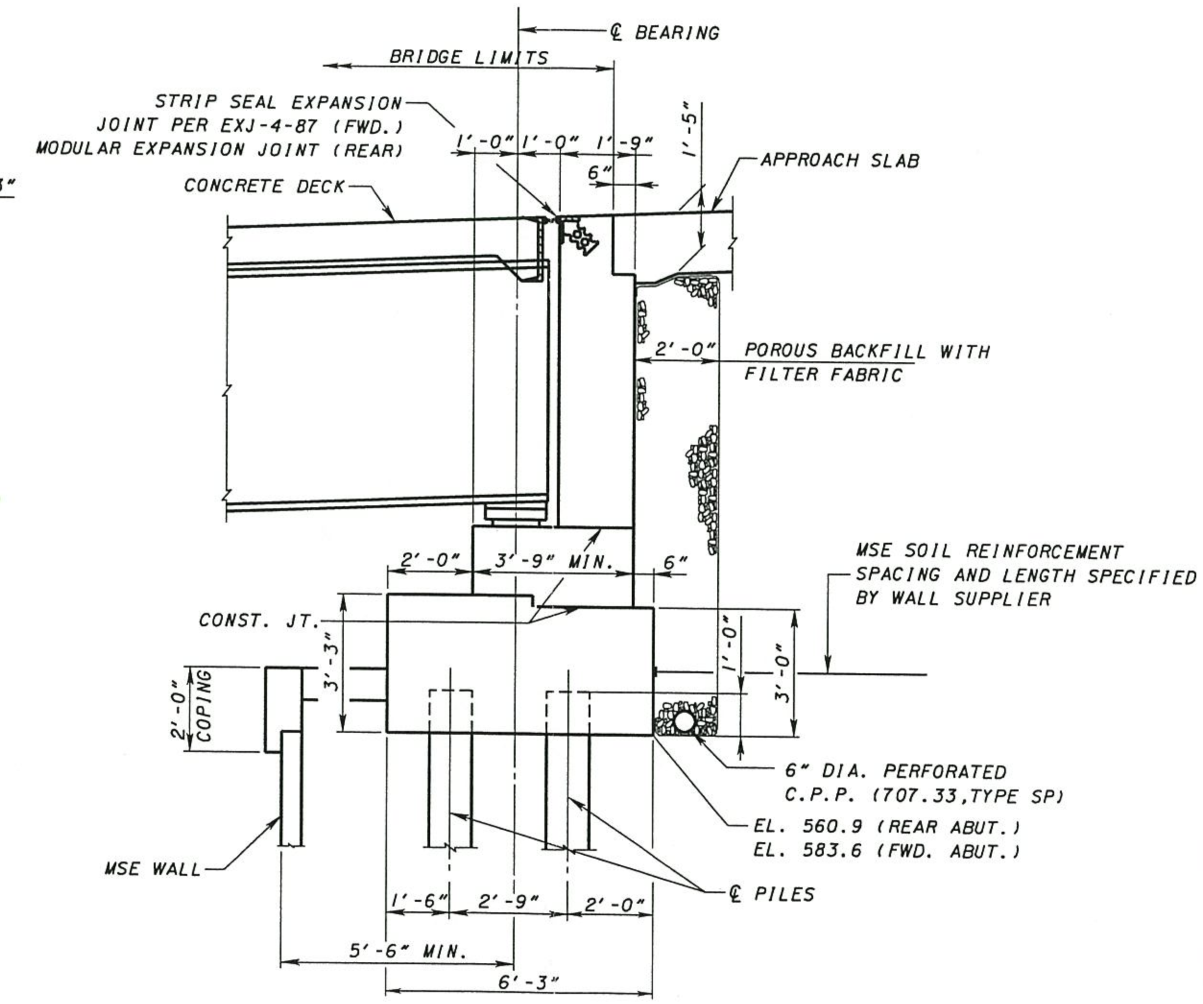
2 / 5



TYPICAL TRANSVERSE SECTION



REFERENCE CHORD SCHEMATIC ALT 1



TYPICAL ABUTMENT SECTION

DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	11/16/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	
MSL			

TYPICAL TRANSVERSE AND ABUTMENT SECTIONS - ALT 1

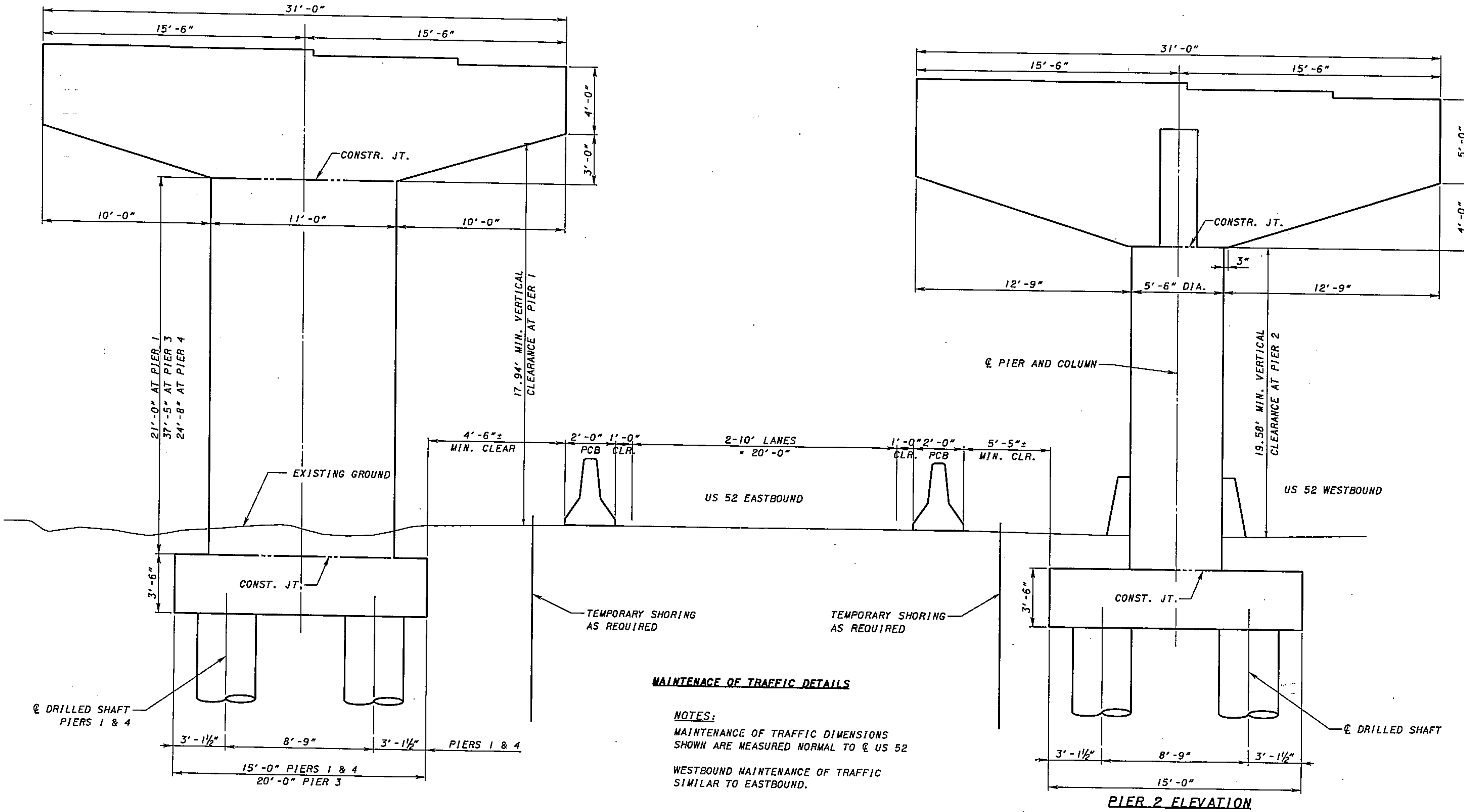
BRIDGE NO. SCI-823-XXXX

SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00

PID 77366

3 / 5



MAINTENACE OF TRAFFIC DETAILS

NOTES:

MAINTENANCE OF TRAFFIC DIMENSIONS SHOWN ARE MEASURED NORMAL TO ℄ US 52

WESTBOUND MAINTENANCE OF TRAFFIC SIMILAR TO EASTBOUND.

DESIGN AGENCY: TranSystems

DESIGNED PJP | CHECKED MSL | DRAWN CAS | REVISED | REVIEWED JRC | DATE 11/16/06 | STRUCTURE FILE NUMBER

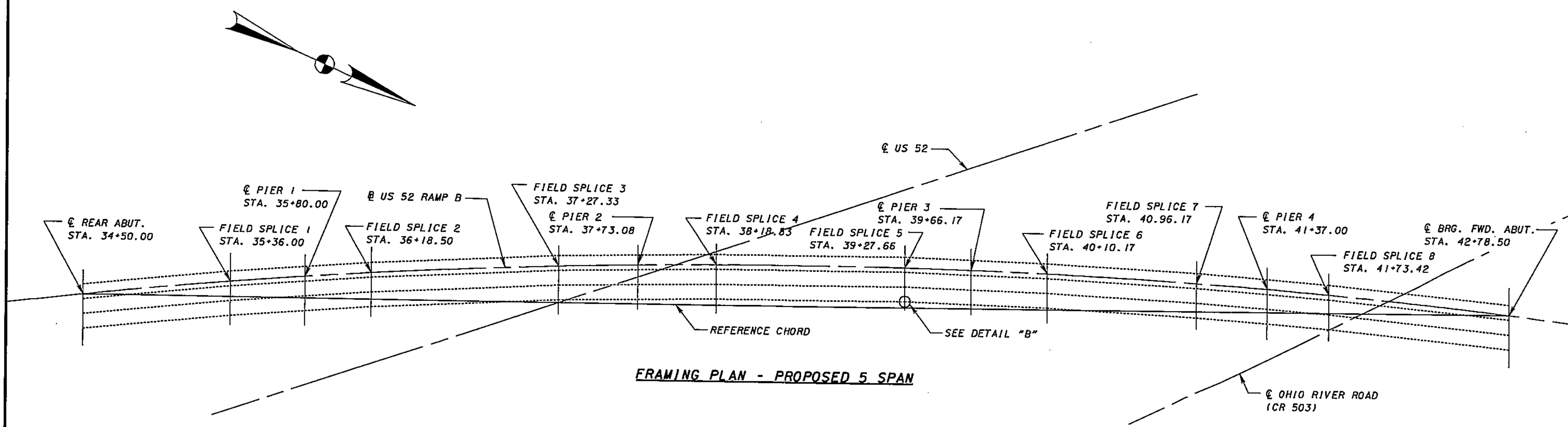
TYPICAL PIER SECTIONS - ALT1

BRIDGE NO. SCI-823-XXXX

SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00

PID 77366



FRAMING PLAN - PROPOSED 5 SPAN

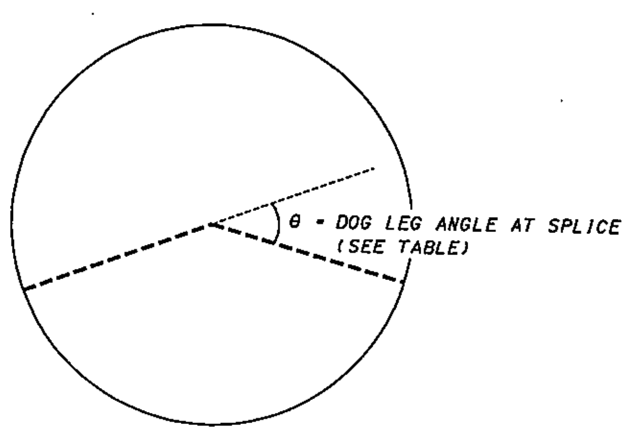
DOG LEG ANGLE AT SPLICES

LOCATION	STATION	θ
SPLICE 1	STA. 35+36.00	1.36°
SPLICE 2	STA. 36+18.50	1.40°
SPLICE 3	STA. 37+27.33	1.89°
SPLICE 4	STA. 38+18.83	1.32°
SPLICE 5	STA. 39+27.66	1.84°
SPLICE 6	STA. 40+10..17	1.18°
SPLICE 7	STA. 40+96.17	1.30°
SPLICE 8	STA. 41+73.42	1.42°

GIRDER LENGTH AND SPACING

FROM	TO	GIRDER LENGTH	GIRDER SPACING *
℄ BRG. REAR. ABUT.	SPLICE 1	86.00'	3 @ 8.58'
SPLICE 1	SPLICE 2	82.50'	3 @ 8.60'
SPLICE 2	SPLICE 3	108.84'	3 @ 8.62'
SPLICE 3	SPLICE 4	91.49'	3 @ 8.63'
SPLICE 4	SPLICE 5	108.83'	3 @ 8.63'
SPLICE 5	SPLICE 6	82.64'	3 @ 8.63'
SPLICE 6	SPLICE 7	85.87'	3 @ 8.62'
SPLICE 7	SPLICE 8	77.25'	3 @ 8.61'
SPLICE 8	℄ BRG. FWD. ABUT.	105.07'	3 @ 8.59'

* GIRDER SPACING IS MEASURED NORMAL TO GIRDER CENTERLINE



DETAIL "B"

DESIGN AGENCY TranSystems

DESIGNED PJP | DRAWN CAS | REVIEWED JRC 11/16/06 | CHECKED MSL | REVISED | STRUCTURE FILE NUMBER

FRAMING PLAN - ALTERNATIVE 1

BRIDGE NO. SCI-823-XXXX

SR 823 US52 RAMP B OVER US52 AND CR 503

SCI-823-0.00

PID 77366

5/5

APPENDIX C

Vertical Clearance Calculations

TranSystems

TranSystems

Made By	PJP	Date	09/22/06	Job No.	P403030064
Checked By	MTN	Date	10/26/06	Sheet No.	

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternative 1 - 4-70" Steel Plate Girders | ***Point Location:*** ***A***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	20.08		-0.86
		Total Adjustment		=	**-0.86**

Superstructure Depth

Comment	Depth (in)	Depth (ft)		
Deck Thickness:	8.5	0.71		
Haunch:	2	0.17		
Girder or Beam Depth:	73	6.08		
	83.5	6.96		
Total Superstructure Depth (ft)			=	**6.96**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**41+53.39**
Offset Location @ Critical Point	=	**20.08' Rt.**
Profile Grade Elevation at Critical Point	=	595.94
Adjustment for Cross Slopes to Beam CL	=	-0.86
Top of Deck Elevation @ Critical Point	=	**595.07**
Total Superstructure Depth	=	-6.96
Bottom of Beam Elevation @ Critical Point	=	**588.11**
Top of Pavement @ Critical Point	=	**559.52**
Actual Vertical Clearance	=	***28.59***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems	Made By: PJP	Date: 05/10/06	Job No.: P403030064		
	Checked By: MTN	Date: 10/26/06	Sheet No.:		

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternative 1 - 4-70" Steel Plate Girders — ***Point Location: B***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)	
Profile grade line to critical pt.:	-0.043	x	20.15	-0.87
			Total Adjustment =	**-0.87**

Superstructure Depth

Comment	Depth (in)	Depth (ft)	
Deck Thickness:	8.5	0.71	
Haunch:	2	0.17	
Girder or Beam Depth:	73.5	6.13	
Bearing Depth	6.25	0.52	
Cap Depth	55	4.58	This is Depth at Edge of Shoulder 7' total depth
	145.25	12.11	

Total Superstructure Depth (ft) = **12.11**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**35+78.38**
Offset Location @ Critical Point	=	**20.15' Rt.**
Profile Grade Elevation at Critical Point	=	579.33
Adjustment for Cross Slopes to Beam CL	=	-0.87
Top of Deck Elevation @ Critical Point	=	**578.46**
Total Superstructure Depth	=	-12.11
Bottom of Beam Elevation @ Critical Point	=	**566.35**
Top of Pavement @ Critical Point	=	**548.41**
Actual Vertical Clearance	=	***17.94***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems	Made By: PJP	Date: 05/10/06	Job No.: P403030064		
	Checked By: MTN	Date: 10/30/06	Sheet No.:		

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure

Description S.R. 823 Ramp B OVER US 52 PID # 77366

TranSystems	Made By PJP	Date 09/22/06	Job No. P403030064		
	Checked By MTN	Date 10/26/06	Sheet No.		

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternative 1 - 4-70" Steel Plate Girders — ***Point Location:*** **C**

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	20.13	=	-0.87
			Total Adjustment	=	**-0.87**

Superstructure and Pier CapDepth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	74.5	6.21
Bearing Depth:	6.25	0.52
Cap Depth:	108	9
	199.25	16.61

Total Superstructure & Cap Depth (ft) = **16.61**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**37+72.57**	CL Brg. Girder 4 Pier 2
Offset Location @ Critical Point	=	**20.13' Rt.**	
Profile Grade Elevation at Critical Point	=	586.49	
Adjustment for Cross Slopes to Beam CL	=	-0.87	
Top of Deck Elevation @ Critical Point	=	585.62	
Total Superstructure Depth	=	-16.61	
Bottom of Beam Elevation @ Critical Point	=	**569.01**	
Top of Pavement @ Critical Point	=	**549.43**	Note: Minimum clearance at toe of barrier adjacent to pier
Actual Vertical Clearance	=	***19.58***	
Preferred Vertical Clearance	=	*17.0*	
Required Vertical Clearance	=	*16.5*	

Alternative 1 - 4-70" Steel Plate Girders	***Point Location: D***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	20.15		-0.87
			Total Adjustment	=	**-0.87**

Superstructure Depth

Comment	Depth (in)	Depth (ft)	
Deck Thickness:	8.5	0.71	
Haunch:	2	0.17	
Girder or Beam Depth:	73	6.08	
Bearing Depth	6.25	0.52	
Cap Depth	71.18	5.93	This is Depth at Edge of Shoulder 7' total depth
	160.934	13.41	

Total Superstructure Depth (ft) = **13.41**

Vertical Clearance at Critical Point

Station @ Critical Point	**=**	**41+38.54**
Offset Location @ Critical Point	**=**	**20.13' Rt.**
Profile Grade Elevation at Critical Point	=	595.72
Adjustment for Cross Slopes to Beam CL	=	-0.87
Top of Deck Elevation @ Critical Point	**=**	**594.85**
Total Superstructure Depth	=	-13.41
Bottom of Beam Elevation @ Critical Point	**=**	**581.44**
Top of Pavement @ Critical Point	**=**	**558.34**
Actual Vertical Clearance	**=**	***23.10***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems

Made By	PJP	**Date**	09/22/06	**Job No.**	P403030064
Checked By	MTN	**Date**	10/26/06	**Sheet No.**	

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternative 1 - 4-70" Steel Plate Girders — ***Point Location:*** *E*

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	20.16	=	-0.87
			Total Adjustment	=	**-0.87**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6.00
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**42+00.43**
Offset Location @ Critical Point	=	**20.16' Rt.**
Profile Grade Elevation at Critical Point	=	596.53
Adjustment for Cross Slopes to Beam CL	=	-0.87
Top of Deck Elevation @ Critical Point	=	**595.66**
Total Superstructure Depth	=	-6.88
Bottom of Beam Elevation @ Critical Point	=	**588.78**
Top of Pavement @ Critical Point	=	**559.45**
Actual Vertical Clearance	=	***29.33***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

Made By PJP Date 09/22/06 Job No. P403030064
Checked By MTN Date 10/26/06 Sheet No.

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternative 1 - 4-70" Steel Plate Girders — ***Point Location: F***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	19.93	=	-0.86
			Total Adjustment	=	**-0.86**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	72	6
	82.5	6.88

Total Superstructure Depth (ft) = **6.88**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**41+76.80**
Offset Location @ Critical Point	=	**19.93' Rt.**
Profile Grade Elevation at Critical Point	=	596.25
Adjustment for Cross Slopes to Beam CL	=	-0.86
Top of Deck Elevation @ Critical Point	=	**595.39**
Total Superstructure Depth	=	-6.88
Bottom of Beam Elevation @ Critical Point	=	**588.51**
Top of Pavement @ Critical Point	=	**559.70**
Actual Vertical Clearance	=	***28.81***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems

Made By	PJP	Date	09/22/06	Job No.	P403030064
Checked By	MTN	Date	10/26/06	Sheet No.	

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 Structure

Description S.R. 823 Ramp B OVER US 52 PID # 77366

Alternatives 2A & 2B - 4-117" Steel Plate Girders **Point Location: A**

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)	
Profile grade line to critical pt.:	-0.043	x	20.1	-0.8643
		Total Adjustment	=	**-0.86**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.75	0.73
Haunch:	2	0.17
Girder or Beam Depth:	119.375	9.95
	130.125	10.85

Total Superstructure Depth (ft) = **10.85**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**35+82.63**
Offset Location @ Critical Point	=	**20.10' Rt.**
Profile Grade Elevation at Critical Point	=	579.48
Adjustment for Cross Slopes to Beam CL	=	-0.86
Top of Deck Elevation @ Critical Point	=	**578.62**
Total Superstructure Depth	=	-10.85
Bottom of Beam Elevation @ Critical Point	=	**567.77**
Top of Pavement @ Critical Point	=	**548.37**
Actual Vertical Clearance	=	***19.40***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems

Made By	*PJP*	**Date**	*09/22/06*	**Job No.**	*P403030064*
Checked By	*MTN*	**Date**	*10/26/06*	**Sheet No.**	

VERTICAL CLEARANCE CALCULATIONS

Job Name *SCI-823-0.00* **Structure**

Description *S.R. 823 Ramp B OVER US 52* **PID #** *77366*

Alternatives 2A & 2B - 4-117" Steel Plate Girders — ***Point Location: B***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	21.6	=	-0.93
			Total Adjustment	=	**-0.93**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.75	0.73
Haunch:	2	0.17
Girder or Beam Depth:	119.375	9.95
	130.125	10.85

Total Superstructure Depth (ft) = **10.85**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**41+50.75**
Offset Location @ Critical Point	=	**21.60' Rt.**
Profile Grade Elevation at Critical Point	=	595.90
Adjustment for Cross Slopes to Beam CL	=	-0.93
Top of Deck Elevation @ Critical Point	=	**594.97**
Total Superstructure Depth	=	-10.85
Bottom of Beam Elevation @ Critical Point	=	**584.12**
Top of Pavement @ Critical Point	=	**559.53**
Actual Vertical Clearance	=	***24.59***
Preferred Vertical Clearance	=	*17.0*
Required Vertical Clearance	=	*16.5*

TranSystems

Made By	*PJP*	**Date**	*09/22/06*
Checked By	*MTN*	**Date**	*10/26/06*

Job No. *P403030064*
Sheet No.

VERTICAL CLEARANCE CALCULATIONS

Job Name *SCI-823-0.00*
Structure
Description *S.R. 823 Ramp B OVER US 52*
PID # *77366*

Alternatives 2A & 2B - 4-117" Steel Plate Girders — ***Point Location: C***

Pier Cap Depth

Comment	Depth (in)	Depth (ft)	
Cap Depth:	32	2.67	Cap dimension from rt. edge to toe of barrier
	32	2.67	

Cap Depth (ft) = **2.67**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**37+74.44**	
Offset Location @ Critical Point	=	**10.45' Rt.**	
Bottom of Pier Cap @ Right Edge		568.67	See Calculations for Point "D"
Increase in Cap Depth	=	-2.67	
Bottom of Pier Cap @ Critical Point	=	**566.00**	
Top of Pavement @ Critical Point	=	**549.44**	
Actual Vertical Clearance	=	***16.56***	
Preferred Vertical Clearance	=	*17.0*	
Required Vertical Clearance	=	*16.5*	

TranSystems

Made By	PJP	**Date**	09/22/06	**Job No.**	P403030064
Checked By	MTN	**Date**	10/26/06	**Sheet No.**	

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Alternatives 2A & 2B - 4-117" Steel Plate Girders — ***Point Location: D***

Adjstment for Cross Slope

Comment	Grade		Offset (from PGL)		
Profile grade line to critical pt.:	-0.043	x	20.42	=	-0.88
			Total Adjustment	=	**-0.88**

Superstructure and Pier CapDepth

Comment	Depth (in)	Depth (ft)	
Deck Thickness:	8.75	0.73	
Haunch:	2	0.17	
Girder or Beam Depth:	121.25	10.1	
Bearing Depth:	8	0.67	
Cap Depth:	60	5	Cap Depth at minimum on rt. edge
	200	16.67	

Total Superstructure & Cap Depth (ft) = **16.67**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**37+65.12**	CL Bearing Girder 4
Offset Location @ Critical Point	=	**20.42' Rt.**	Pier 1
Profile Grade Elevation at Critical Point	=	586.22	
Adjustment for Cross Slopes to Beam CL	=	-0.88	
Top of Deck Elevation @ Critical Point	=	**585.34**	
Total Superstructure Depth	=	-16.67	
Bottom of Pier Cap @ Critical Point	=	**568.67**	
Top of Pavement @ Critical Point	=	**549.55**	
Actual Vertical Clearance	=	***19.12***	
Preferred Vertical Clearance	=	*17.0*	
Required Vertical Clearance	=	*16.5*	

APPENDIX D

Preliminary Structure Site Plan

TranSystems

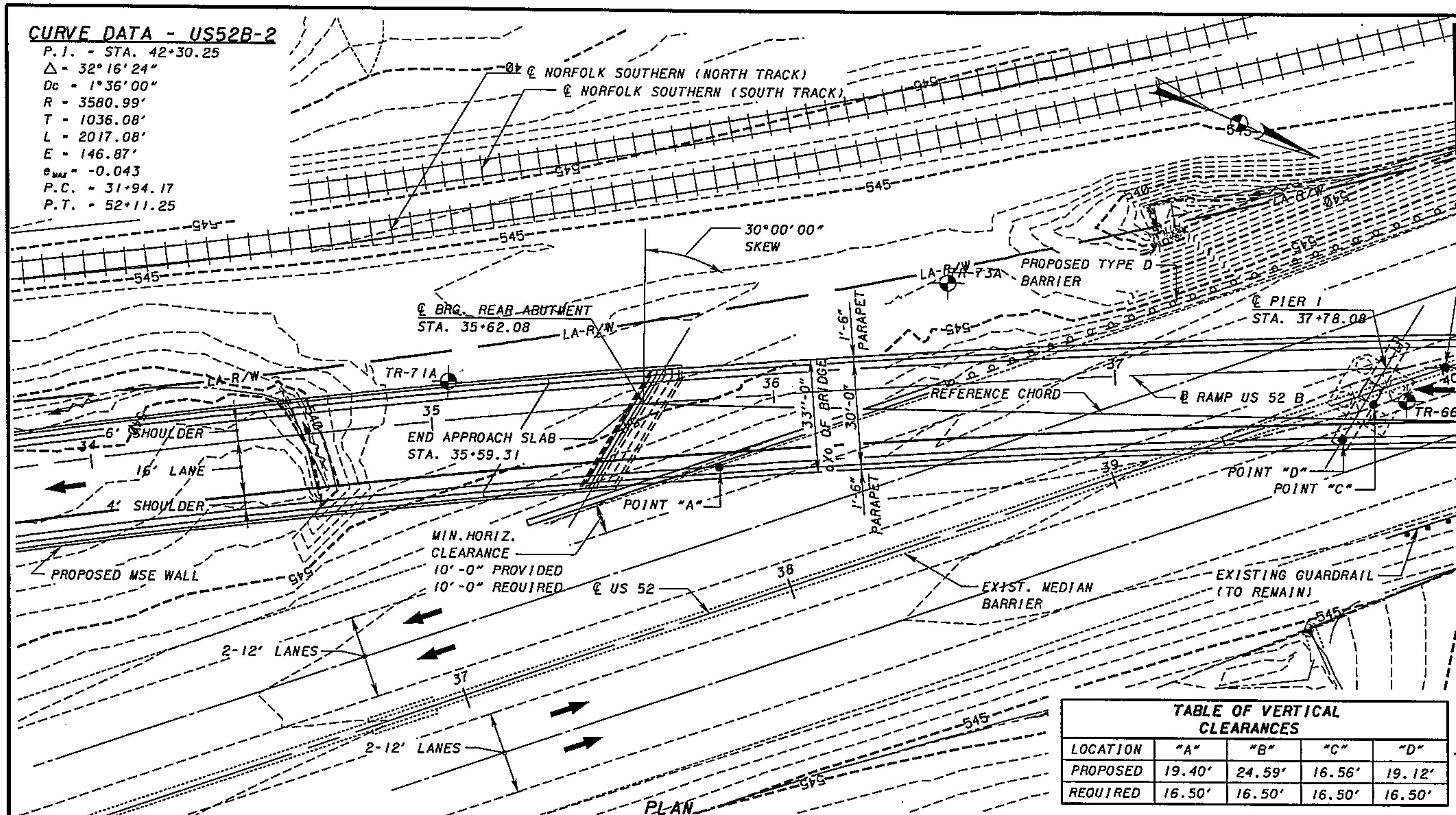
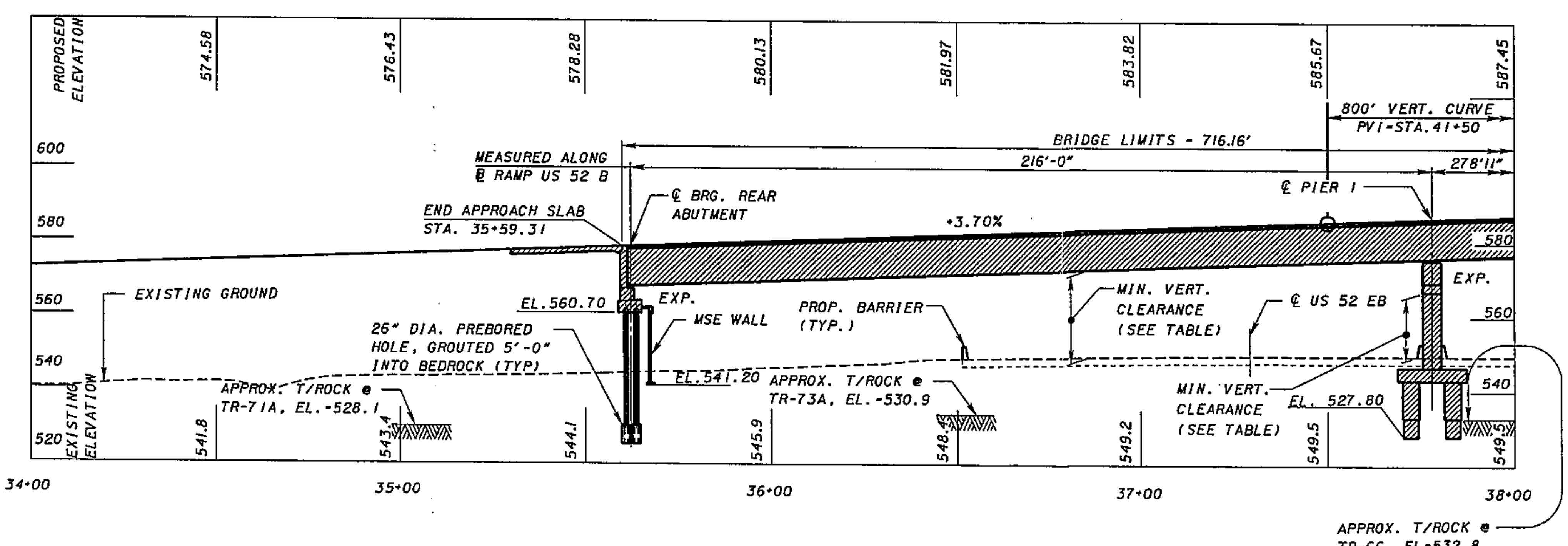


TABLE OF VERTICAL CLEARANCES				
LOCATION	"A"	"B"	"C"	"D"
PROPOSED	19.40'	24.59'	16.56'	19.12'
REQUIRED	16.50'	16.50'	16.50'	16.50'



PROFILE ALONG ℄ RAMP US52 B

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

TRAFFIC DATA
(RAMP B)
CURRENT YEAR ADT (2010) - 13400
DESIGN YEAR ADT (2030) - 21000
CURRENT YEAR ADTT (2010) - 1876
DESIGN YEAR ADTT (2030) - 2940

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:

PILES AT REAR AND FWD. ABUTMENT SHALL BE 14" CIP AND HAVE A MAXIMUM CAPACITY OF 70 TON PER PILE. ALLOWABLE BEARING CAPACITY FOR SPREAD FOOTING ON ROCK, ??? TSF. ALLOWABLE BEARING CAPACITY FOR DRILLED SHAFT, ??? TSF.

PROPOSED STRUCTURE

ALT 2A - 3 SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W, DOG LEG AT SPLICES WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS.

ALT 2B - 3 SPAN CONTINUOUS CURVED STEEL PLATE GIRDER A709 GRADE 50W, DOG LEG AT SPLICES WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS.

SPANS: 216'-0" - 278'-11" - 216'-0"

ROADWAY: 30'-0" T/T OF PARAPETS

LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING, FWS = 60 PSF

SKEW: 30°00'00" (MEASURED TO REFERENCE CHORD)

SUPERELEVATION: 0.043FT/FT

ALIGNMENT: 1°36'00" CURVE TO THE RIGHT

WEARING SURFACE: MONOLITHIC CONCRETE

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

LATITUDE:

LONGITUDE:

LEGEND

⌖ - BORING LOCATION

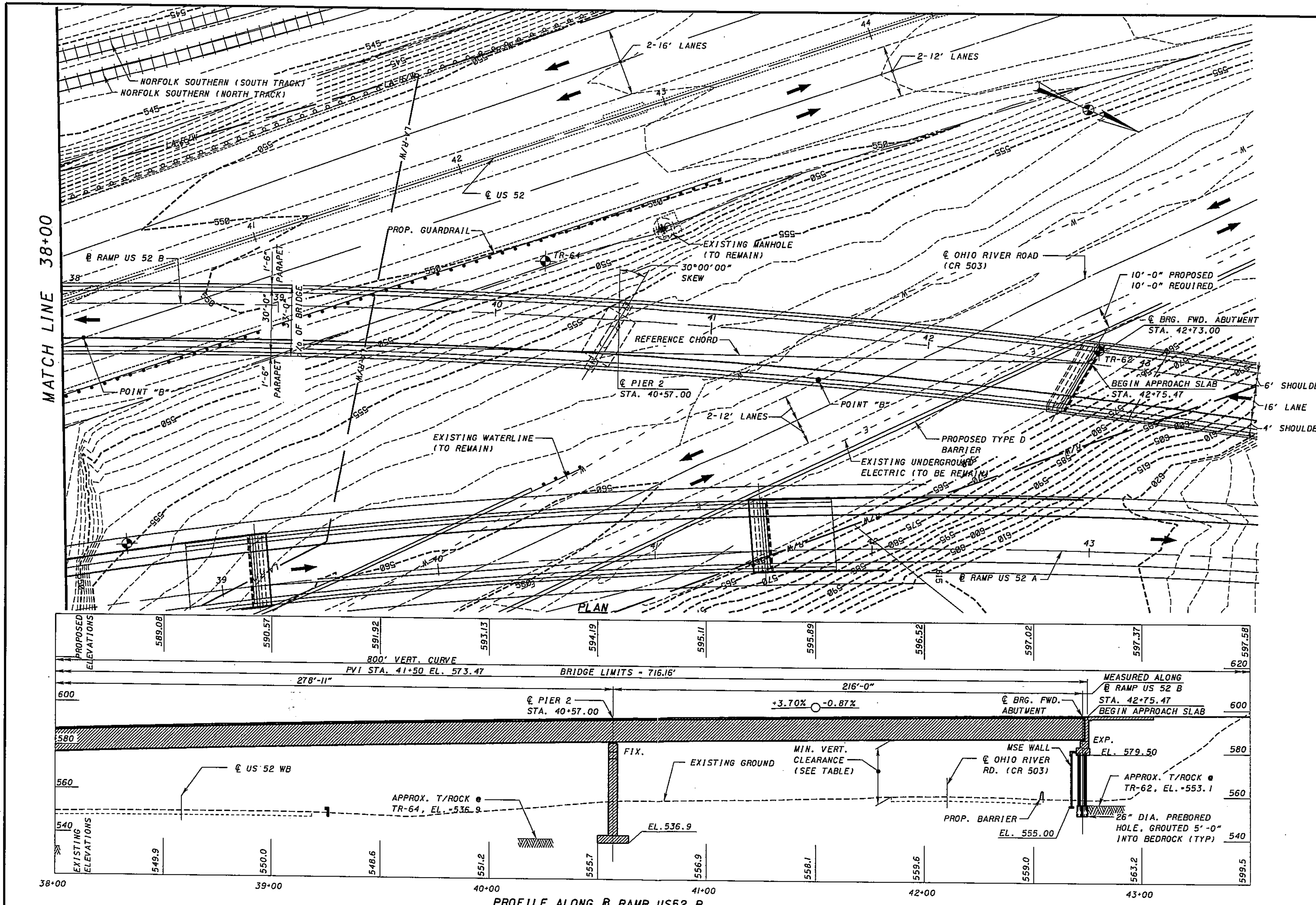
DESIGN AGENCY: TranSystems

DESIGNED PJP | CHECKED MSL | DRAWN CAS | REVISED | REVIEWED JRC | DATE 11/16/06 | STRUCTURE FILE NUMBER

SCIOTO COUNTY
STA. 35+59.31
STA. 42+75.47

SITE PLAN - ALTERNATIVES 2A & 2B
BRIDGE NO - SCI - 823 - XXX
SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00
PID 77366



DESIGN AGENCY: TranSystems

DESIGNED PJP	DRAWN CAS	REVIEWED JRC	DATE 11/16/06
CHECKED MSL	REVISED	STRUCTURE FILE NUMBER	

SCIOTO COUNTY
STA. 35+59.31
STA. 42+75.47

SITE PLAN ALTERNATIVE 2A & 2B

BRIDGE NO. SCI-823-XXXX
SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00
PID 77366

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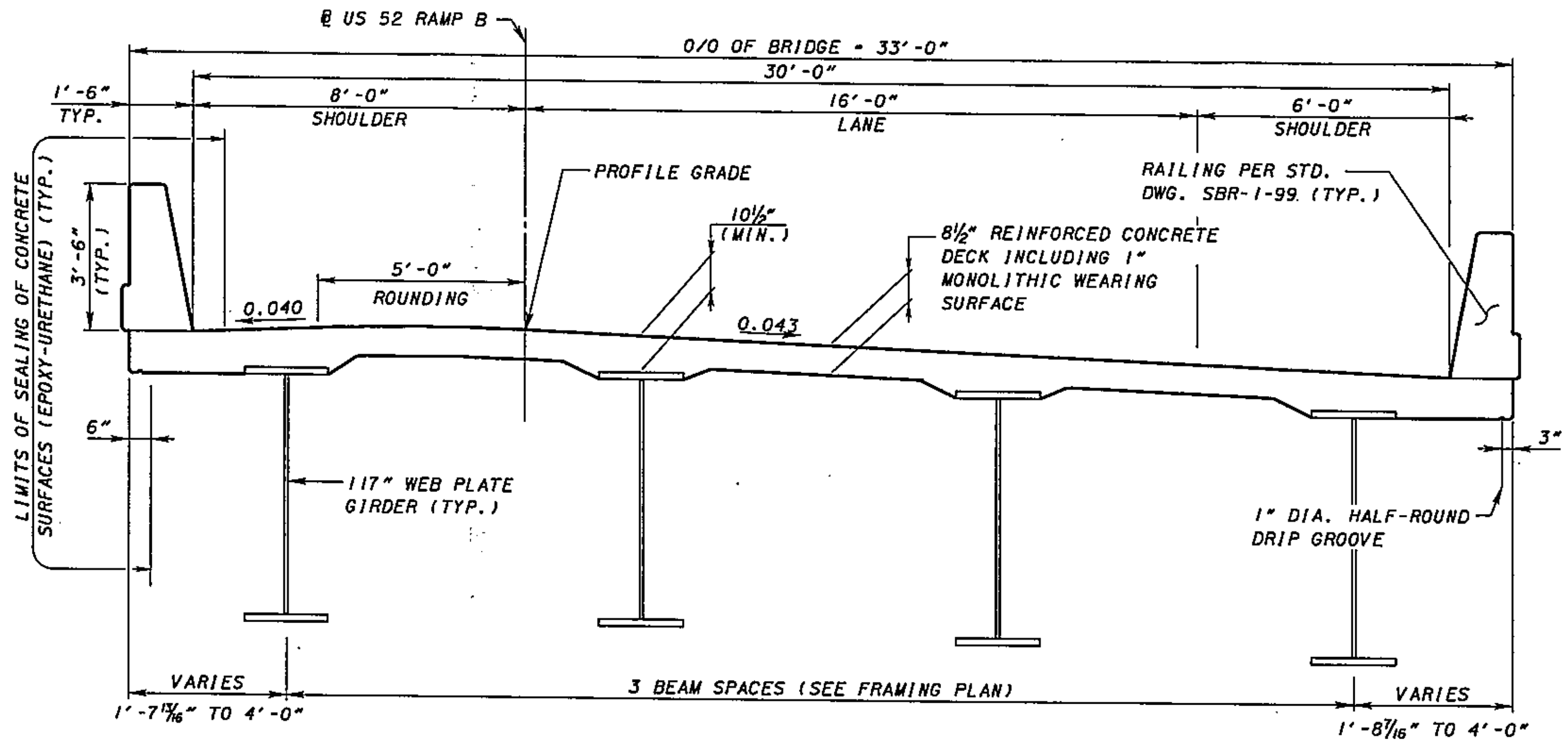
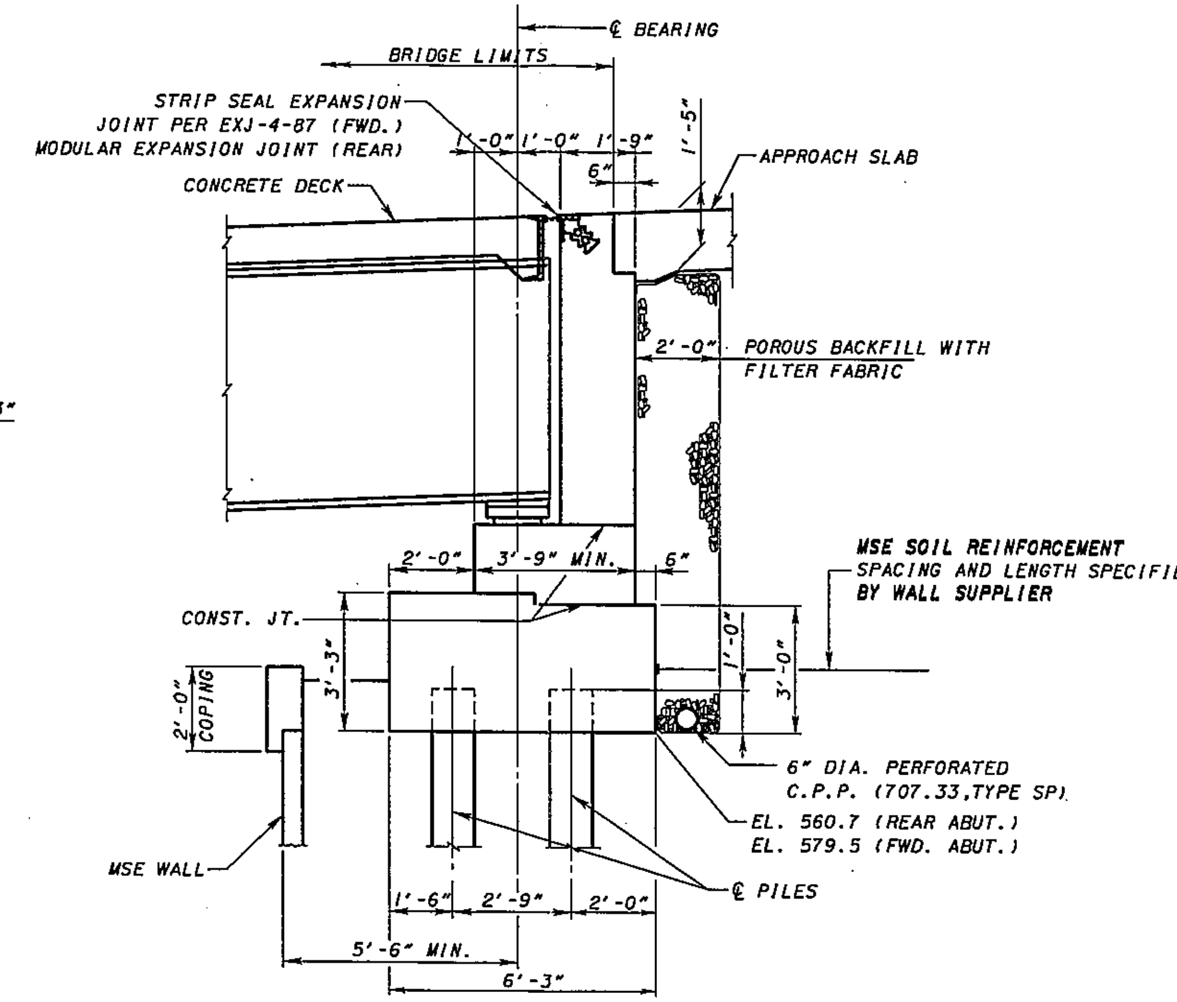
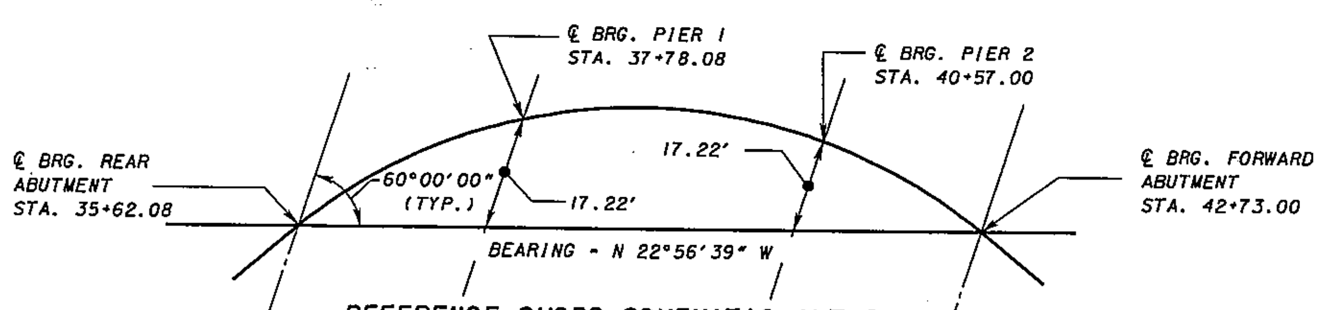


TYPICAL TRANSVERSE SECTION



TYPICAL ABUTMENT SECTION



REFERENCE CHORD SCHEMATIC ALT 2

DESIGN AGENCY: TranSystems

DESIGNED	CHECKED	DRAWN	REVISED	REVIEWED	DATE	STRUCTURE FILE NUMBER
PJP	WSL	CAS		JRC	11/16/06	

TYPICAL TRANSVERSE & ABUTMENT SECTION - ALT 2A

<BRIDGE NO. SCI-823-XXXX>

SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00

PID 77366

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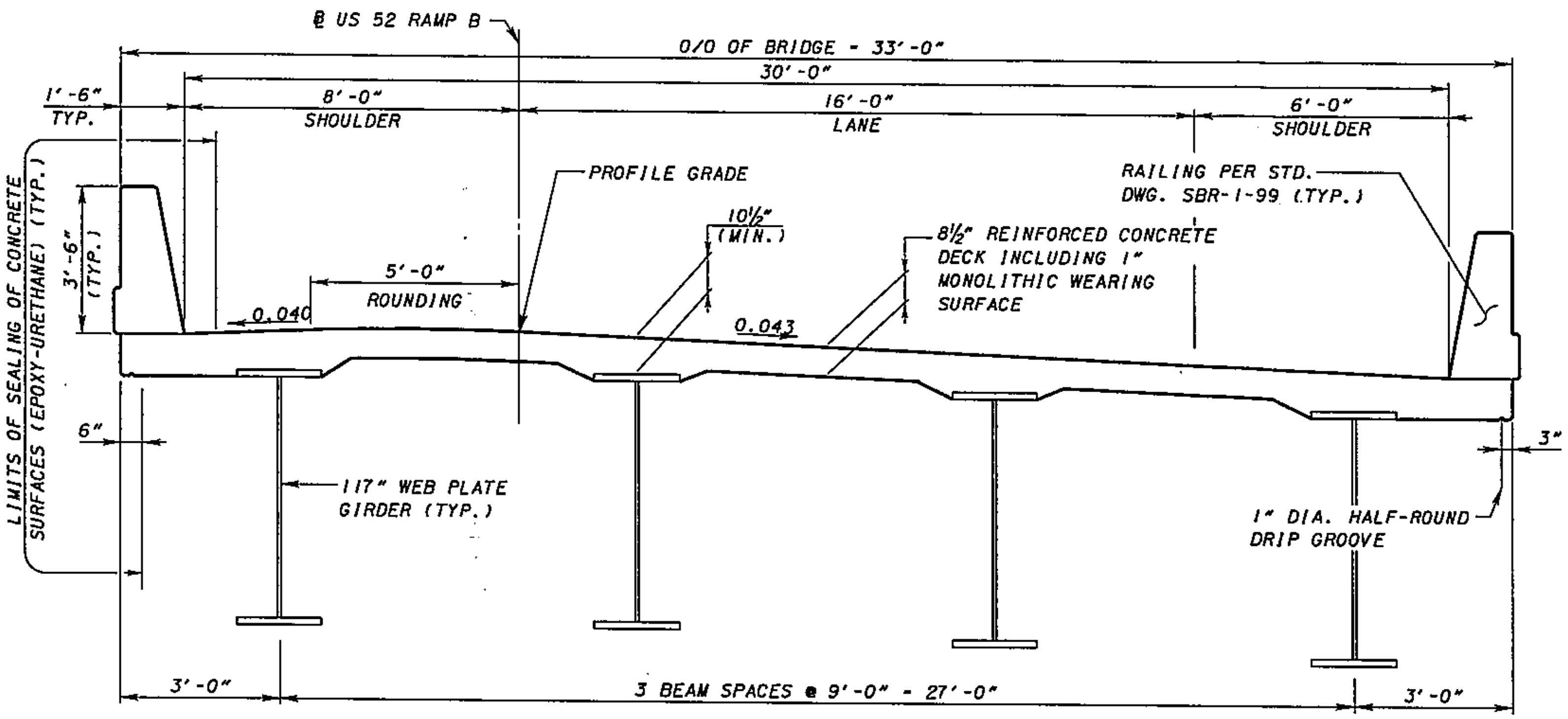
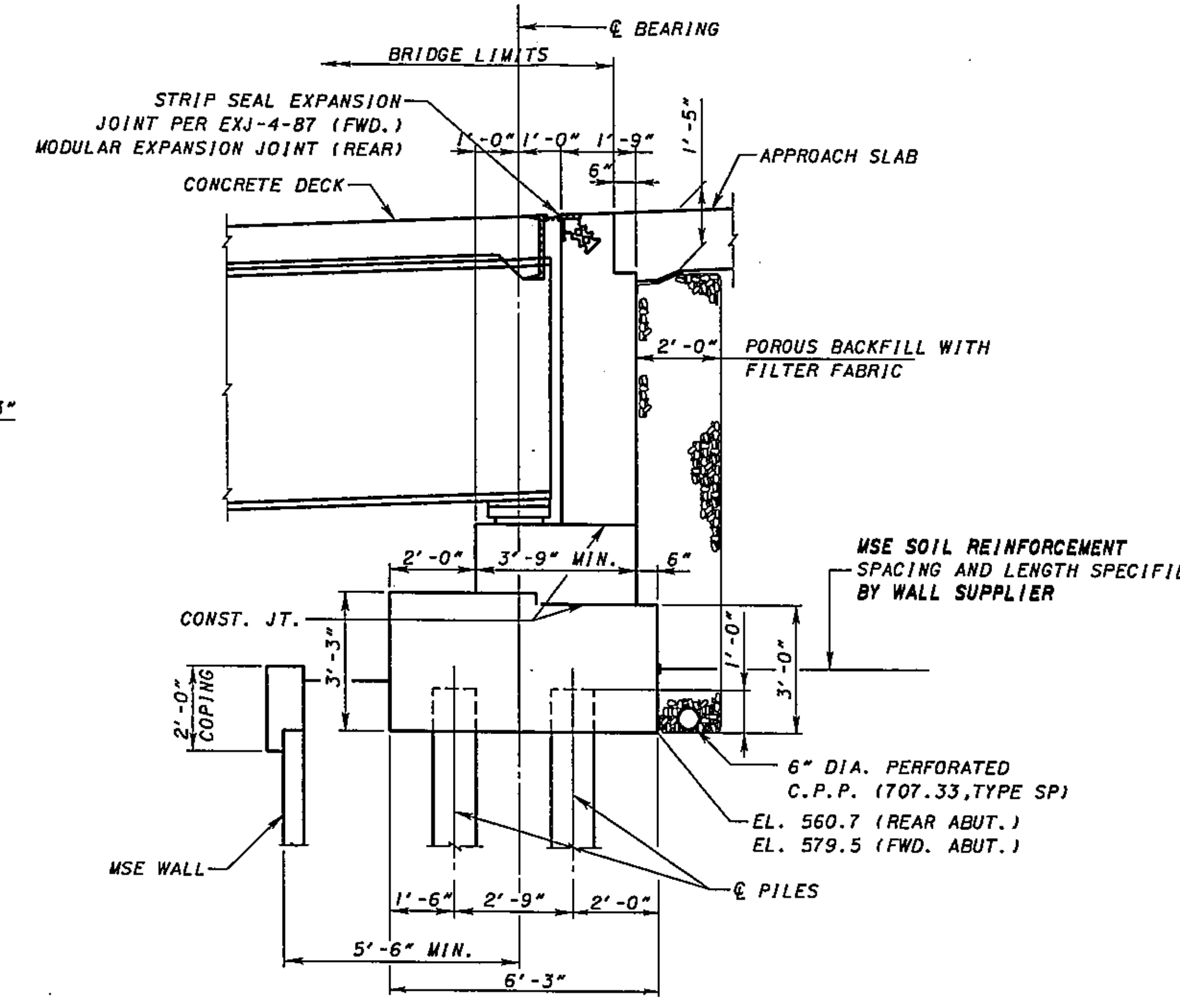
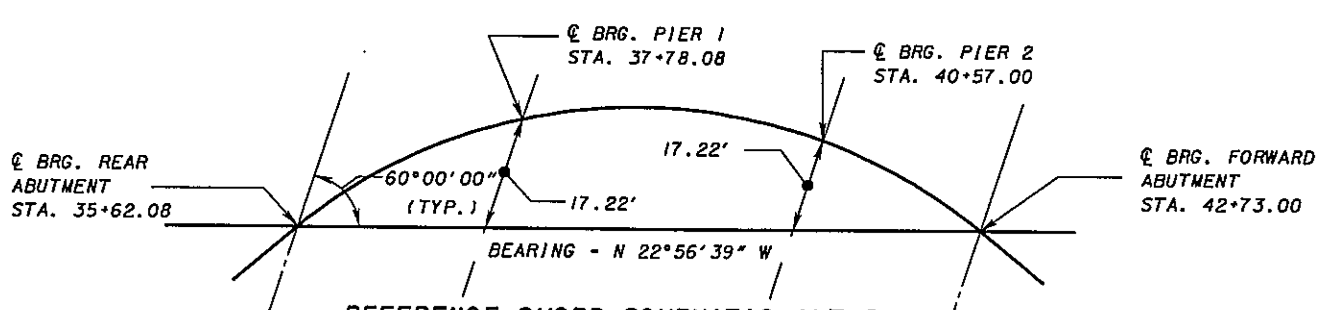


TYPICAL TRANSVERSE SECTION



TYPICAL ABUTMENT SECTION



REFERENCE CHORD SCHEMATIC ALT 2

DESIGN AGENCY TranSystems

DESIGNED	CHECKED	DRAWN	REVISED	REVIEWED	DATE
PJP	MSL	CAS		JRC	11/16/06

STRUCTURE FILE NUMBER

TYPICAL TRANSVERSE & ABUTMENT SECTION - ALT 2B

BRIDGE NO. SCI-823-XXXX

SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00

PID 77366

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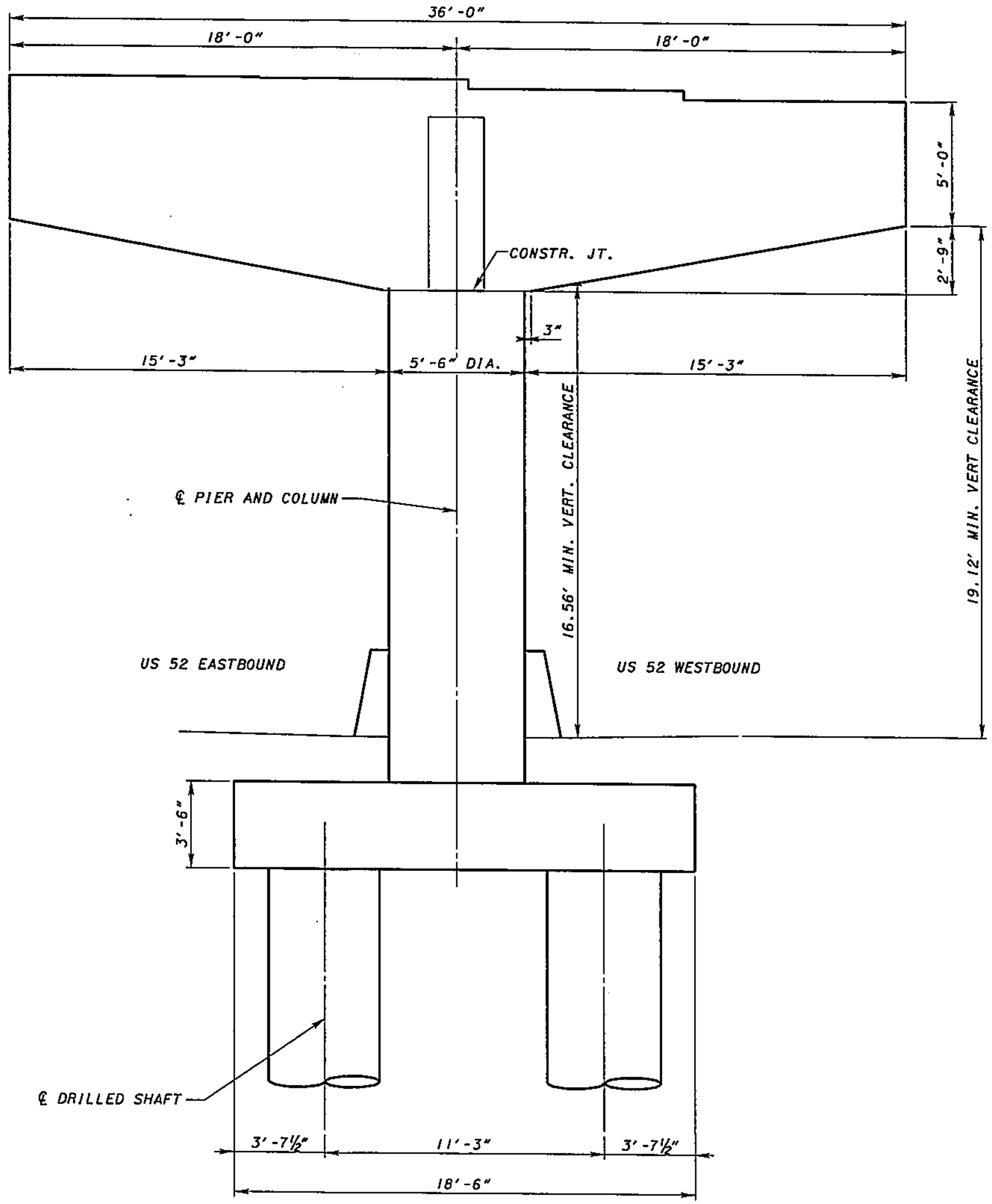
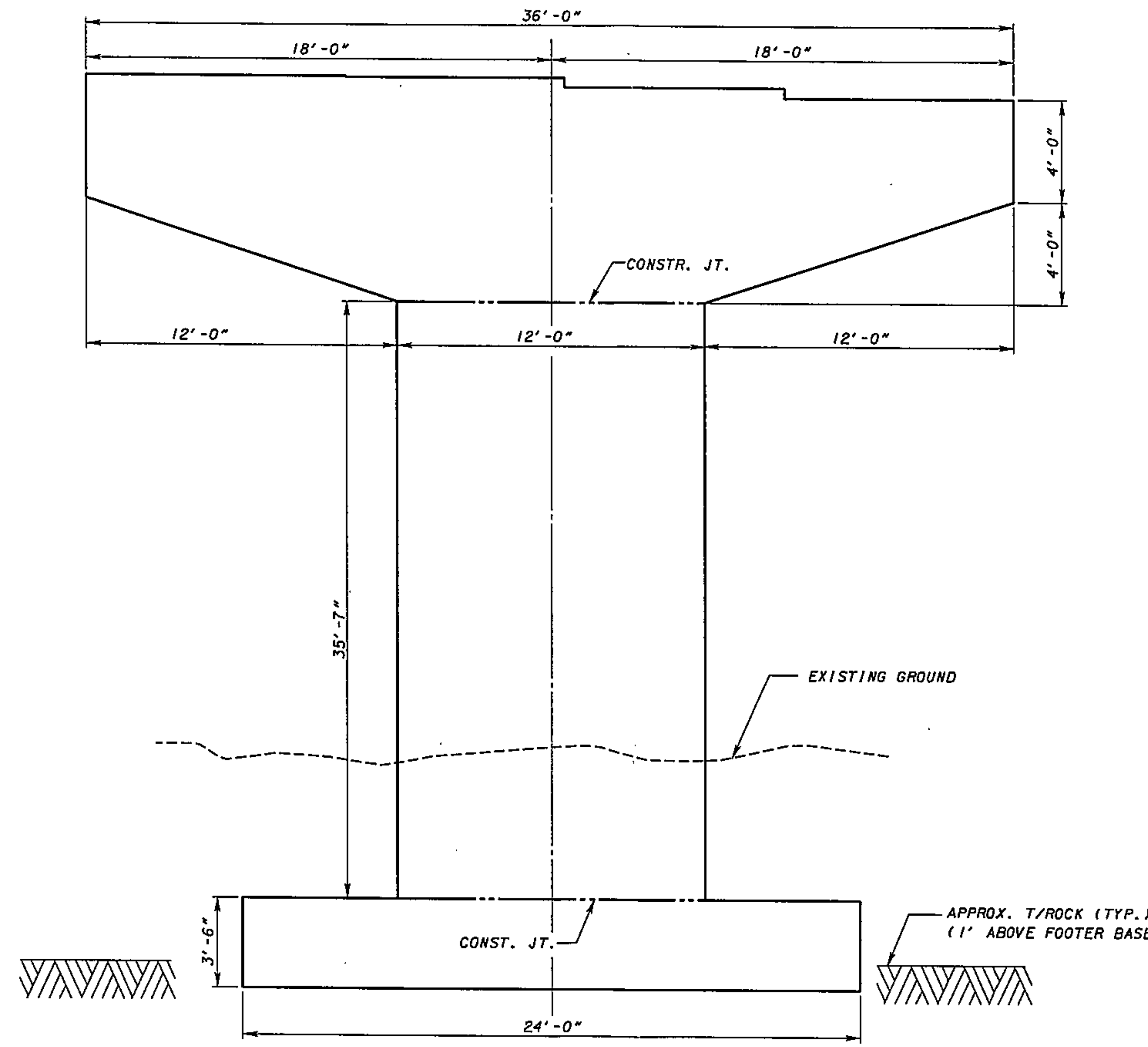


PIER 1 ELEVATION



PIER 2 ELEVATION

DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	11/16/06
CHECKED WSL	REVISED	STRUCTURE FILE NUMBER	

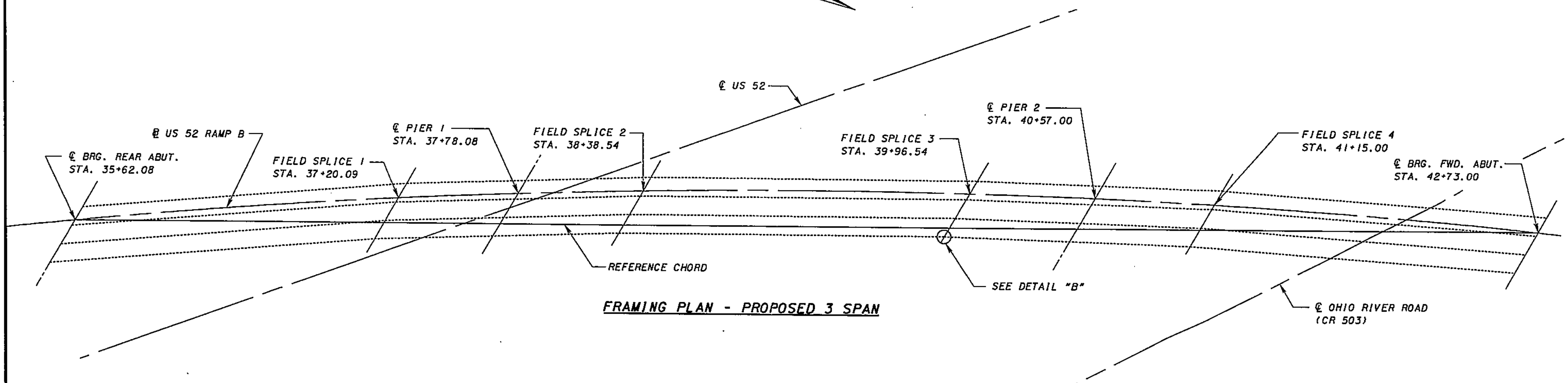
TYPICAL PIER SECTIONS - ALTERNATIVE 2A & 2B

BRIDGE NO. SCI-823-XXXX

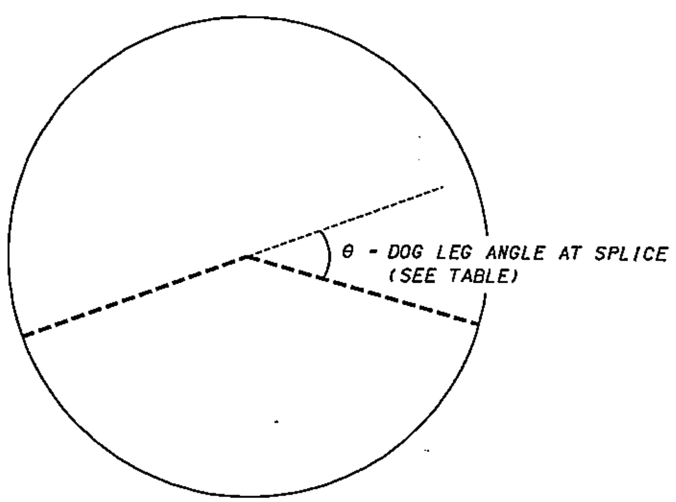
SR 823 RAMP US52 B OVER US52 AND CR 503

SCI-823-0.00
PID 77366

5/6



FRAMING PLAN - PROPOSED 3 SPAN



DETAIL "B"

DOG LEG ANGLE AT SPLICES		
LOCATION	STATION	θ
SPLICE 1	STA. 37+20.09	2.65°
SPLICE 2	STA. 38+38.54	2.14°
SPLICE 3	STA. 39+96.54	1.67°
SPLICE 4	STA. 41+15.00	2.41°

GIRDER LENGTH AND SPACING			
FROM	TO	GIRDER LENGTH	GIRDER SPACING*
℄ BRG. REAR ABUT.	SPLICE 1	158.40'	3 @ 8.63'
SPLICE 1	SPLICE 2	118.16'	3 @ 8.90'
SPLICE 2	SPLICE 3	157.75'	3 @ 9.10'
SPLICE 3	SPLICE 4	118.88'	3 @ 9.25'
SPLICE 4	℄ BRG. FWD. ABUT.	158.24'	3 @ 9.45'

* GIRDER SPACING IS MEASURED NORMAL TO GIRDER CENTERLINE

DESIGN AGENCY: TranSystems

DESIGNED PJP | CHECKED MSL | DRAWN CAS | REVISED | REVIEWED JRC | DATE 11/16/06 | STRUCTURE FILE NUMBER

FRAMING PLAN - ALTERNATIVE 2A
BRIDGE NO. SCI-823-XXXX
S.R. 823 RAMP US52 OVER US52 & CR 503

SCI-823-0.00
PID 77366

APPENDIX E

Preliminary Geotechnical Report & Preliminary MSE Wall Evaluation

TranSystems

Report of:

Preliminary Subsurface Exploration
Bridge and MSE Retaining Walls
US 52 Ramp B from Southbound SR 823 to Eastbound US 52
SCI-823-0.00 Portsmouth Bypass
Scioto County, Ohio

Prepared for:

TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, Ohio 43017

Ohio Department of Transportation
District 9

DLZ Ohio, Inc.
6121 Huntley Road
Columbus, OH 43229
Phone: (614) 888-0040
Fax: (614) 436-0161

DLZ Job No. 0121-3070.03

October 24, 2006

Prepared by:

DLZ

REPORT

OF

PRELIMINARY SUBSURFACE EXPLORATION

FOR

BRIDGE AND MSE RETAINING WALLS

US 52 RAMP B FROM SOUTHBOUND SR 823 TO EASTBOUND US 52

SCI-823-0.00 PORTSMOUTH BYPASS

SCIOTO COUNTY, OHIO

For:

TranSystems Corporation
5747 Perimeter Drive, Suite 240
Dublin, Ohio 43017

By:

DLZ OHIO, INC.
6121 Huntley Road
Columbus, OH 43229

DLZ Job. No. 0121-3070.03

October 24, 2006

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REPORT
OF
PRELIMINARY SUBSURFACE EXPLORATION
FOR
BRIDGE AND MSE RETAINING WALLS
US 52 RAMP B FROM SOUTHBOUND SR 823 TO EASTBOUND US 52
SCI-823-0.00 PORTSMOUTH BYPASS
SCIOTO COUNTY, OHIO

1.0 INTRODUCTION

This report includes the findings of the preliminary subsurface exploration, and the engineering evaluation of the foundation and mechanically stabilized earth (MSE) retaining walls for Ramp B of the US 52 interchange. The findings included in this report pertain to the US 52 Ramp B only. The findings of other structure evaluations will be submitted in separate documents.

The project consists in part of placing a bridge ramp structure for the proposed US 52 over Ohio River Road (CR 503) and US 52 travel lanes. Currently, two alternatives are being analyzed. Alternative 1 consists of a five-span structure, while alternative 2 consists of a three-span structure. As planned, both structures will use MSE walls to contain the roadway embankment and structure abutments.

The purpose of this exploration was to 1) determine the subsurface conditions to the depths of the borings, 2) evaluate the engineering characteristics of the subsurface materials, and 3) provide information to assist in the design of the structure foundations and the MSE walls. The exploration presented in this report was performed essentially in accordance with DLZ Ohio, Inc.'s (DLZ) proposal for the project.

The findings and recommendations presented in this report should be considered preliminary. After the bridge and ramp designs are refined, it will be necessary to drill additional borings in the area of the proposed structures in accordance with ODOT's specifications for subsurface investigations in order to finalize the MSE wall and foundation evaluations.

The geotechnical engineer has planned and supervised the performance of the geotechnical engineering services, considered the findings, and prepared this report in accordance with generally accepted geotechnical engineering practices. No other warranties, either expressed or implied, are made as to the professional advice included in this report.

2.0 GENERAL PROJECT INFORMATION

It is understood that the plan location of the bridge structure for the proposed US 52 Ramp B over Ohio River Road (CR 503) and US 52 has not changed from the approved location, as shown on the structure plan and profile drawings in Appendix I. However, two alternatives for placement of the MSE walls have been proposed. The first alternative (Alternative 1) involves placing the rear abutment MSE wall at station 34+55 and the forward abutment MSE wall at station 42+72. The pier locations for alternative 1 are as follows; station 35+80, 37+73, 39+66, and 41+37. The second alternative (Alternative 2) involves placing the rear abutment MSE wall at station 35+68 and the forward abutment of the MSE wall at station 42+68. The pier locations for alternative 2 are as follows; station 37+78 and 40+57. See attached structure plan and profile drawings in Appendix I.

Based upon the structure plan and profile drawings, the embankments/MSE walls for alternative 2 are higher than the walls planned in alternative 1. To consider the worst-case scenario, the maximum wall heights indicated on the plan and profile drawings for alternative 2 will be used for the analyses. Consequently, it is assumed that the maximum height of the embankment/MSE wall at the rear and forward abutments will be approximately 39.0 and 34.0 feet, respectively. These heights are based upon the maximum difference between the proposed grade of the US 52 Ramp B and the approximate existing grade indicated on the structure plan and profile drawing.

The analyses and recommendations presented in this report have been made on the basis of the foregoing information. If the proposed locations or structural concept are changed or differ from that assumed, DLZ should be informed of the changes so that recommendations and conclusions presented in this report may be revised as necessary.

3.0 FIELD EXPLORATION

The field exploration consisted of five preliminary structural borings (TR-62, TR-64, TR-66, TR-71A and TR-73A). The borings were drilled between March 18 , 2005 and July 13, 2006. A boring plan is presented in Appendix I. The boring logs are presented in Appendix II. Information concerning the drilling procedures is also presented in Appendix II.

The boring locations were determined by representatives of DLZ. The surveyed locations and ground surface elevations of the borings were determined by representatives from Lockwood, Lanier, Mathias & Noland, Inc. (2LMN).

4.0 FINDINGS

4.1 Geology of the Site

The area of this structure is characterized by gently to steeply sloping topography rising from of the floodplain of the Ohio River. The project area is located in the Shawnee-Mississippian Plateau of the unglaciated portion of the Appalachian Plateau Physiographic Region. The Shawnee-Mississippian Plateau is characterized by Devonian aged to Pennsylvanian aged rocks and contains residual, colluvial, alluvial, and lacustrine soils.

The genesis of the soils varies across the site. Soils in the floodplain consist primarily of alluvium and alluvial terraces, generally composed of silty clay, coarse sand, gravel, and cobbles. Below approximately elevation 700, the soils on the hillsides are generally lacustrine deposits. Lacustrine soils in this area are commonly known as "Minford Silts" or the Minford Complex. These deposits were formed during the early to middle Pleistocene age when the northward flowing Teays River system was blocked by the southward advance of the Kansan aged ice sheets. As the glaciers advanced, the course of the Teays River was blocked south of Chillicothe and a large lake was formed from the impoundment of the waterways. As a result of the impoundment, vast quantities of sediments were deposited ranging from 10 to 80 feet in thickness, thinning towards the margins. Bedrock within the structure area is primarily sandstone of the Logan Formation of Mississippian age. Bedrock of the Pennsylvanian Breathitt Formation can be found at the top of the slopes to typically above approximately elevation 770.

4.2 Subsurface Conditions

The following sections present the generalized subsurface conditions encountered by the borings. For more detailed information, refer to the boring logs presented in Appendix II. Laboratory test results are presented on the boring logs and also in Appendix III.

4.2.1 Soil Conditions

The results of this investigation indicated that soil conditions at the site were somewhat uniform. In general, the subsoil stratigraphy consisted of shallow surficial materials consisting of topsoil or asphalt concrete pavement underlain by native cohesive and granular soil deposits and sandstone.

All borings encountered surficial materials except boring TR-62. Borings TR-64, TR-71A, and TR-73A encountered 1 to 6 inches of topsoil while boring TR-66 encountered 10 inches of asphalt concrete pavement.

All borings encountered both natural cohesive and granular soil deposits below the ground surface except boring TR-64 where natural granular soil deposits only were encountered. The natural cohesive deposits consisted of very stiff sandy silt (A-4a), stiff to very stiff silt (A-4b), and stiff to very stiff silt and clay (A-6a). The natural granular deposits consisted of medium dense gravel with sand (A-1-b), medium dense gravel with sand and silt (A-2-4), and medium dense sandy silt (A-4a). The natural soil deposits extended to approximate depths between 6 and 17 feet corresponding to approximate elevations between 529.3 and 553.1 where bedrock was encountered.

4.2.2 Bedrock Conditions

In the area of the proposed structure, bedrock was encountered in all borings below the natural soil deposits. The bedrock consisted of soft to hard, slightly to highly weathered/decomposed, slightly to highly fractured sandstone. The amount of rock cores recovered ranged between 89 and 100 percent. The rock quality designation (RQD) of the bedrock ranged between 11 and 78 percent with an average of 50 percent, indicating very poor to good quality rock.

Unconfined compressive strength of tested cores ranged between 10,209 and 12,706 psi. The tested cores were selected from the depths between 9.3 and 23.3 feet. This corresponds to elevations 520.4 to 549.8. A summary of the unconfined compressive strength of the tested cores is shown in Table 1, on the following page.

Table 1-Unconfined Compressive Strength of Rock Core Results

Boring	Depth (ft)	Elevation	Unconfined Compressive Strength (psi)
TR-62	9.3-9.7	549.0-549.8	10,794
TR-64	19.5-19.8	528.6-528.9	12,706
TR-66	22.8-23.3	526.5-527.0	11,463
TR-71A	21.6-22.0	520.8-520.4	10,209
TR-73A	19.2-19.6	525.2-525.6	11,260

4.2.3 Groundwater Conditions

Seepage was encountered only in borings TR-66, TR-71A, and TR-73A between approximate depths of 7.3 and 17.0 feet. Water was encountered prior to coring in borings TR-66 at an approximate depth of 16 feet. Water was used during rock coring and masked any seepage zones that might exist in the rock. Measurable water levels were present in all borings upon the completion of coring (includes drill water) between approximate depths of 0.0 and 8.0 feet.

It should be noted that groundwater levels may fluctuate with seasonal variations and following periods of heavy or prolonged precipitation, and therefore, the readings indicated on the boring logs may not be representative of the long-term groundwater level. Long-term monitoring would be needed to obtain a more accurate estimate of the groundwater table elevation.

5.0 CONCLUSIONS AND RECOMMENDATIONS

It is anticipated that the proposed ramp will be constructed as described in Sections 1 and 2 of this report. At this time, it is not known what foundation type would be used to support the abutments. Recommendations for spread footings, drilled shafts, and pipe piles are included for the support of the abutments. Drilled shaft and spread footing foundation recommendations are also included for the piers. Given the existing site conditions, MSE walls are suitable to contain the abutments and hold back the roadway embankment. Recommendations for foundations and MSE walls are presented in the following sections.

5.1 Bridge Foundation Recommendations

5.1.1 Rear and Forward Abutments

I. Pipe Piles

It is understood through previous communications with the ODOT Office of Structural Engineering (OSE) that pipe piles can be used to support the abutments. This foundation alternative includes supporting the abutments by steel pipe piles placed in prebored holes 12 inches larger than the diameter of the pile and 5 feet deep into bedrock. After installing the steel pipe pile in the prebored hole, grout or cement should be placed in the void area around the pile in the prebored hole prior to constructing the embankment granular fill (per OSE). Therefore, a pile sleeve may not be required for the installation of the piles. However, consideration should be given to the use of pile sleeves to mitigate down drag effects from compaction and to protect the pile during the embankment and MSE wall construction. The allowable capacity of the pipe pile may be determined according to ODOT BDM 202.2.3.2.b for the proposed structures. Excessive lateral loading and uplift is not anticipated to be a concern at this site. However, if these forces are determined to be significant, longer socket lengths may be required.

Due to the relatively small rigidity of the steel pipe piles compared to drilled shafts, the steel pipe piles are anticipated to provide lower lateral resistance. Therefore, the prebored and socketed steel pipe pile foundation system may be a concern if significant lateral loads are present.

II. Drilled Shafts

Drilled shafts may also be considered for the support of the abutments. Based upon the existing site conditions, it appears that a systems of drilled shafts socketed a minimum of 5 feet into competent rock could be used to support the proposed structural abutments. The drilled shafts should be straight (not belled) and may be designed based on an allowable bearing pressure of 80 kips per square foot (ksf) or (40 tsf).

It is recommended that skin friction in the overburden (soil/fill) and five-foot rock socket be neglected in the design of the drilled shafts. The bearing surface should be clean and free of loose material and water prior to placement of concrete. The center-to-center spacing of the drilled shafts should generally be no less than 2.5 times their diameter. A qualified representative or the Geotechnical Engineer should field verify that the drilled shafts are founded on competent bearing materials and the installation procedures meet specifications.

If adequate capacity cannot be developed with a reasonable shaft diameter, consideration should be given to the use of deeper rock sockets. Neglecting the upper two feet of the socket, allowable sidewall shear stress/adhesion of 7,500 pounds per square foot (psf) may be used. If deeper sockets are used, the shafts should be designed such that design loads are carried entirely by the socket resistance and that any end bearing capacity be ignored.

Precautions should be taken to permit the shafts to be drilled and the concrete placed under relatively dry conditions. Only minor seepage was encountered in three of the borings drilled for this structure. However, water could flow into the drilled shafts during installation particularly from seepage zones and wet zones not encountered in the borings. It should be anticipated that materials across the site could vary considerably and temporary casing will be required during the drilling and concrete placement to seal out water seepage in the overburden and prevent cave-in. During simultaneous concrete placement and casing removal operations, sufficient concrete should be maintained inside the casing to offset the hydrostatic pressure of any groundwater. Extreme care must be exercised during concrete placement and removal of the casing so that soil intrusion is avoided.

III. Spread Footings

Spread footings bearing in the MSE wall fill are also considered to support the abutments. As per the Bridge Design Manual 204.6.2.1, an allowable bearing capacity of 4 kips per square foot (ksf) may be used to design the footings.

5.1.2 Piers

I. Spread Footings

Spread footings bearing on the rock encountered by the borings can be used to support the piers. Competent bedrock was generally encountered within two to three feet of the soil-rock interface. Spread footings bearing on competent bedrock may be designed using an allowable bearing capacity of 80 kips per square foot (ksf) or (40 tsf).

II. Drilled Shafts

Drilled shafts may also be considered for the support of the abutments. Based upon the existing site conditions, it appears that a systems of drilled shafts socketed a minimum of 5 feet into competent rock could be used to support the proposed structural abutments. The drilled shafts should be straight (not belled) and may be designed based on an allowable bearing pressure of 80 kips per square foot (ksf) or (40 tsf).

It is recommended that skin friction in the overburden (soil/fill) and five-foot rock socket be neglected in the design of the drilled shafts. The bearing surface should be clean and free of loose material and water prior to placement of concrete. The center-to-center spacing of the drilled shafts should generally be no less than 2.5 times their diameter. A qualified representative or the Geotechnical Engineer should field verify that the drilled shafts are founded on competent bearing materials and the installation procedures meet specifications.

If adequate capacity cannot be developed with a reasonable shaft diameter, consideration should be given to the use of deeper rock sockets. Neglecting the upper two feet of the socket, allowable sidewall shear stress/adhesion of 7,500 pounds per square foot (psf) may be used. If deeper sockets are used, the shafts should be designed such that design loads are carried entirely by the socket resistance and that any end bearing capacity be ignored.

Precautions should be taken to permit the shafts to be drilled and the concrete placed under relatively dry conditions. Only minor seepage was encountered in three of the borings drilled for this structure. However, water could flow into the drilled shafts during installation particularly from seepage zones and wet zones not encountered in the borings. It should be anticipated that materials across the site could vary considerably and temporary casing will be required during the drilling and concrete placement to seal out water seepage in the overburden and prevent cave-in. During simultaneous concrete placement and casing removal operations, sufficient concrete should be maintained inside the casing to offset the hydrostatic pressure of any groundwater. Extreme care must be exercised during concrete placement and removal of the casing so that soil intrusion is avoided.

Table 2 below, summarizes the foundation recommendations. It should be noted that the bedrock surface varies across the project area. The approximate bearing elevations presented below indicate the elevations at the boring locations only. Variations in the elevation at which competent bedrock is encountered should be anticipated. Borings drilled for the final structure will help to better define soil and bedrock in the area of the substructures.

Table 2-Summary of Foundation Recommendation

Structural Element	Borings	Existing Ground Surface Elevation (Feet)	Foundation Type	Approximate Bearing Elevation (Feet)	Allowable Bearing Capacity
Rear Abutment	TR-71A	542.8	Pipe Piles	524.3 *	Pile Capacity[+]
			Drilled Shafts	524.3 *	80 ksf[++]
			Spread Footings	MSE Fill	4 ksf
Piers	TR-62 TR-64 TR-66 TR-73A	559.1 (TR-62) 548.4 (TR-64) 549.8 (TR-66) 544.8 (TR-73A)	Spread Footings	553.1 (TR-62) 536.9 (TR-64) 532.8 (TR-66) 530.9 (TR-73A)	80 ksf
		559.1 (TR-62) 548.4 (TR-64) 549.8 (TR-66) 544.8 (TR-73A)	Drilled Shafts	548.1* (TR-62) 531.9* (TR-64) 527.8* (TR-66) 525.9* (TR-73A)	80 ksf[++]
Forward Abutment	TR-62	559.1	Pipe Piles	548.1 *	Pile Capacity[+]
			Drilled Shafts	548.1 *	80 ksf[++]
			Spread Footings	MSE Fill	4 ksf

* *Includes 5-foot socket into competent rock.*

[+] *Pile capacity should conform to ODOT BDM 202.2.3.2.*

[++] *End bearing capacity only.*

5.2 Mechanically Stabilized Earth (MSE) Retaining Wall Recommendations

It is understood that MSE walls would be used to construct the embankments and contain the abutments. Recommendations for the MSE wall are presented in the following sections. The MSE wall should be constructed per the recommendations presented in this report and in conformance with the manufacturer's specifications.

5.2.1 MSE Walls: General Information

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.

A global stability analysis and a 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 and overturning.

Calculations for bearing capacity, sliding, and overturning as well as the results of the global stability analyses are presented in Appendix IV. 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 in Table 3, on the following page. 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.

Table 3, Soil Parameters Used in The MSE Wall Stability Analyses

Zone	Soil Type	Unit Weight (pcf)	Strength Parameters			
			Undrained		Drained	
			c	ϕ	c'	ϕ'
Reinforced Fill	Compacted Granular Fill	120	0	34	0	34
Retained Soil	Compacted Embankment Fill	120	0	30	0	30
Foundation Soil (Rear Abutment) (Boring TR-71A)	Stiff Silt and Clay (A-6a)	120	1500	0	0	29
Foundation Soil (Forward Abutments) (Borings TR-62)	Stiff to Hard Sandy Silt (A-4a)	120	3500	0	0	29

5.2.2 MSE Wall Evaluations and Recommendations

The rear abutment location was selected to be analyzed for this proposed structure location due to the existence of relatively thick soil overburden cover over the rock. Due to the close proximity of rock at the forward abutment location, the MSE wall is anticipated to be bearing on rock or near bedrock, and hence the stability is not of concern. The proposed embankment in both alternatives is slightly higher at the forward abutment location than at the rear abutment. It should be noted that variations may be found in borings drilled for the final design that may change the results of the analyses.

Analyses for the MSE walls bearing on the native soils at the rear abutment yielded factors of safety above the minimum recommended values for undrained and drained global stability, as well as stability (sliding and overturning) and drained bearing capacity. However, the factor of safety for the undrained bearing capacity was calculated to be 1.4, below the required minimum value of 2.5. Consequently, additional analyses were undertaken to evaluate possible remedies to this low factor of safety for undrained bearing capacity.

UTEXAS3 was utilized to evaluate the bearing capacity of the MSE wall. UTEXAS3 is a computer program that can be used to evaluate several types of global stability failure modes. If the problem is modeled so the failure surface passes through or below the toe of the MSE wall volume, this analysis can be considered a global stability failure mode that is essentially a bearing capacity failure. Using this type of failure model for the MSE walls, the factor of safety for undrained bearing capacity of the full height wall was calculated to be less than the required minimum value of 2.5. Therefore, additional analyses were performed to determine the maximum allowable staged construction height to achieve a minimum factor of safety for undrained bearing capacity. This analysis resulted in a maximum allowable staged height of 19 feet, with a factor of safety of 2.5. A waiting period will be required prior to the placement of additional fill. The waiting period will allow excess pore water pressures to dissipate before the placement of the additional fill. Calculations for this waiting period will be included in the final report. These calculations will be based upon the results of testing from borings drilled for the final structure locations. In addition, as an alternative to staged construction, an undercut of the cohesive soils could be considered to remedy the low factor of safety for undrained bearing capacity. A recommended depth of undercut will be determined in the final report based upon the results of the borings drilled for the approved bridge structure.

Due to the inherent variations of the subsurface conditions, the actual required waiting period may be shorter or longer than anticipated. It is recommended that piezometers be installed in the clay layer to monitor the excess pore water pressures that will develop during construction and ensure that a critical pore water pressure is not exceeded. Analyses will be performed for the final report to determine the critical pore water pressures.

The stability analysis of the MSE wall was based on the assumption that the top 8.5 to 10.5 feet of the native soil along the MSE wall consists of natural cohesive deposits. The minimum embedment of the MSE wall in accordance to ODOT and AASHTO guidelines is 3.0 feet. If any loose, soft or compressible soils are encountered while excavating for the leveling pad, these soils should be removed and replaced with compacted granular fill. Any compacted granular fill below the leveling pad should be aggregate base conforming to CMS Item 304. In all cases, the thickness of the unreinforced concrete leveling pad shall not be less than 6 inches conforming to BDM Item 204. For stability, calculations have indicated that a minimum reinforcement length of 0.85H or 31.5 feet is required for stability of the proposed MSE wall at the rear abutment location. Similarly, a minimum reinforcement length of 0.8H or 33.6 feet is required for stability of the proposed MSE wall at the forward abutment.

The total maximum settlement of the MSE wall volume at the rear abutment was estimated to be approximately 7 inches at the centerline of the wall. Settlement was calculated using the computer program EMBANK, using the "end of fill" option to model the non-continuous embankments. Differential settlement at this location was estimated to be approximately 0.66 percent. MSE retaining walls are able to withstand relatively large amounts of differential settlement, typically up to 100 millimeters per 10 meters of wall length (1.0 percent). Settlement calculations are presented in Appendix IV. The MSE wall at the forward abutment will be founded at or near bedrock. Therefore, the settlement at the forward abutment location is assumed to be negligible.

Time-rate of settlement calculations will be presented in the final report based upon laboratory test results from samples collected in the final borings.

Tables 4A and 4B, below and on the following page present the MSE retaining wall parameters and results of analyses.

Table 4A, MSE Retaining Wall Parameters and Analyses Results (Rear Abutment)

Retained Soil (New Embankment) Unit Weight = 120 pcf Coefficient of Active Earth Pressure (K_a) = 0.33 (Based on Φ' = 30º)
Sliding along base of MSE wall Sliding Coefficient (μ)(0.67) = tan 29°(0.67) = 0.37 Use (μ)(0.67) = 0.35 as a maximum value as per AASHTO, BDM,303.4.1.1
Allowable Bearing Capacity – Undrained Condition **q_{all} = 3,153 psf**
Allowable Bearing Capacity – Drained Condition q_{all} = 6,967 psf (rear abutment)
Global Stability Factor of Safety – Undrained Condition = 1.6 Factor of Safety – Drained Condition = 1.6 Factor of Safety – Drained Seismic Condition = 1.5
Estimated Settlement of MSE volume Maximum Total Settlement ≈ 7 inches Differential Settlement ≈ 0.66% < 1.0%
Minimum Embedment Depth = 3.0 feet Maximum Allowable Construction Stage = 19.0 feet Minimum Length of Reinforcement for External Stability = 31.5 feet*

Table 4B, MSE Retaining Wall Parameters and Analyses Results (Forward Abutment)

Retained Soil (New Embankment) Unit Weight = 120 pcf Coefficient of Active Earth Pressure (K_a) = 0.33 (Based on $\Phi' = 30^{\circ}$)
Sliding along base of MSE wall Sliding Coefficient (μ)(0.67) = tan 29°(0.67) = 0.37 Use (μ)(0.67) = 0.35 as a maximum value as per AASHTO, BDM,303.4.1.1
Allowable Bearing Capacity – Undrained Condition q_{all} = 7,265 psf
Allowable Bearing Capacity – Drained Condition q_{all} = 7,219 psf (rear abutment)
Global Stability *(Wall founded on or near bedrock)* Factor of Safety – Undrained Condition > 1.5 Factor of Safety – Drained Condition > 1.5 Factor of Safety – Drained Seismic Condition > 1.3
Estimated Settlement of MSE volume *(Wall founded on or near bedrock)* Maximum Total Settlement ≈ 0 inches Differential Settlement ≈ 0.0% < 1.0%
Minimum Embedment Depth = 3.0^{+} feet Minimum Length of Reinforcement for External Stability = 33.6 feet*

$^{+}$ *Minimum embedment depth. No embedment in bedrock is required.*

5.3 MSE Wall Foundation Earthwork Recommendations

Excavations for the proposed MSE wall should be prepared in accordance with ODOT-CMS Item 503, "Excavation for Structures." Excavations deeper than 5.0 feet must be sloped or shored to protect workers entering the excavations. Refer to OSHA regulations (29 CFR Part 1926) concerning sloping and shoring requirements for excavations. It is recommended that earthwork be performed under continuous observation and testing by a soils technician with the general guidance of a geotechnical engineer. Backfill material used to establish planned grades may consist of nonfrost susceptible clean granular soil free of topsoil or organic material. Alternatively, the excavation may be backfilled with Ohio Department of Transportation (ODOT) Construction and Material Specifications (CMS) Item 304 and should be compacted in conformance to CMS 203.06 and 203.07.

5.4 Groundwater Considerations

Water seepage was encountered in three of the borings only (TR-66, TR-71A, and TR-73A). Groundwater was noted prior to adding drill water only in boring TR-66. Representative final water levels could not be obtained due to the use of water during rock coring. Excavation for the pier foundation is expected to be between 3 and 17 feet. Foundation construction on the rock is expected to encounter only minor seepage. Excavations or shafts extending below bedrock level may encounter more significant seepage through fractured zones in the rock. The contractor should be prepared to deal with seepage and water flow that may enter any excavations.

6.0 CLOSING REMARKS

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 report.

Respectfully submitted,

DLZ OHIO, INC.

Steven Riedy
Geotechnical Engineer

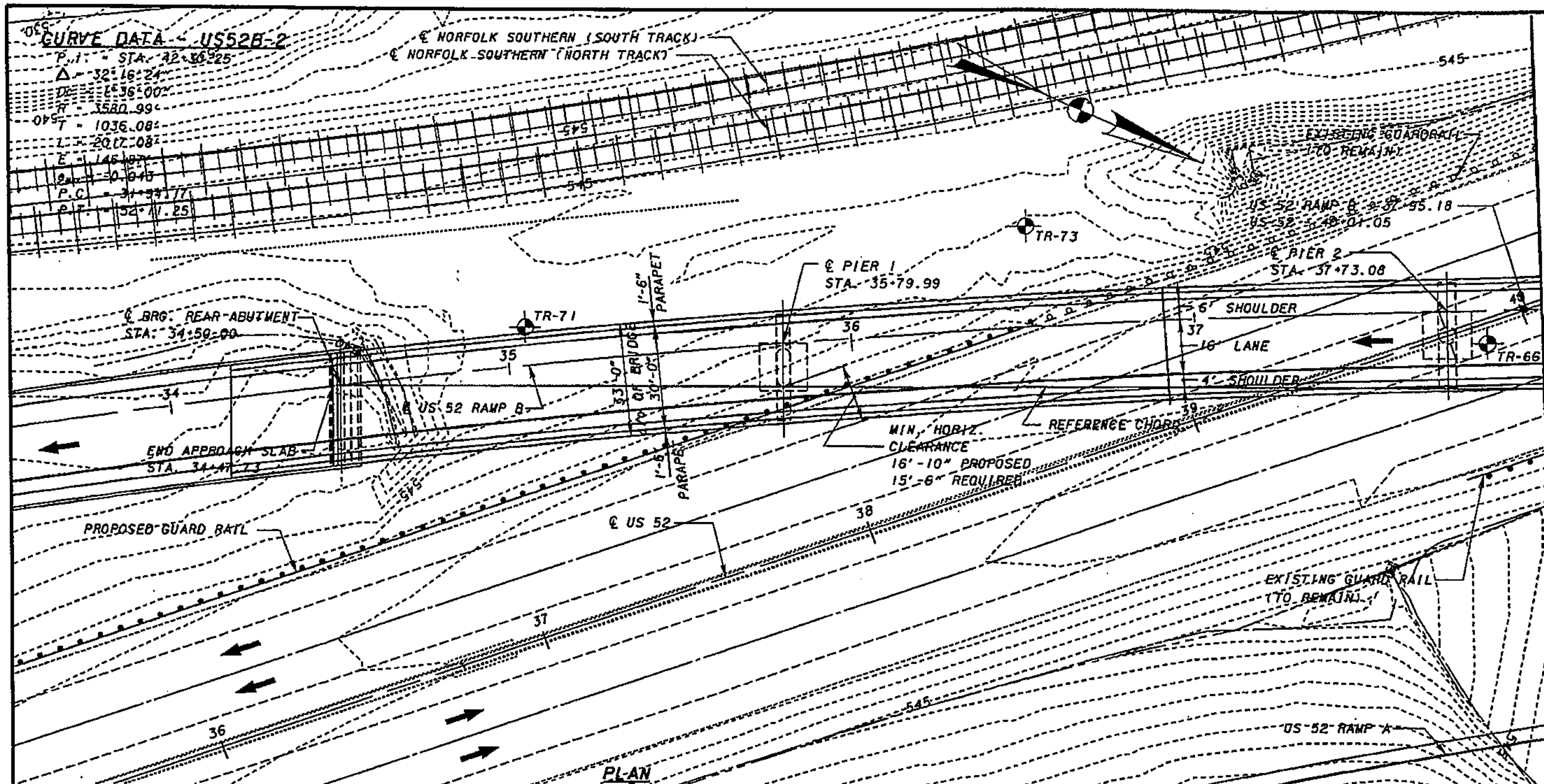
Eric Tse, P.E.
Geotechnical Engineer

sjr

M:\proj\0121\3070.03\US 52\Ramp B\New after Transystem Final Plans_10_18_2006\US 52 Ohio River Road-Structure Report-RAMP B 10-23-2006 SJR.doc

APPENDIX I

Structure Plan and Profile Drawings - Two (2) -11"x17"
Boring Plan - 11"x17"



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.

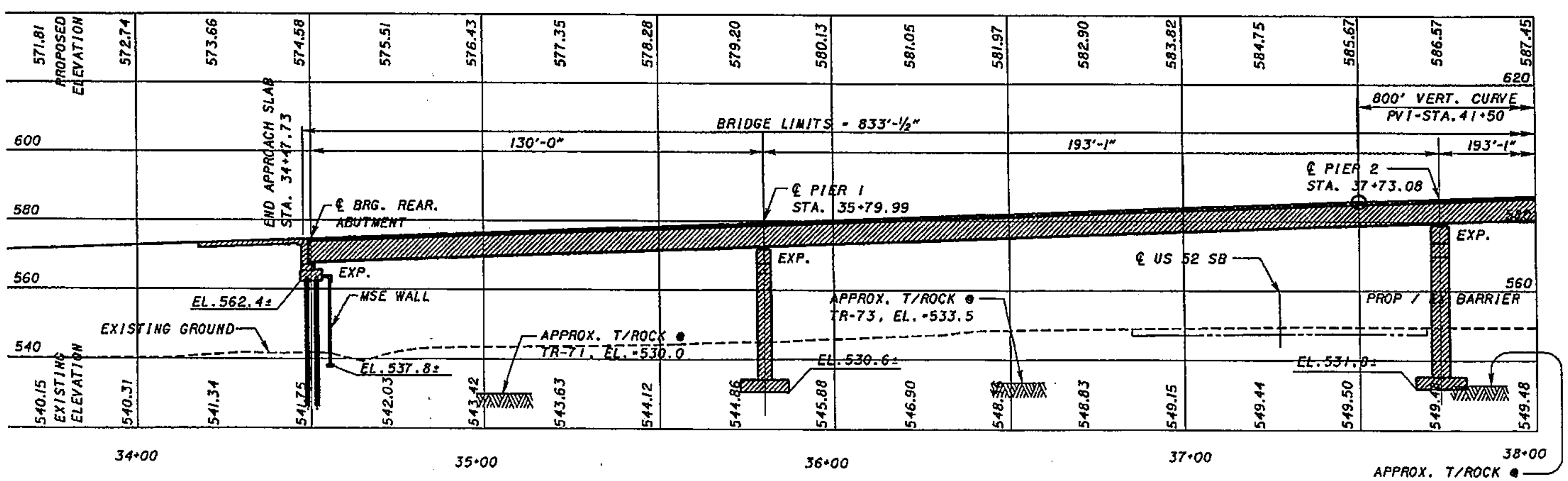
BENCHMARK 1	BENCHMARK 2
(TO BE PROVIDED LATER)	(TO BE PROVIDED LATER)

TRAFFIC DATA

(RAMP B)
CURRENT YEAR ADT (2010) = 13400
DESIGN YEAR ADT (2030) = 21000
CURRENT YEAR ADTT (2010) =1880
DESIGN YEAR ADTT (2030) = 2940

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.



ELEVATION ALONG PROFILE GRADE B RAMP B

PROPOSED STRUCTURE

TYPE: 5 SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W, DOG LEG AT SPLICES WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS.

SPANS: 130' - 191'-1" - 191'-1" - 170'-10" - 141'-6"

ROADWAY: 30'-0" T/T OF PARAPETS

LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING, FWS = 60 PSF

SKEW: NONE (MEASURED TO REFERENCE CHORD)
SUPERELEVATION: 4.30%
ALIGNMENT: 1°36'00" CURVE TO THE RIGHT
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (30' LONG)
LATITUDE:
LONGITUDE:

LEGEND

⊕ = LOCATION

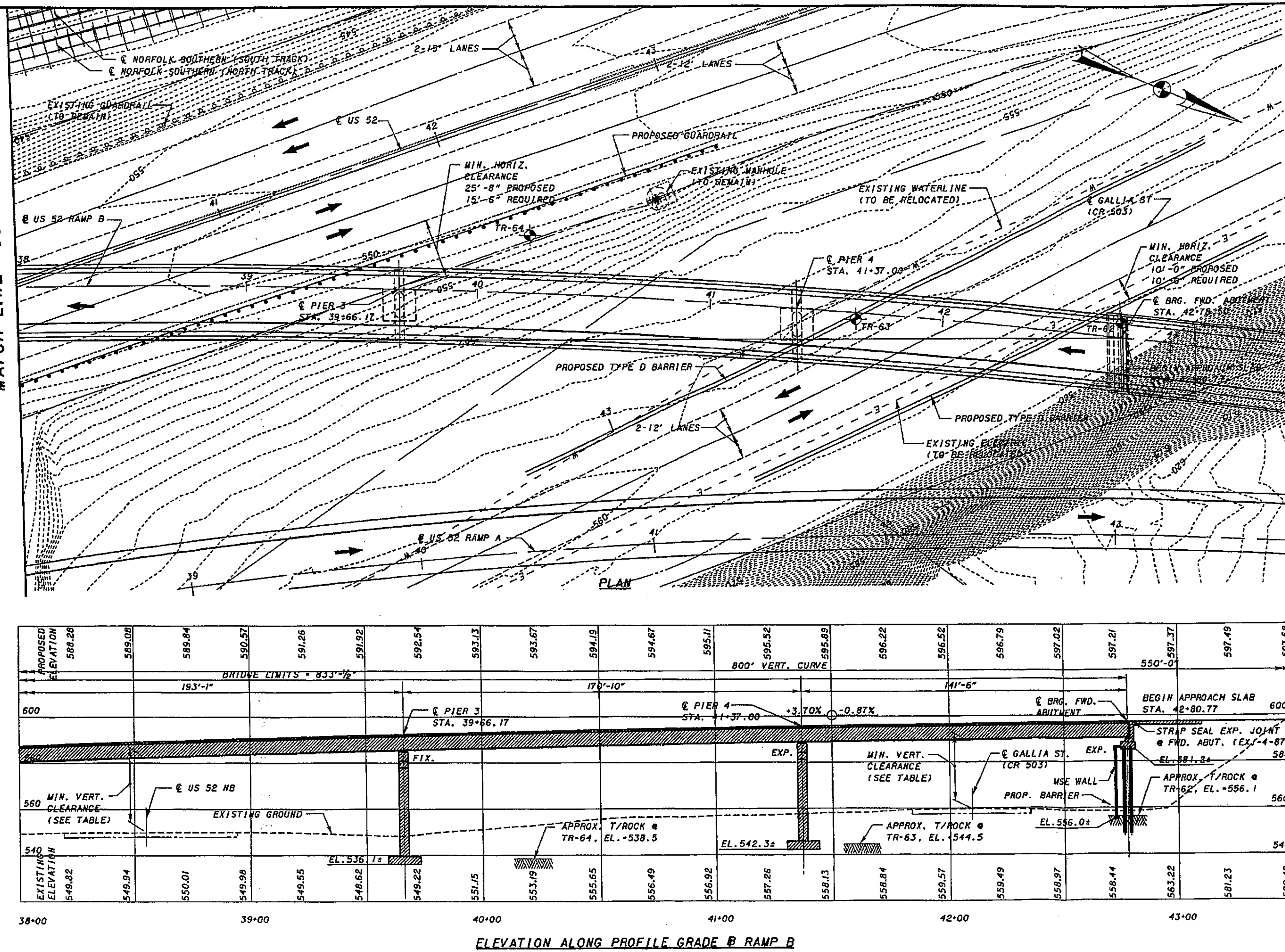
DESIGN AGENCY: TranSystems
DESIGNED PJP | CHECKED
DRAWN CAS | REVISED
REVIEWED JRC | DATE | STRUCTURE FILE NUMBER

SCIOTO COUNTY
STA. 34+47.73
STA. 42+80.77

SITE PLAN - ALTERNATIVE 1
BRIDGE NO. SCI-823-XXX
US 52 RAMP B OVER US 52

SCI-823-0.00
PID 19415

1 / 2



DESIGN AGENCY: Tran Systems

DESIGNED: PJP | DRAWN | REVIEWED | DATE | CHECKED | REVISED | STRUCTURE FILE NUMBER

STA. 34+47.73
STA. 42+80.77

SITE PLAN

BRIDGE NO. SCI- 5 SPAN
US 53 RAMP B OVER US 52

SCI-823-0.00
PID 19415

2 / 2

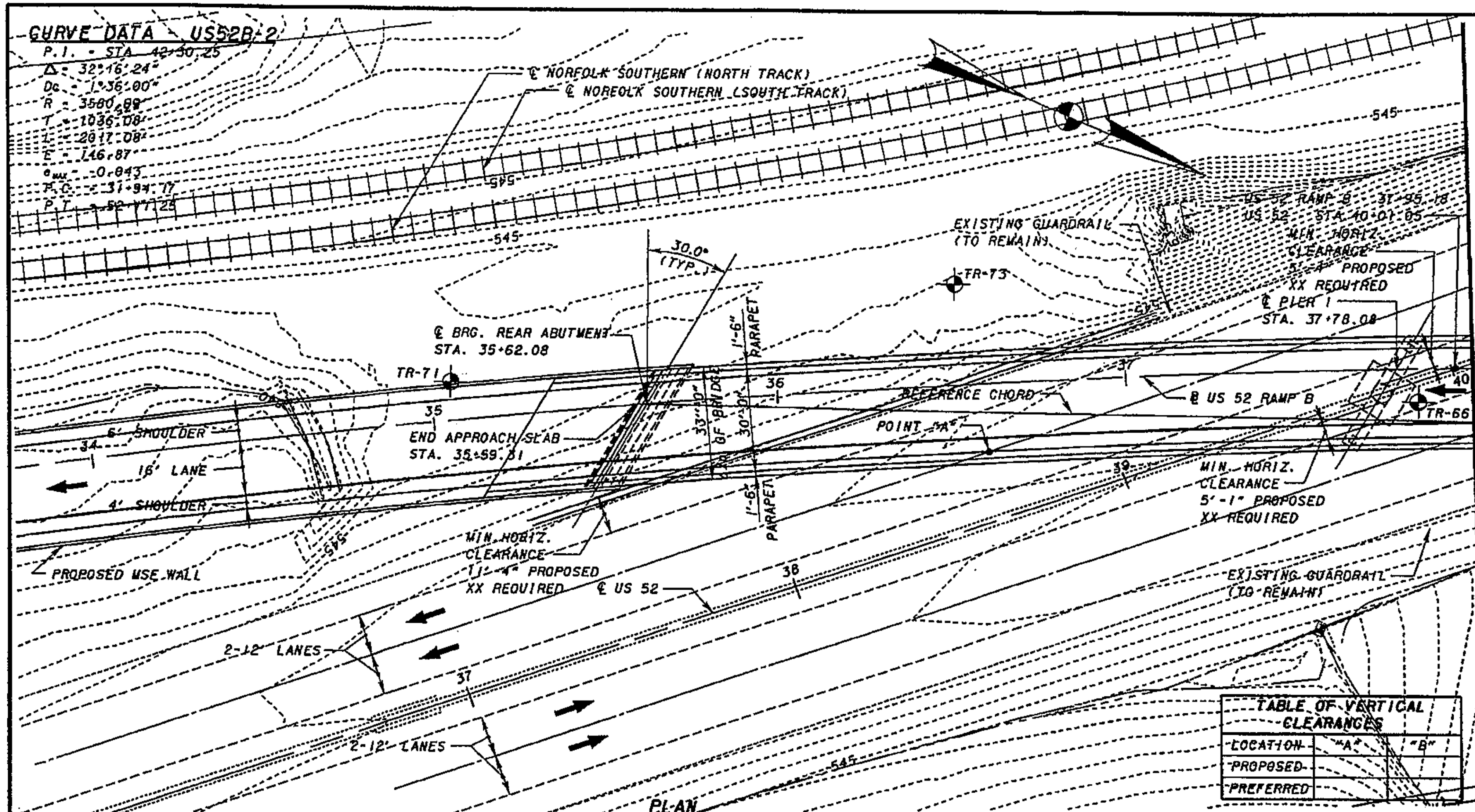


TABLE OF VERTICAL CLEARANCES		
LOCATION	"A"	"B"
PROPOSED		
PREFERRED		

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.

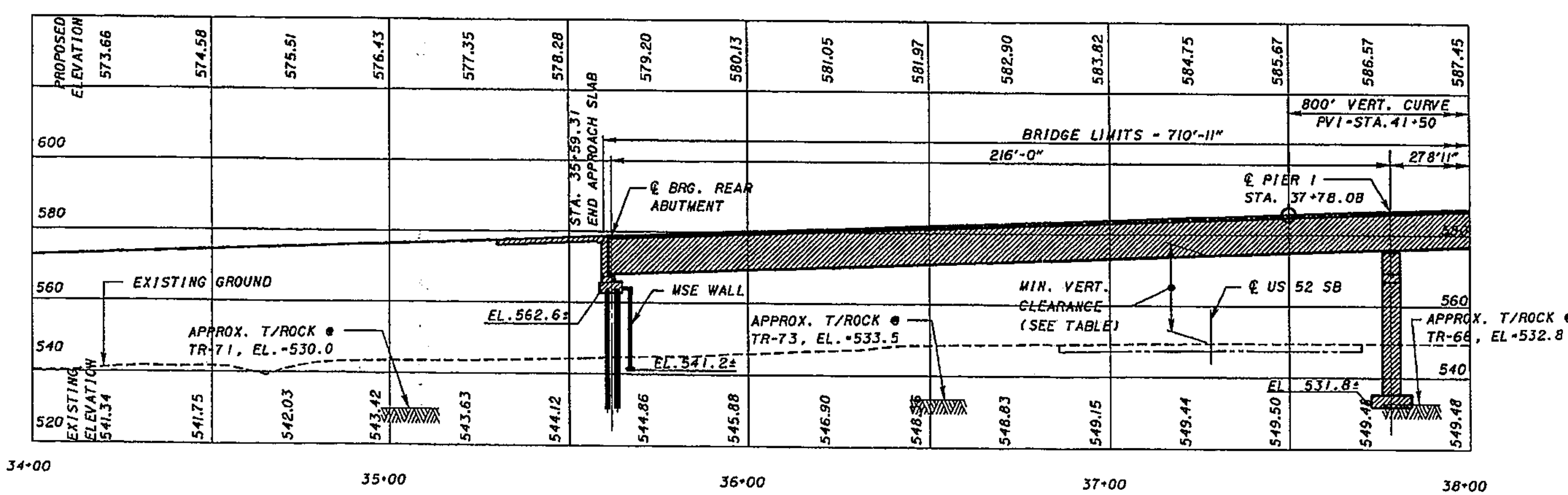
BENCHMARK 1	BENCHMARK 2
(TO BE PROVIDED LATER)	(TO BE PROVIDED LATER)

TRAFFIC DATA

(RAMP B)
CURRENT YEAR ADT (2010) = 13400
DESIGN YEAR ADT (2030) = 21000
CURRENT YEAR ADTT (2010) = 1880
DESIGN YEAR ADTT (2030) = 2940

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.



ELEVATIONS ALONG PROFILE GRADE B RAMP B

PROPOSED STRUCTURE

TYPE: 3 SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W, DOG LEG AT SPLICES WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS.

SPANS: 216'-0" - 278'-11" - 216'-0"

ROADWAY: 30'-0" T/T OF PARAPETS

LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING, FWS = 60 PSF

SKEW: 30°00'00" (MEASURED TO REFERENCE CHORD)
SUPERELEVATION: 4.30%
ALIGNMENT: 1°36'00" CURVE TO THE RIGHT
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (30' LONG)
LATITUDE:
LONGITUDE:

LEGEND

BTA-1 = BRIDGE TERMINAL ASSEMBLY TYPE 1
BTA-2 = BRIDGE TERMINAL ASSEMBLY TYPE 2
⌖ = BORING LOCATION

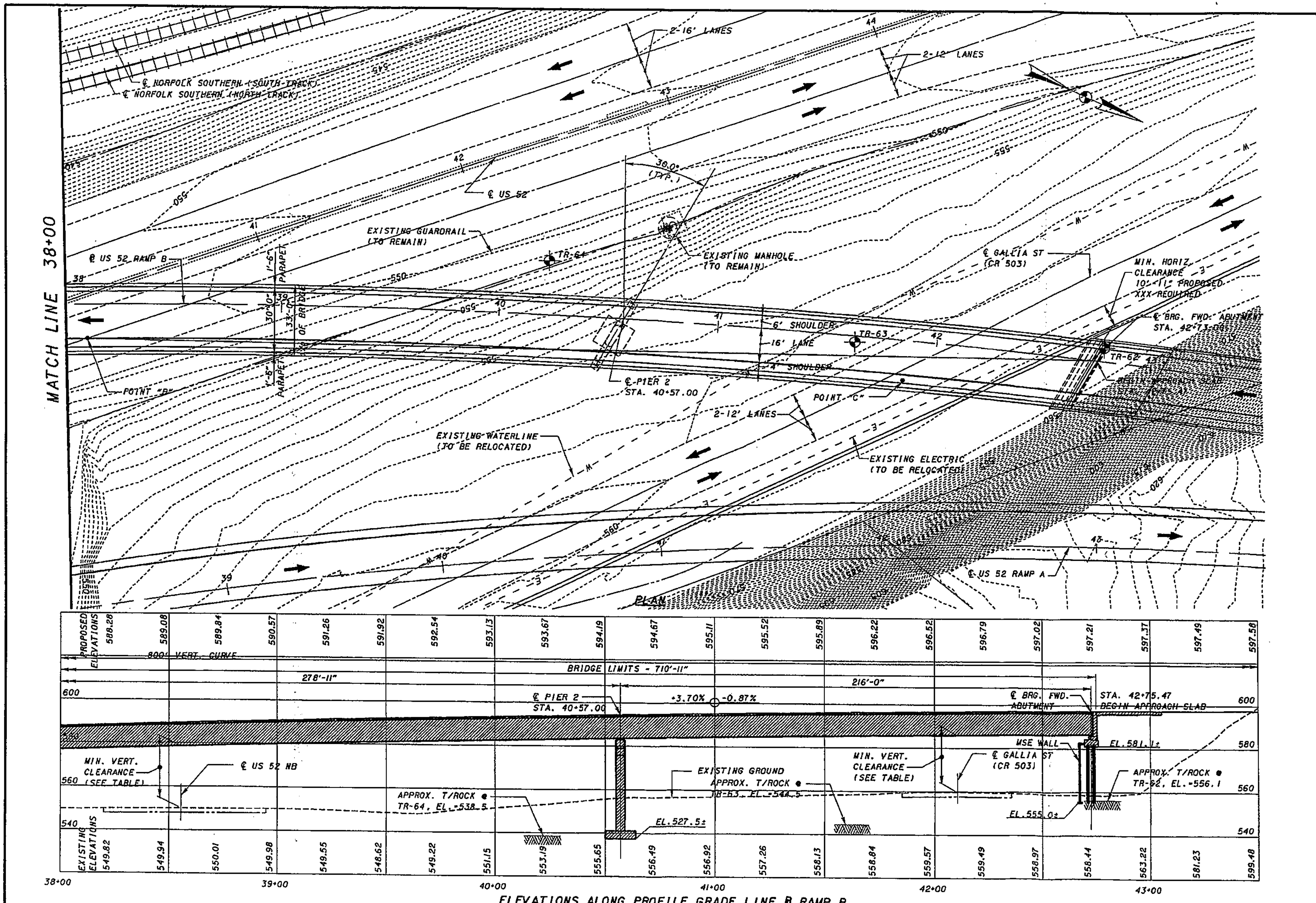
DESIGN AGENCY TranSystems
DESIGNED PJP | CHECKED | DRAWN CAS | REVISED | REVIEWED | DATE | STRUCTURE FILE NUMBER

STA. 35+59.31
STA. 42+75.47

SITE PLAN ALTERNATIVE 2
BRIDGE NO - SCI - 823 - XXX
US-52 RAMP B OVER US-52

SCI-823-0.00
PID 19415

1 / 2



DESIGN AGENCY: Transystems

DESIGNED PJP | DRAWN CAS | REVIEWED | DATE | STRUCTURE FILE NUMBER
CHECKED | REVISED

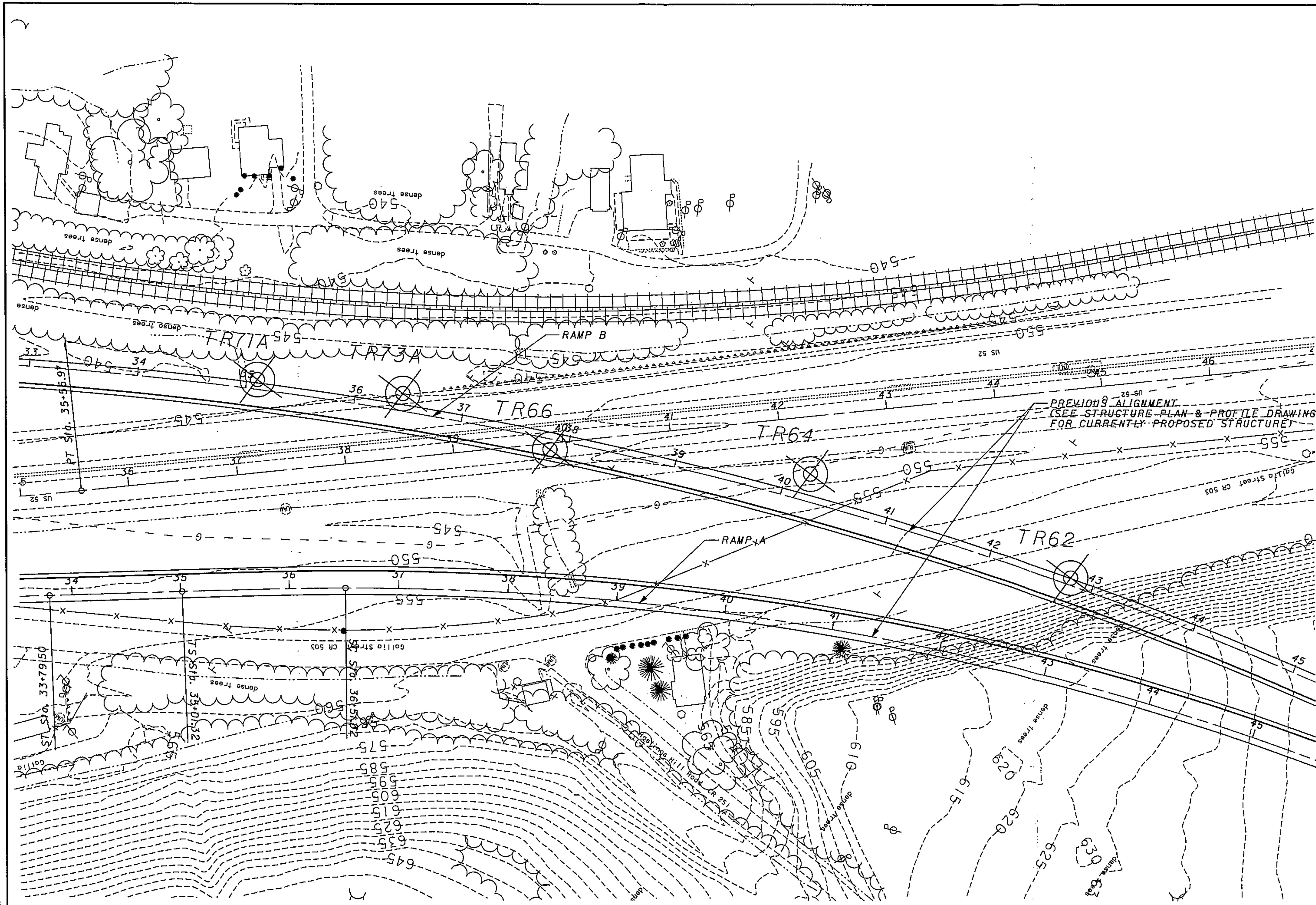
STA. 35+59.31
STA. 42+75.47

SITE PLAN ALTERNATIVE 2

BRIDGE NO. SCI- 3 SPAN
US 52 RAMP B OVER US 52

SCI-823-0.00
PID 19415

2 / 2



0 20 40 80
HORIZONTAL SCALE IN FEET

CALCULATED
CHECKED

US 52 RMP B OVER OHIO RIVER RD AND US 52
PRILIMINARY STRUCTURE BORING PLAN

SCI-823

APPENDIX II

General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Boring Logs – Two (2) Borings

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.

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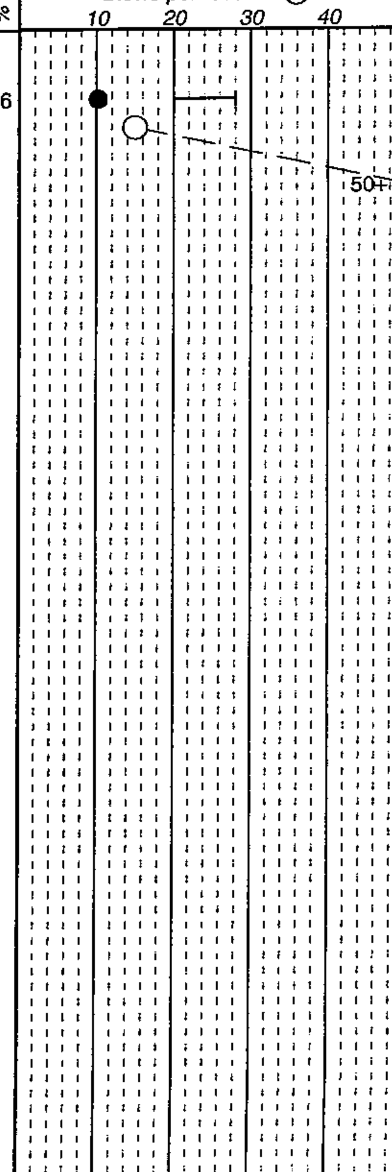
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-62 | Location: As Per Plan | Date Drilled: 3-18-05

WATER OBSERVATIONS: Water seepage at: None Observed
Water level at completion: None (prior to coring)
1.9' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	559.1												
		8 9 6	14	1		3.5	Very stiff gray SANDY SILT (A-4a), little gravel, little clay; contains sandstone fragments; damp.	17	15	--	6	46	16
3.5	555.6	50/2	2	2			Soft to medium hard gray SANDSTONE; fine grained, highly weathered to decomposed, broken.						
6.0	553.1	Core 120"	Rec 120"	RQD 78%	R-1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, thinly bedded, slightly fractured. @ 9.3', qu = 10,794 psi. @ 11.2' to 11.3' high angle fracture.						
16.0	543.1						Bottom of Boring - 16.0'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 | 10/24/2006 3:02 PM |

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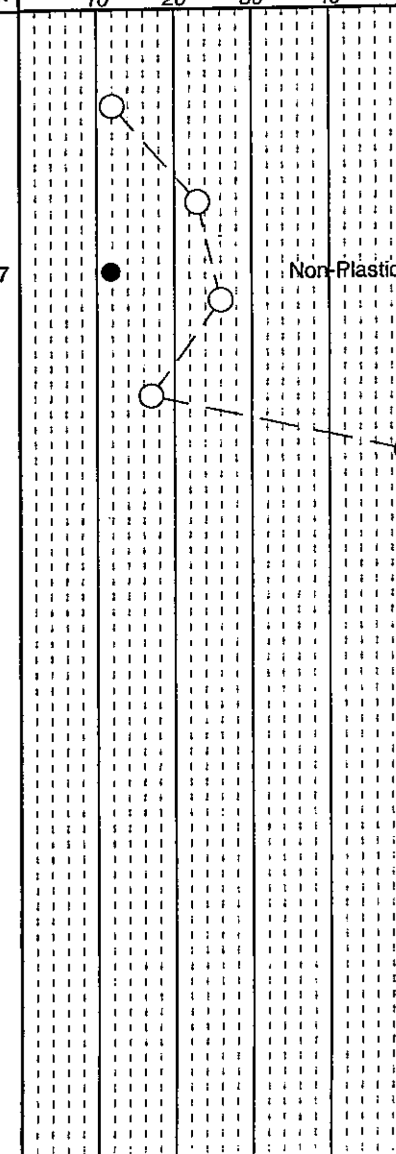
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-64 | Location: As Per Plan | Date Drilled: 3/30/05

WATER OBSERVATIONS: Water seepage at: None
Water level at completion: 0.0' (inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
	548.4												
0.1	548.3						Topsoil - 1"						
		6 7 5	14	1			Medium dense brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay; contains sandstone fragments; damp to moist.						
		7 11 12	16	2									
		7 11 15	17	3				21	19	--	25	28	7
		4 7 10	16	4									
10.5	537.9						Medium hard to hard brown SANDSTONE; moderately to highly weathered.						
		50/4	2	5									
11.5	536.9						Hard brown and gray SANDSTONE; very fine to fine grained, moderately to highly weathered, thickly bedded to massive, highly fractured. @ 15.3', clay seam @ 15.7', gray.						
		Core 120"	Rec 118"	RQD 11%	R1		@ 19.5', qu = 12,706 psi.						
21.5	526.9						Bottom of Boring - 21.5'						



FILE: 0121-3070-03 | 10/24/2006 3:02 PM]

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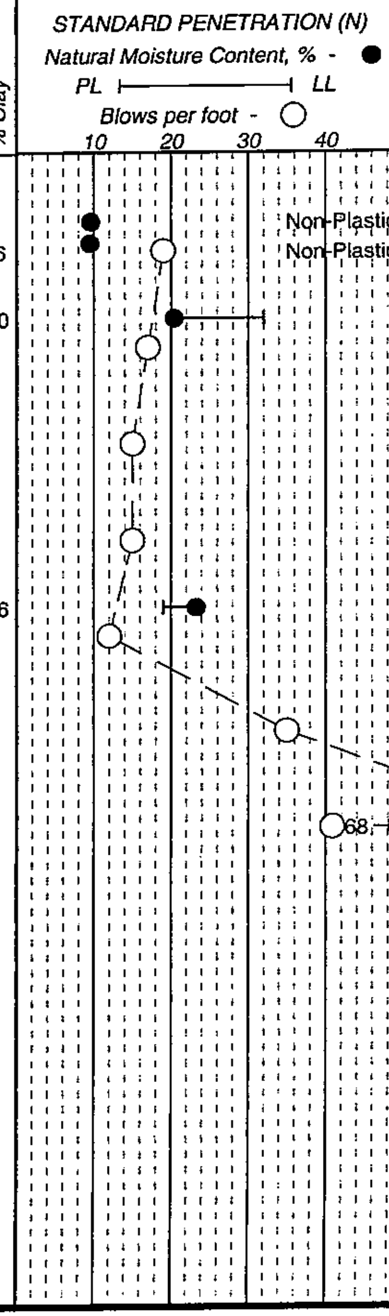
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-66 | Location: As Per Plan | Date Drilled: 3/30/05

WATER OBSERVATIONS: Water seepage at: 16.0'-17.0'
Water level at completion: 14.0' (prior to coring rock)
8.0' (inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	549.8						Asphalt Concrete Pavement - 10.0"						
0.8	549.0						Medium dense gray GRAVEL WITH SAND (A-1-b), trace silty clay; damp.						
1.3	548.5	11 10 9	12	1A				44	28	--	19	9	
				1B				19	27	--	27	21	6
3.0	546.8						Medium dense brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay; damp.						
		5 7 10	13	2		3.5	Very stiff brown SILT AND CLAY (A-6a), little fine to coarse sand; damp to moist.	0	1	--	12	57	30
5.5	544.3						Stiff to very stiff brown SILT (A-4b), little clay, little fine sand, trace coarse sand; contains sandstone fragments; damp.						
		10 7 8	10	3		2.0							
		7 10 5	9	4		2.0							
		8 5 7	17	5		2.5	@ 11.0' to 12.5', damp to moist.	0	1	--	19	64	16
		3 6 29	14	6									
		11 18 50/3	13	7									
17.0	532.8						Hard brown SANDSTONE; very fine to fine grained, slightly to highly weathered, argillaceous, micaceous, thickly bedded to massive, moderately to highly fractured. @ 19.1', gray. @ 17.5' to 20.0', broken.						
		Core 120"	Rec 120"	RQD 58%	R1		@ 22.8', qu = 11,463 psi.						
27.5	522.3						Bottom of Boring - 27.5'						



FILE: 0121-3070-03 [10/24/2006 6:23 PM]

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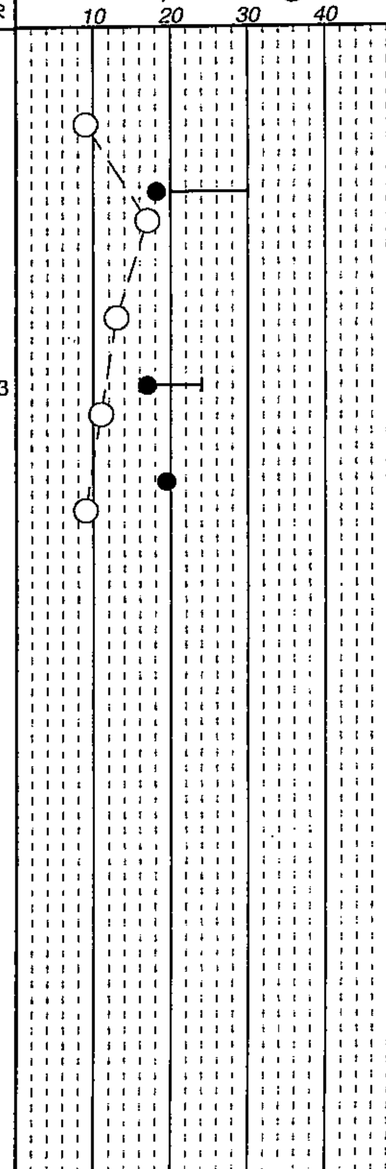
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-71A | Location: As Per Plan | Date Drilled: 07/31/06

WATER OBSERVATIONS: Water seepage at: 9.5' - 12.5'
Water level at completion: None (prior to coring)
3.3' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	542.8												
0.5	542.3						Topsoil - 6"						
		4 5 4	15	1		2.25	Very stiff brown SILT AND CLAY (A-6a), trace fine sand; damp.						
		3 7 10	16	2		2.25	@ 3.0', Mottled brown and gray.	0	1	--	8	91	
		3 5 8	18	3		3.0							
8.5	534.3	2 3 8	18	4			Loose to medium dense brown SANDY SILT (A-4a), trace to little clay; moist.	14	8	--	23	43	13
		1 4 5	18	5			@ 10.5', Moist to wet.						
13.5	529.3	50/3	2	6			Soft to medium hard brown SANDSTONE interbedded with SHALE; fine grained, highly weathered to decomposed, broken, contains argillaceous seams.						
14.7	528.1	Core 120"	Rec 110"	RQD 49%	R-1		Medium hard brown SANDSTONE; fine to medium grained, moderately to highly weathered, broken, contains argillaceous seams. @ 16.7', High angle fracture. @ 16.9', Highly fractured.						
19.8	523.0						Hard gray SANDSTONE; fine to medium grained, slightly to moderately weathered, pyritic (halos), micaceous, thickly bedded to massive, highly to moderately fractured. @ 21.6', qu = 10,209 psi.						
23.9	518.9						Bottom of Boring - 23.9'						
25													
30													

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○



FILE: 0121-3070-03 [10/24/2006 6:23 PM]

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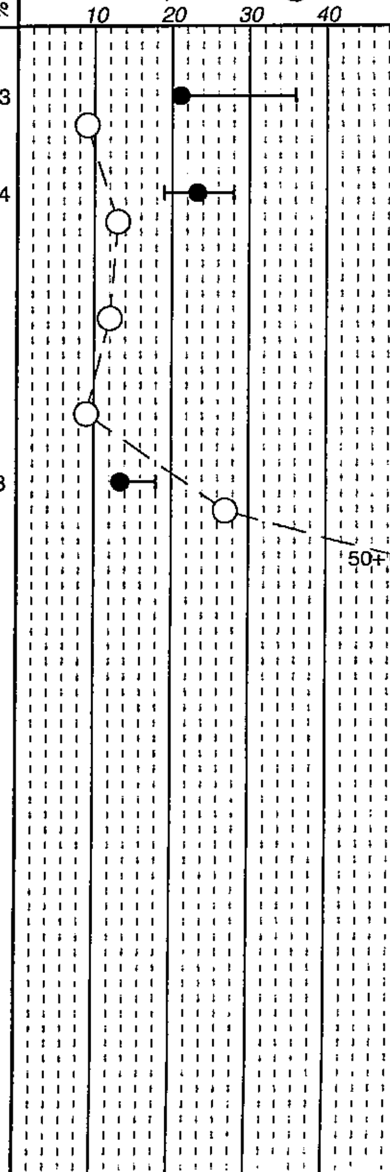
Client: TranSystems, Inc. | Project: SCI-823-0.00 | Job No. 0121-3070.03

LOG OF: Boring TR-73A | Location: As Per Plan | Date Drilled: 07/27/06

WATER OBSERVATIONS: Water seepage at: 7.3' - 7.4', 11.0' - 12.0'
Water level at completion: None (prior to coring)
1.6' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	544.8												
0.5	544.3						Topsoil - 6"						
		4 4 5	16	1			Stiff to very stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; damp to moist.	1	1	--	4	62	33
3.0	541.8	4 7 6	18	2		2.0	Stiff brown SILT (A-4b), some clay, trace fine to coarse sand, trace aggregate; moist.	1	1	--	7	67	24
		4 4 8	18	3		1.5							
		3 5 4	18	4		1.5							
10.5	534.3	5 8 19	18	5A 5B			Medium dense brown GRAVEL WITH SAND AND SILT (A-2-4); damp to moist.	28	15	--	27	22	8
12.0	532.8	50/3	3	6			Soft to medium hard brown SANDSTONE interbedded with SHALE; fine grained, highly weathered to decomposed, broken, contains argillaceous seams.						
13.9	530.9	Core 120"	Rec 107"	RQD 55%	R-1		Medium hard brown SANDSTONE; fine grained, highly weathered, micaceous, thickly bedded, broken, contains clay filled seams. @ 16.3' to 17.9', argillaceous. @ 19.2', 11,260 psi.						
19.2	525.6						Hard gray SANDSTONE; fine grained, slightly weathered, thickly bedded to massive, slightly fractured.						
23.9	520.9						Bottom of Boring - 23.9'						

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ├──┤ LL
Blows per foot - ○

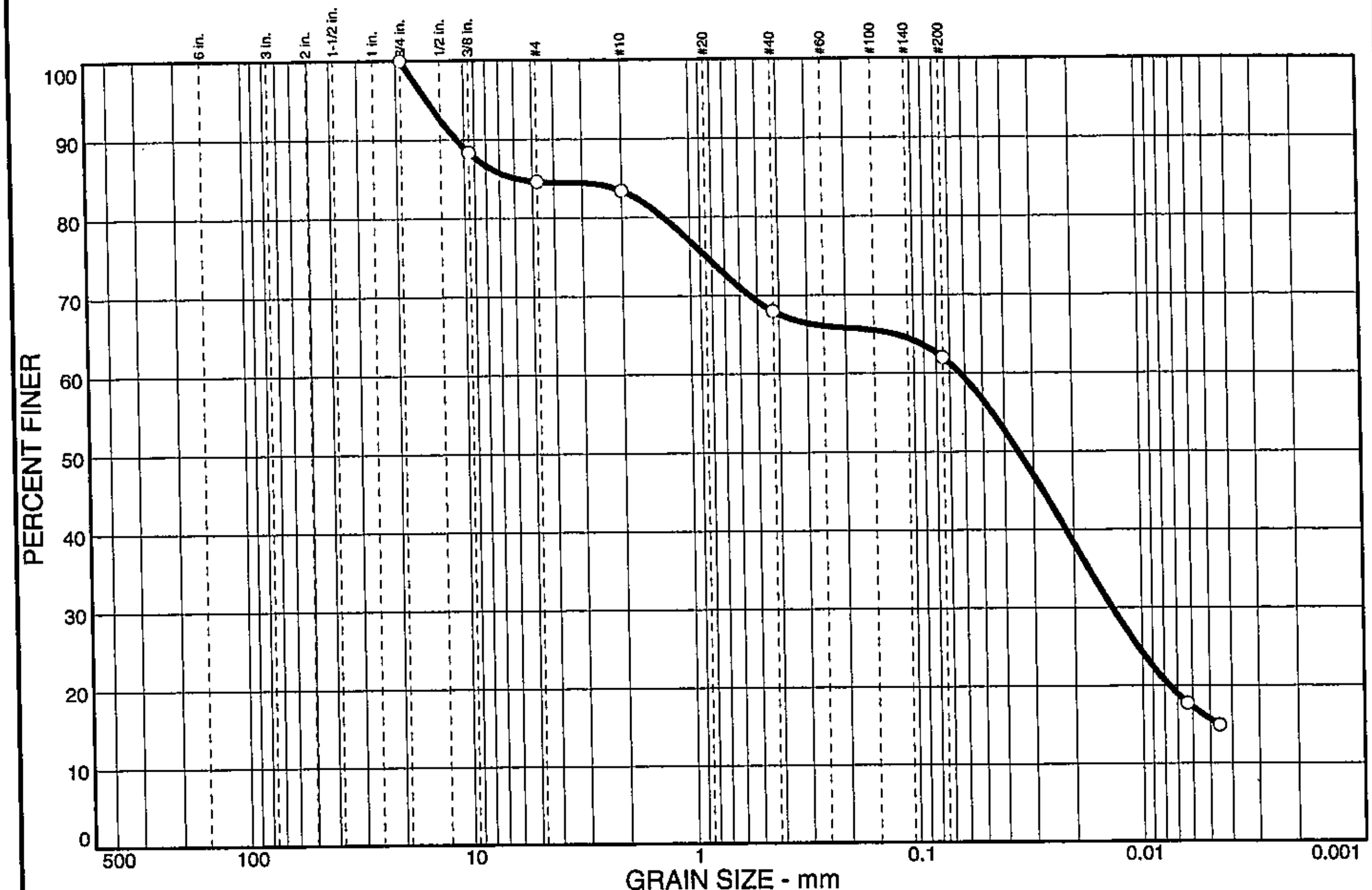


FILE: 0121-3070-03 [10/24/2006 3:02 PM]

APPENDIX III

Laboratory Test Results

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	15.4	1.2	15.4	6.0	46.3	15.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.375 in.	88.3		
#4	84.6		
#10	83.4		
#40	68.0		
#200	62.0		

* (no specification provided)

Soil Description

Sandy lean clay with gravel

Atterberg Limits

PL= 20 LL= 28 PI= 8

Coefficients

D_{85}= 5.86 D_{60}= 0.0631 D_{50}= 0.0350
D_{30}= 0.0136 D_{15}= 0.0046 D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(3)

Remarks

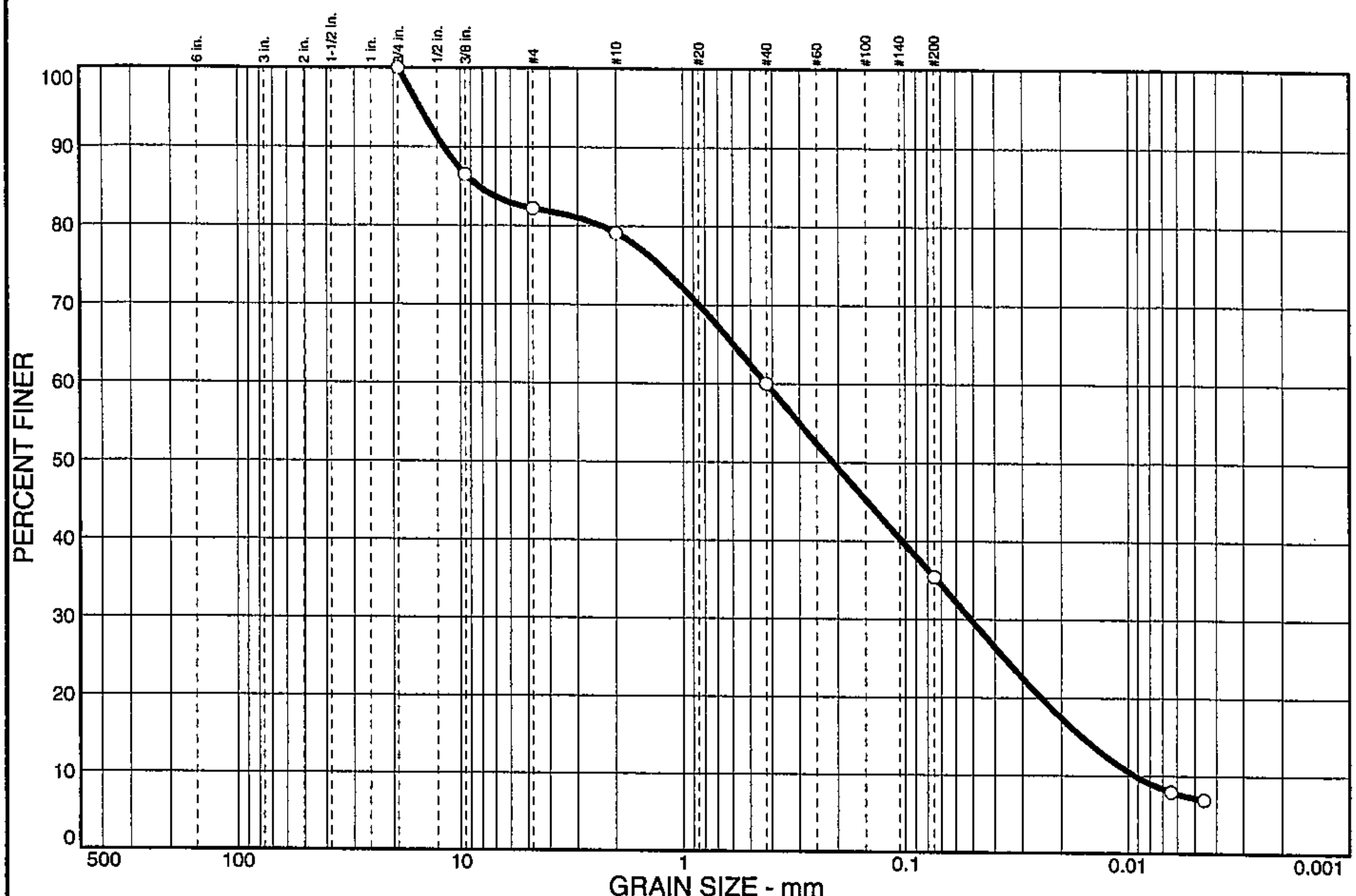
Moisture Content= 10.2%

Sample No.: 1 **Source of Sample:** TR-62 **Date:** 4/12/05
Location: **Elev./Depth:** 1

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	17.8	3.1	19.1	24.6	28.3	7.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.375 in.	86.5		
#4	82.2		
#10	79.1		
#40	60.0		
#200	35.4		

* (no specification provided)

Soil Description

Silty sand with gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 8.33 D_{60}= 0.425 D_{50}= 0.212
D_{30}= 0.0515 D_{15}= 0.0162 D_{10}= 0.0093
C_u= 45.60 C_c= 0.67

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

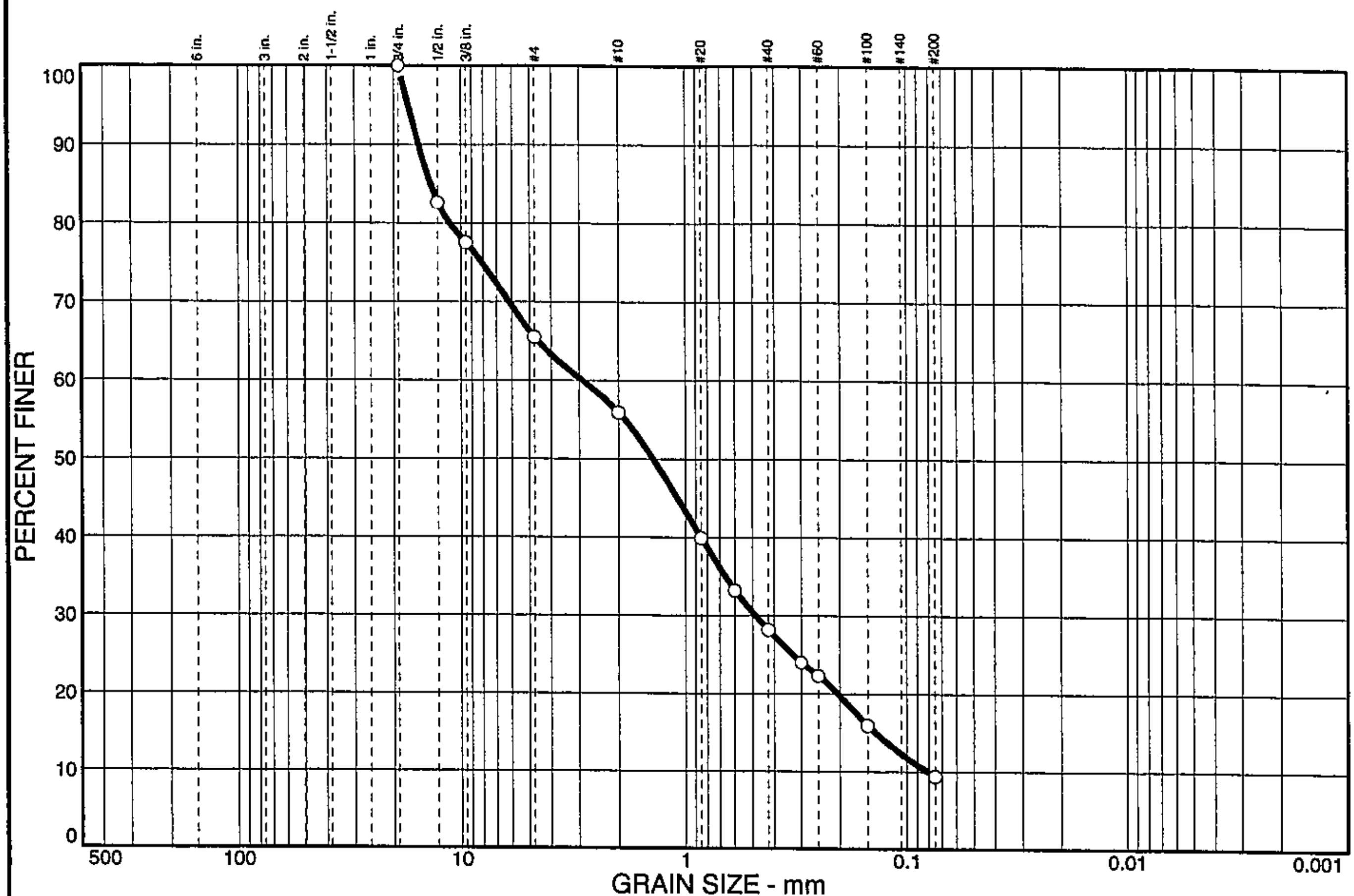
Moisture Content= 11.8%

Sample No.: 3 **Source of Sample:** TR-64 **Date:** 5/28/05
Location: **Elev./Depth:** 6.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	34.5	9.6	27.7	18.8	9.4	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.50 in.	82.6		
0.375 in.	77.5		
#4	65.5		
#10	55.9		
#20	39.9		
#30	33.2		
#40	28.2		
#50	24.0		
#60	22.3		
#100	15.9		
#200	9.4		

* (no specification provided)

Soil Description

Well-graded sand with silt and gravel

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 13.7 D_{60}= 2.90 D_{50}= 1.40
D_{30}= 0.486 D_{15}= 0.139 D_{10}= 0.0809
C_u= 35.92 C_c= 1.00

Classification

USCS= SW-SM AASHTO= A-1-b

Remarks

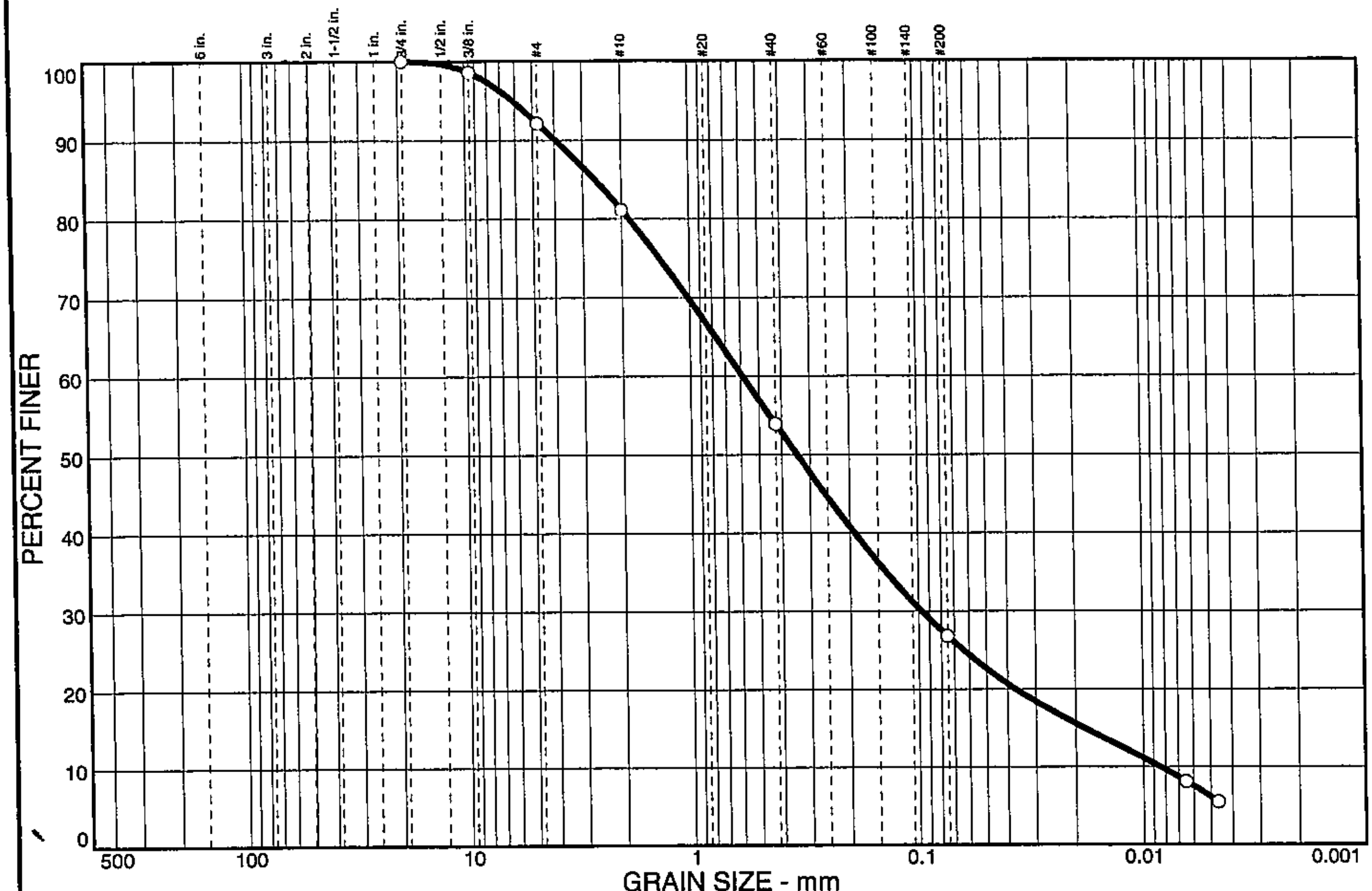
Moisture Content= 9.6%

Sample No.: 1A **Source of Sample:** TR-66 **Date:** 5/28/05
Location: **Elev./Depth:** 1.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	7.9	11.0	27.2	27.1	20.7	6.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.375 in.	98.6		
#4	92.1		
#10	81.1		
#40	53.9		
#200	26.8		

* (no specification provided)

Soil Description

Silty sand

Atterberg Limits

PL= NP LL= NP PI= NP

Coefficients

D_{85}= 2.65 D_{60}= 0.591 D_{50}= 0.343
D_{30}= 0.0972 D_{15}= 0.0184 D_{10}= 0.0085
C_u= 69.78 C_c= 1.89

Classification

USCS= SM AASHTO= A-2-4(0)

Remarks

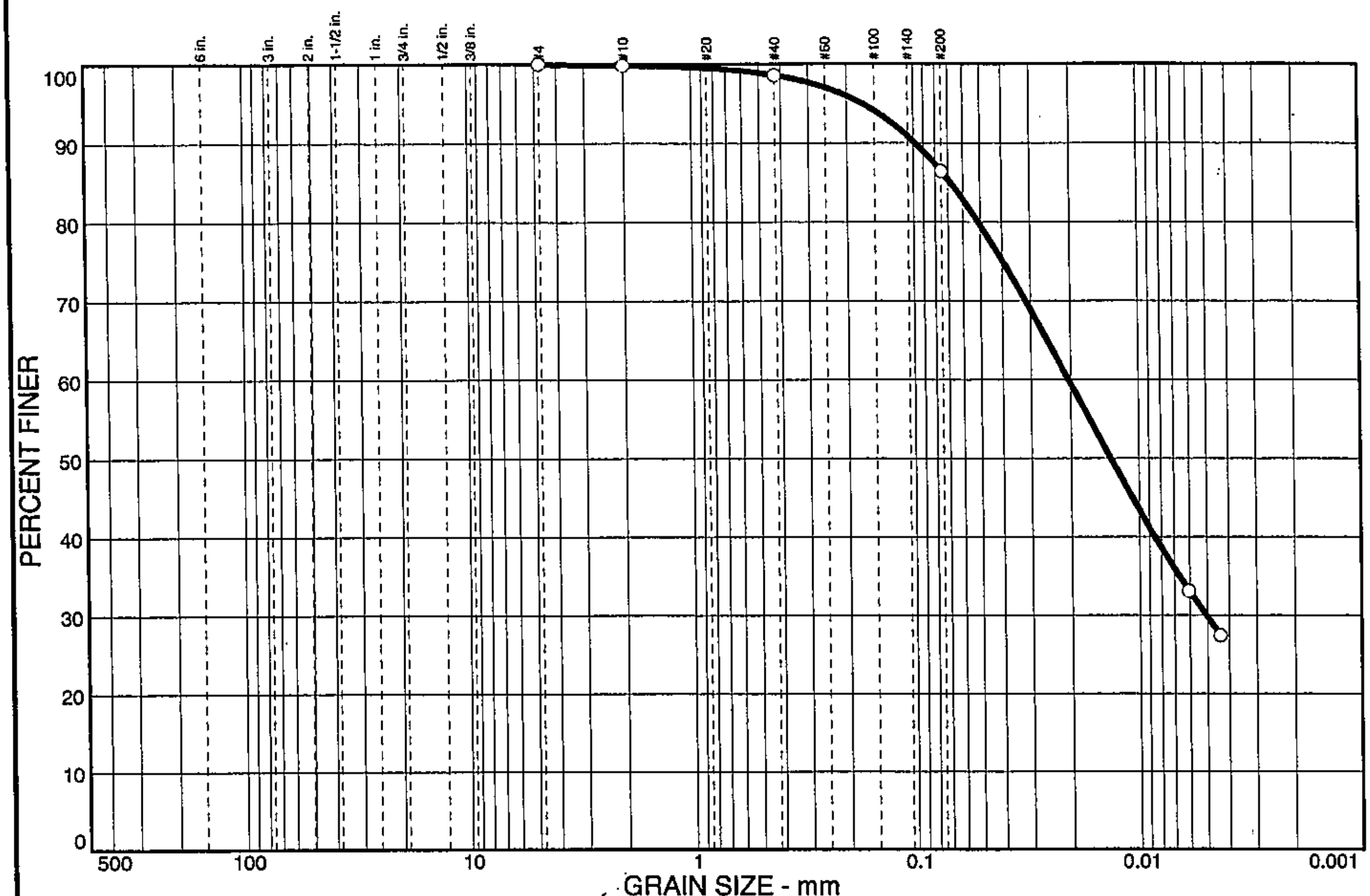
Moisture Content= 9.5%

Sample No.: 1B **Source of Sample:** TR-66 **Date:** 5/28/05
Location: **Elev./Depth:** 2.3

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.2	1.2	12.2	56.7	29.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#4	100.0		
#10	99.8		
#40	98.6		
#200	86.4		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 21 LL= 32 PI= 11

Coefficients

D_{85}= 0.0685 D_{60}= 0.0205 D_{50}= 0.0134
D_{30}= 0.0051 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(9)

Remarks

Moisture Content= 20.4%

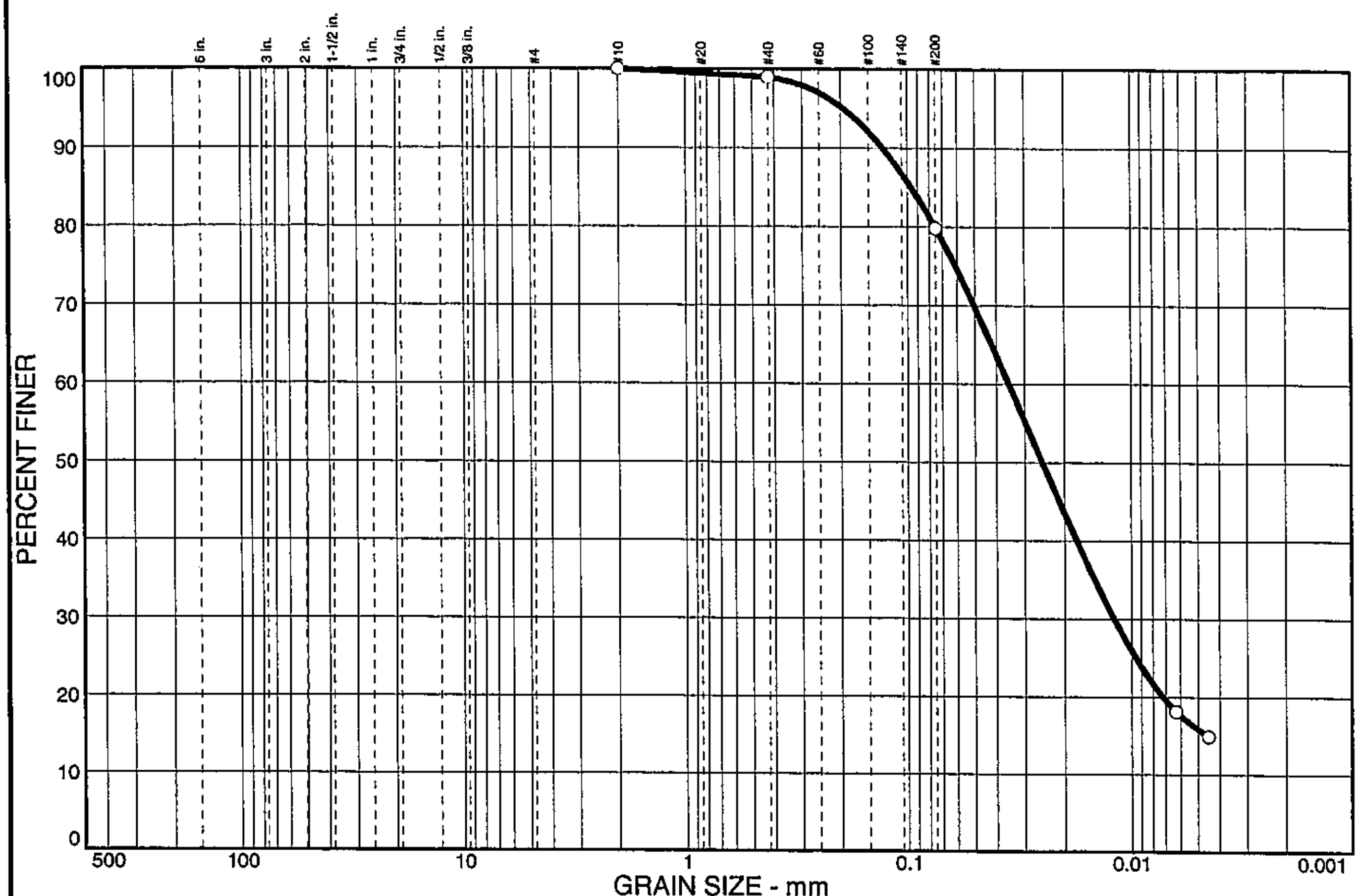
Sample No.: 2 **Source of Sample:** TR-66 **Date:** 5/28/05
Location: **Elev./Depth:** 3.5

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00

Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	1.0	19.2	64.0	15.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#40	99.0		
#200	79.8		

* (no specification provided)

Soil Description

Silty clay with sand

Atterberg Limits

PL= 19 LL= 24 PI= 5

Coefficients

D_{85}= 0.0964 D_{60}= 0.0354 D_{50}= 0.0252
D_{30}= 0.0120 D_{15}= 0.0045 D_{10}=
C_u= C_c=

Classification

USCS= CL-ML AASHTO= A-4(2)

Remarks

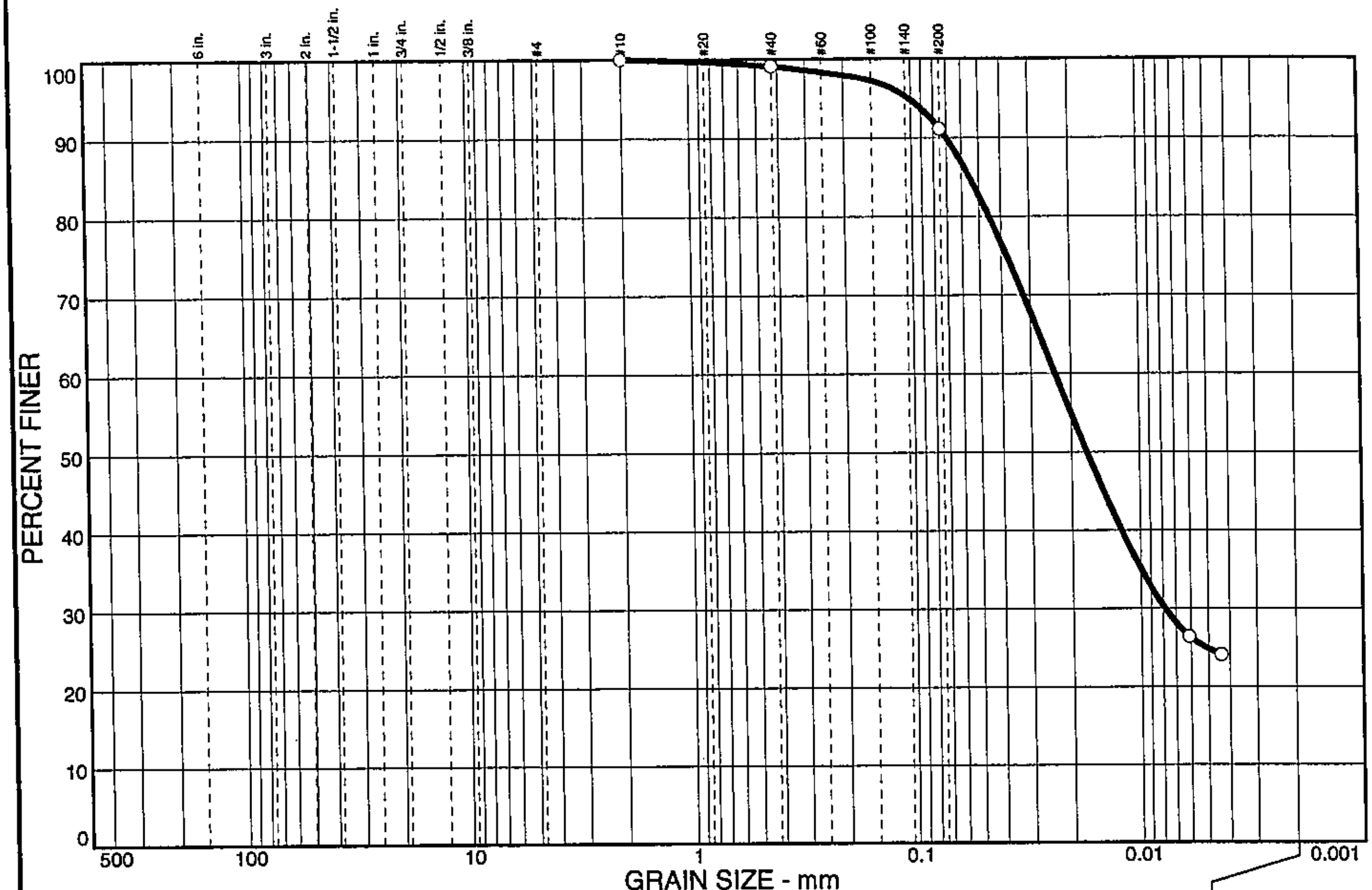
Moisture Content= 23.3%

Sample No.: 5 **Source of Sample:** TR-66 **Date:** 5/28/05
Location: **Elev./Depth:** 11.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.0	0.0	0.9	8.0	91.1	

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
#10	100.0		
#40	99.1		
#200	91.1		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 20 LL= 30 PI= 10

Coefficients

D_{85}= 0.0553 D_{60}= 0.0235 D_{50}= 0.0172
D_{30}= 0.0078 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(8)

Remarks

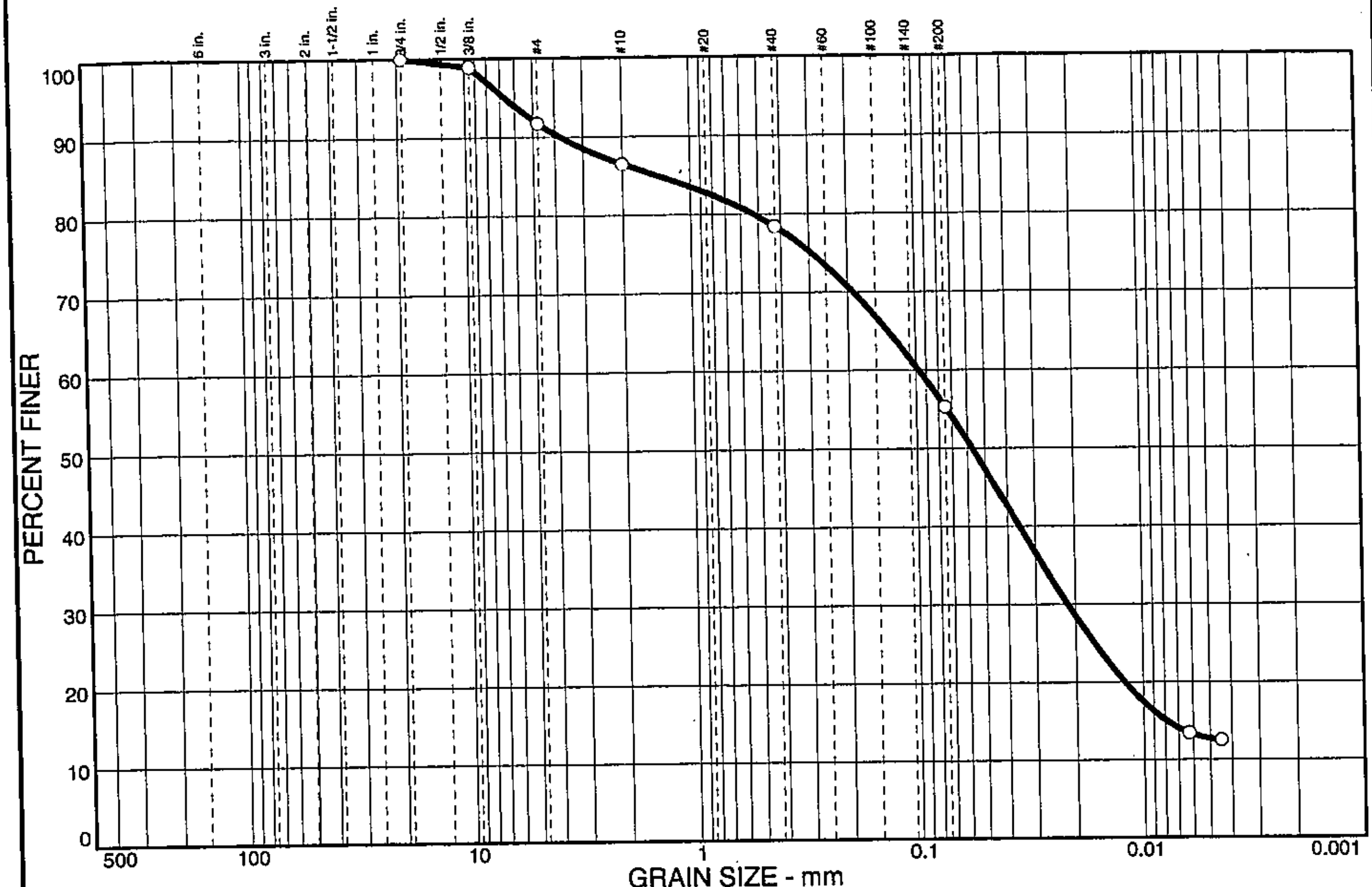
Moisture Content= 18.2%

Sample No.: 2 **Source of Sample:** TR-71A **Date:** 10/23/06
Location: **Elev./Depth:** 3.5

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	8.3	5.2	8.1	23.1	42.6	12.7

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.375 in.	98.9		
#4	91.7		
#10	86.5		
#40	78.4		
#200	55.3		

* (no specification provided)

Soil Description

Sandy lean clay

Atterberg Limits

PL= 16 LL= 24 PI= 8

Coefficients

D_{85}= 1.41 D_{60}= 0.0974 D_{50}= 0.0572
D_{30}= 0.0217 D_{15}= 0.0079 D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(2)

Remarks

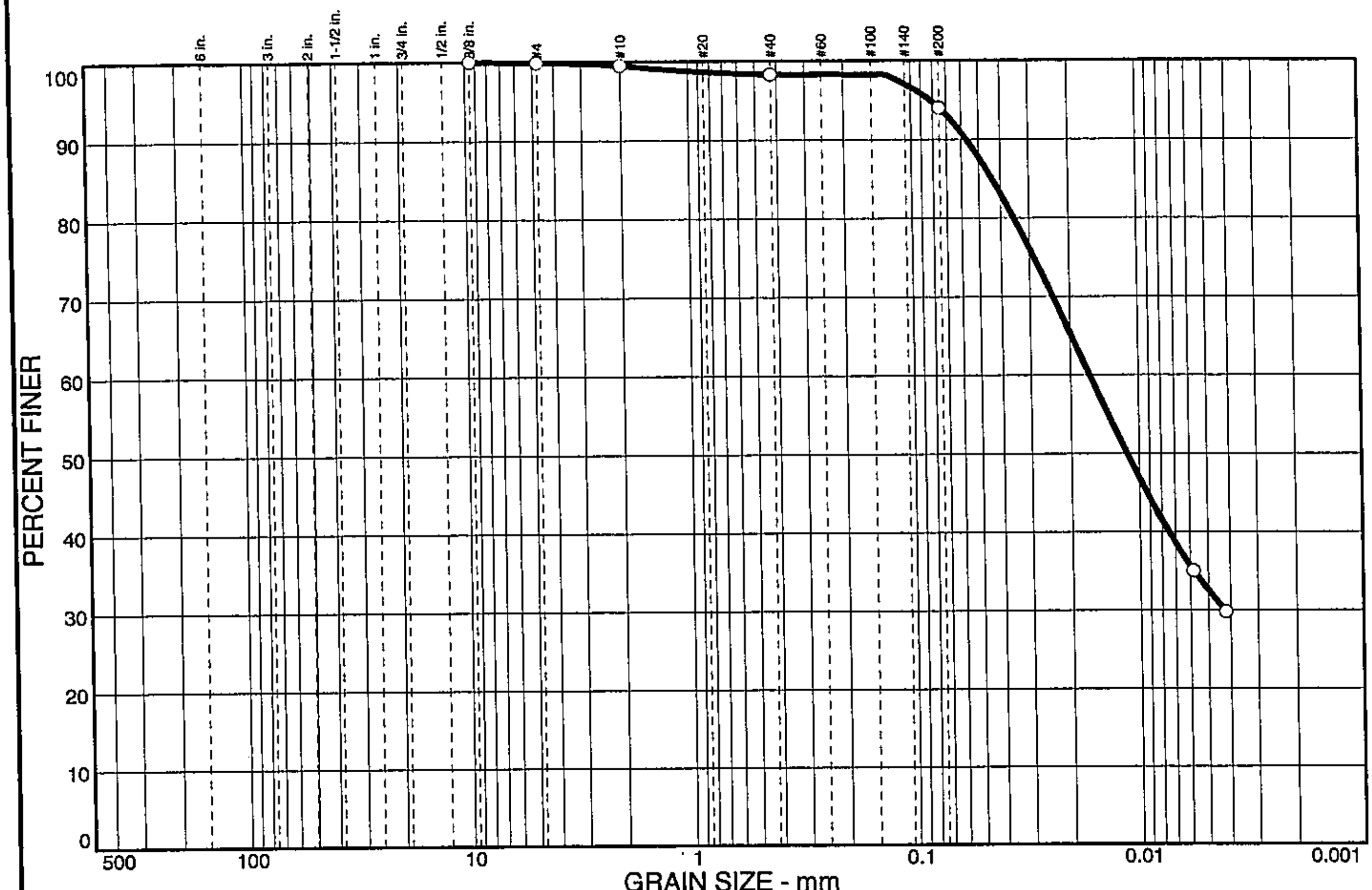
Moisture Content= 17.0%

Sample No.: 4 **Source of Sample:** TR-71A **Date:** 10/23/06
Location: **Elev./Depth:** 8.5

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	0.4	1.2	4.3	61.5	32.5

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	99.9		
#10	99.5		
#40	98.3		
#200	94.0		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 21 LL= 36 PI= 15

Coefficients

D_{85}= 0.0440 D_{60}= 0.0165 D_{50}= 0.0114
D_{30}= 0.0042 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-6(15)

Remarks

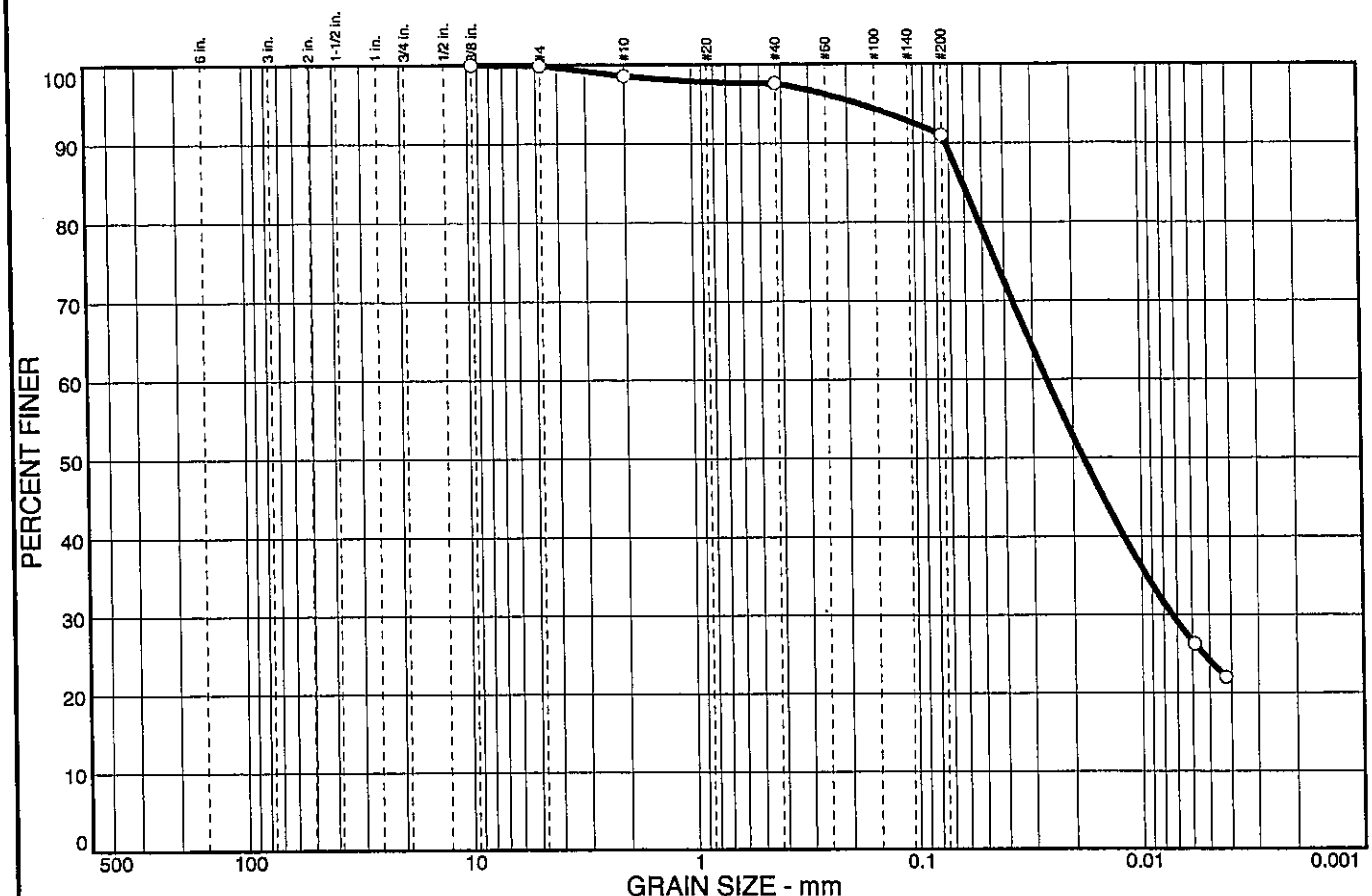
Moisture Content = 21.1%

Sample No.: 1 **Source of Sample:** TR-73A **Date:** 08/16/06
Location: **Elev./Depth:** 1.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	0.1	1.3	1.0	6.6	66.9	24.1

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.375 in.	100.0		
#4	99.9		
#10	98.6		
#40	97.6		
#200	91.0		

* (no specification provided)

Soil Description

Lean clay

Atterberg Limits

PL= 19 LL= 28 PI= 9

Coefficients

D_{85}= 0.0613 D_{60}= 0.0261 D_{50}= 0.0181
D_{30}= 0.0074 D_{15}= D_{10}=
C_u= C_c=

Classification

USCS= CL AASHTO= A-4(7)

Remarks

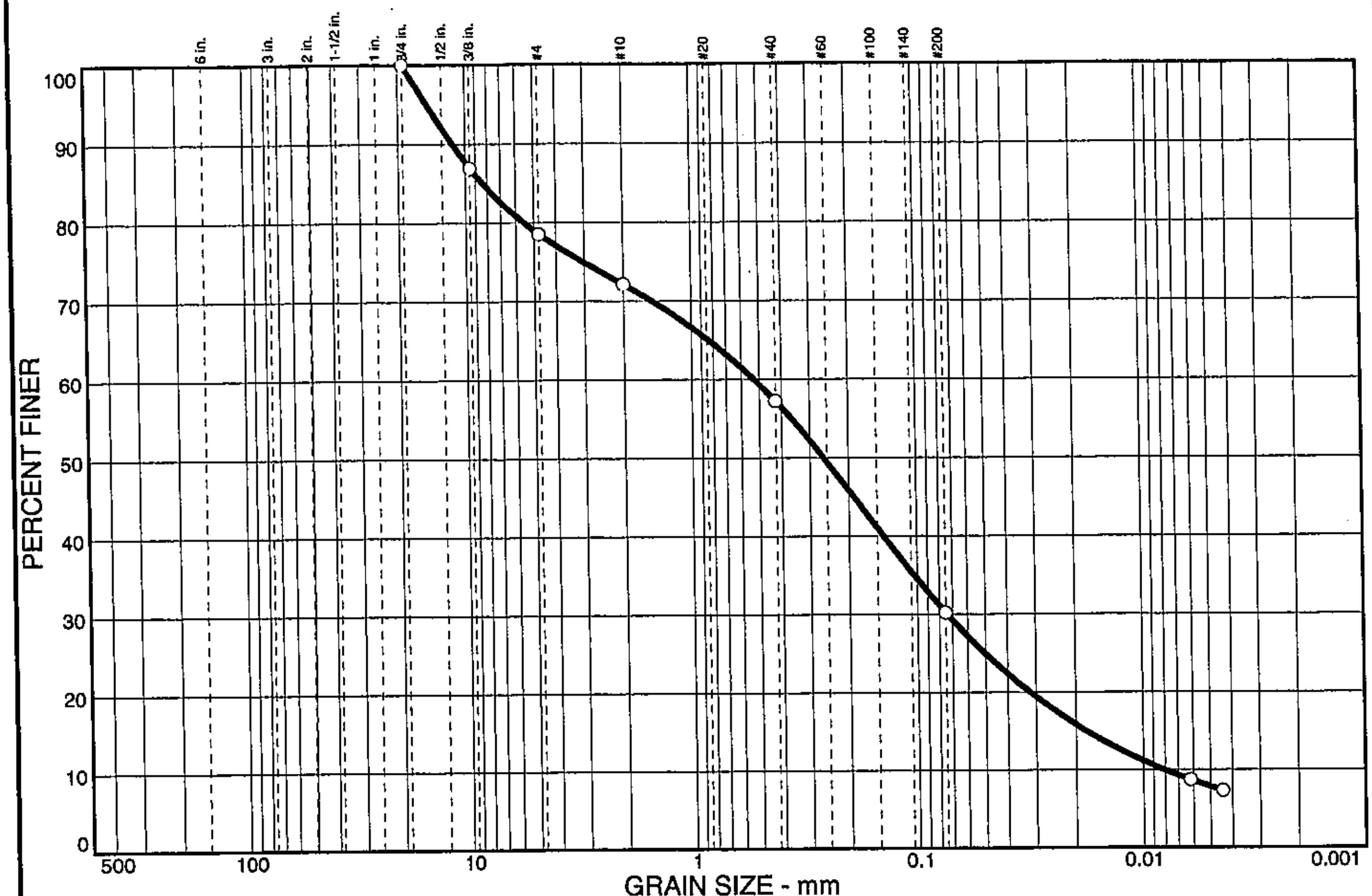
Moisture Content = 23.3%

Sample No.: 2 **Source of Sample:** TR-73A **Date:** 08/16/06
Location: **Elev./Depth:** 3.5

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00
Project No: 0121-3070.03 **Figure**

PARTICLE SIZE DISTRIBUTION TEST REPORT



% COBBLES	% GRAVEL		% SAND			% FINES	
	CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
0.0	0.0	21.5	6.4	14.9	27.0	22.4	7.8

SIEVE SIZE	PERCENT FINER	SPEC.* PERCENT	PASS? (X=NO)
0.75 in.	100.0		
0.375 in.	86.9		
#4	78.5		
#10	72.1		
#40	57.2		
#200	30.2		

* (no specification provided)

Soil Description

Silty, clayey sand with gravel

Atterberg Limits

PL= 14 LL= 18 PI= 4

Coefficients

D_{85}= 8.40 D_{60}= 0.529 D_{50}= 0.261
D_{30}= 0.0739 D_{15}= 0.0180 D_{10}= 0.0081
C_u= 65.31 C_c= 1.27

Classification

USCS= SC-SM AASHTO= A-2-4(0)

Remarks

Moisture Content = 13.4%

Sample No.: 5A **Source of Sample:** TR-73A **Date:** 08/16/06
Location: **Elev./Depth:** 11.0

DLZ

Client: TranSystems, Inc.
Project: SCI-823-0.00

Project No: 0121-3070.03 **Figure**

Unconfined Compression of Rock Core Specimens
(ASTM D-2938)

DLZ Project No.: 0121-3070.03

Client: TranSystems

Project Name: SCI-823-0.00

Date: 10/3/2006

Boring	Run	Depth (ft.)	D_1	D_2	D_3	$D_{(ave)}$	L_1	L_2	L_3	$L_{(ave)}$	L/D	Volume (ft^3)	Mass (Gram)	Unit Wt.(pcf)	Load (lbs)	Strength (psi)
TR-62	1	9.3'-9.7'	1.989	1.987	1.991	1.989	4.691	4.696	4.677	4.688	2.357	0.0084284	590.26	154.40	33,550	**10,794**
			1.989	1.991	1.989											
TR-64	1	19.5'-19.8'	1.980	1.982	1.979	1.982	4.393	4.395	4.392	4.393	2.217	0.0078379	525.02	147.68	39,190	**12,706**
			1.982	1.983	1.984											
TR-66	1	22.8'-23.3'	1.981	1.982	1.980	1.982	4.694	4.678	4.677	4.683	2.362	0.0083603	548.51	144.64	35,380	**11,463**
			1.982	1.982	1.987											
TR-73A	1	19.2'-19.6'	1.969	1.980	1.979	1.977	4.538	4.541	4.539	4.539	2.296	0.0080589	521.31	142.61	34,560	**11,260**
			1.983	1.967	1.983											
TR-71A	1	21.6'-22.0'	1.980	1.990	1.981	1.981	4.781	4.771	4.760	4.771	2.409	0.008501	551.65	143.06	31,450	**10,209**
			1.980	1.976	1.976											

DLZ

Engineers * Architects * Scientists

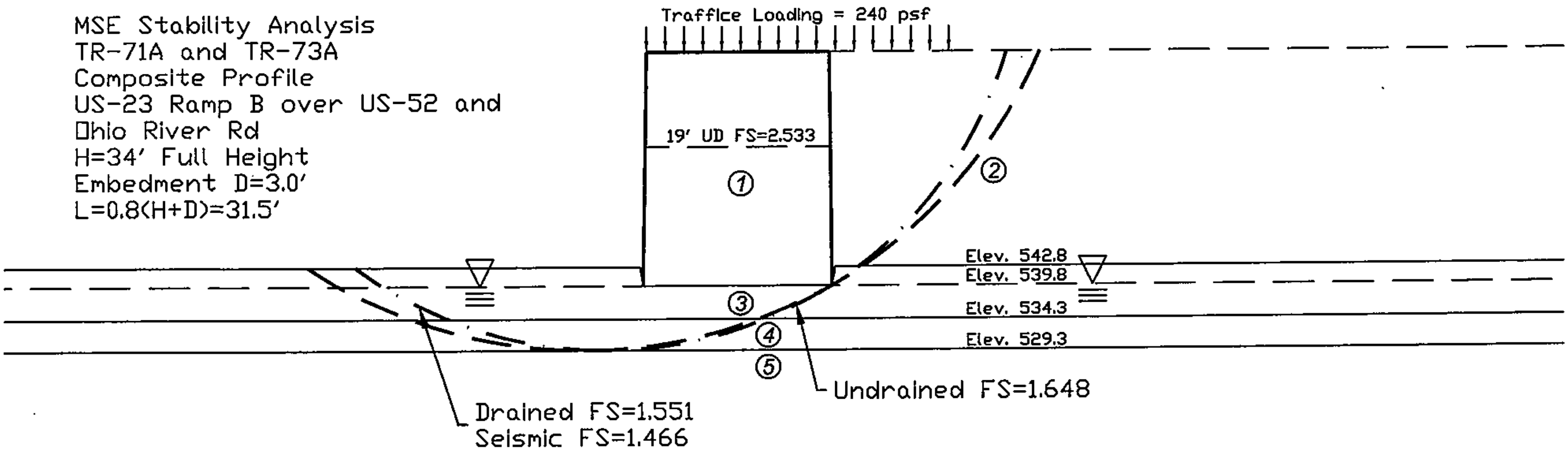
6121 Huntley Road * Columbus, Ohio * 43229-1003 * Phone: (614) 888-0576 * Fax (614) 888-6415

APPENDIX IV

MSE Wall Global Stability Analysis Results
MSE Wall Bearing Capacity and Stability Calculations
MSE Wall Settlement Calculations
Drilled Shaft – End Bearing and Side Resistance Calculations

Material	Consistency	Soil Type	Undrained C (psf)	Undrained φ (deg)	Drained C' (psf)	Drained φ' (deg)	γ (pcf)
Material 1	Compacted	MSE Fill	0	34	0	34	120
Material 2	Compacted	Emb. Fill	0	30	0	30	120
Material 3	Stiff	Silt and Clay	1500	0	0	29	120
Material 4	M. Dense	Sandy Silt/Grvl	0	29	0	29	120
Material 5		BEDROCK	10000	45	10000	45	145

MSE Stability Analysis
TR-71A and TR-73A
Composite Profile
US-23 Ramp B over US-52 and
Ohio River Rd
H=34' Full Height
Embedment D=3.0'
L=0.8(H+D)=31.5'



Sheet 1 of 9

US-52 Ramp B over US-52
and Ohio River Road
BASED ON BORING TR-73A and TR-71A PROFILE

MSE STABILITY ANALYSIS

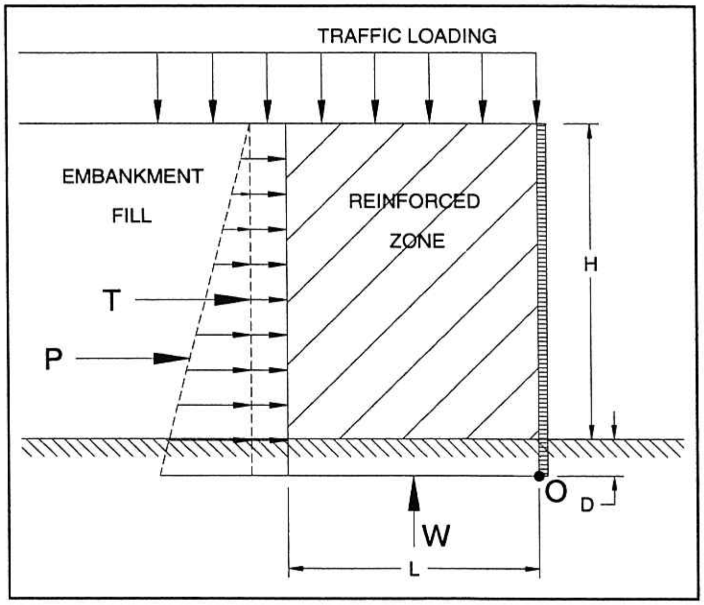
SCI-823-0.00

PROJECT NO. 0121-3070.03	CALC: SJR	DATE 10/20/06

STABILITY OF MSE WALL

Assumptions:	Wall Properties				Foundational Soil Properties				
1 Estimated height of embankment; H=34'	H+D	=	37	feet	c	=	1500	psf	Cohesion
2 It is assumed that abutment is supported on deep foundations	γ_{mse}	=	120	pcf	ϕ'	=	29	deg	Friction angle
3 Ground water; Dw=0.0'	L	=	31.45	feet	ω_T	=	240	psf	Traffic loading
4 Traffic loading is neglacted in resisting forces	L factor	=	0.85		Length factor-range (0.7 - 1.0)				
5	ϕ	=	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 = 30,037 lbs per foot of wall

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

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

0.67μ Max. = 0.35 {AASHTO, Bridge Design Manual, 303.4.1.1}

P_r = 48,873 lbs per foot of wall

Use Undrained Value

$P_r = L(c)$ (Undrained)

P_r = 47,175 lbs per foot of wall

USE THIS VALUE

$FS = \frac{P_r}{P_a}$

Calculated: FS = **1.57**

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

$\Sigma M_{resisting}$ = 2,195,808 lb-ft

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

$\Sigma M_{overturning}$ = 388,522 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 = **5.65**

Required: FS = 2.00

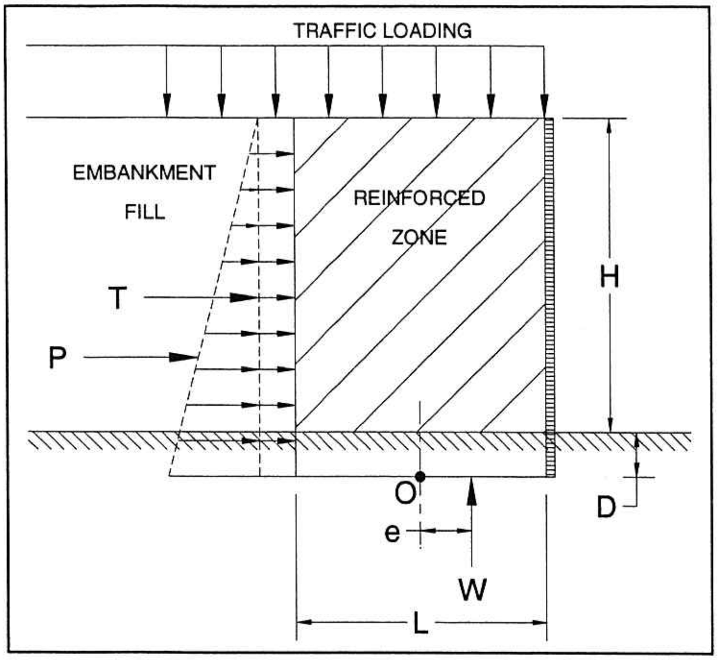
Resistance Against Overturning is **OK**

DLZ

SUBJECT			
Client	TranSystems	JOB NUMBER	0121-3070.03
Project	SCI 823-0.00 Portsmouth Bypass	SHEET NO.	3 OF 9
Item	MSE Wall Bearing Capacity	COMP. BY	SJR DATE 10/19/06
US-52 Ramp B Rear Abutment Alternative 2		CHECKED BY	EWT DATE 10-24-06

BEARING CAPACITY OF A MSE WALL

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



Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	1500	psf	Cohesion	Foundation soil
ϕ	=	0	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	31.45	ft	Length of MSE reinforcement
L factor	=	0.85		Length factor-range (0.7 - 1.0)
D	=	3	ft	Embedment depth
Dw	=	3	ft	Groundwater depth
H+D	=	37	ft	
H	=	34	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	12.333	ft	Moment arm
Γ Wt	=	18.5	ft	Moment arm
B'	=	26.17	ft	
γ'	=	57.6	pcf	
W_t		7,548	lb/ft of wall	Weight from traffic
W_{mse}	=	139,638	lb/ft of wall	Weight from MSE wall

Effective Bearing Pressure

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

σ_v = 5,624 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 7,883 psf

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

q_{ALL} = 3,153 psf

Factor of Safety = **1.40** **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} = 17,417 psf

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

q_{ALL} = 6,967 psf

Factor of Safety = **3.10** **OK**

Bearing Capacity Factors for Equations (AASHTO)

Undrained		Drained	
N_c	5.14	N_c	27.86
N_q	1.00	N_q	16.44
N_γ	0.00	N_γ	19.34

Eccentricity of Resultant Force

e = 2.64 ft

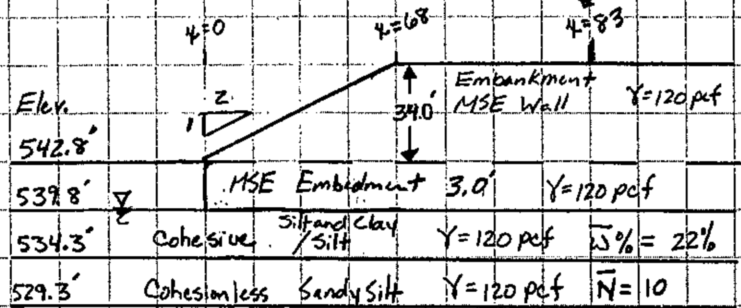
Kern

e < L/6 = 5.24 ft

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

CLIENT: TranSystems Corp. / ODOT D-9 PROJECT NO. 0121-3070.03
PROJECT: SCI-823 Portsmouth Bypass SHEET NO. 4 OF 9
SUBJECT: Consolidation Parameters COMP. BY SJR DATE 10-20-06
US-52 Ramp B - Rear Abutment - MSE CHECKED BY GWT DATE 10-23-06

Most Critical Soil Profile is at boring TR-71A location
*Assuming MSE/Embankment height based upon Alt 2, H = 34'.



{Assume Incompressible
{$C_c = 0.22$ $e_o = 0.594$ [FHWA-NHI-00-045]
*{$\bar{N}' \simeq 10 \rightarrow C' \simeq 43$ [FHWA]
↳ [$C_c =$, $e_o = 1.0$] See Calculation Below

* Consolidation Parameters are estimated from FHWA NHI-00-045 for; cohesive soils based upon moisture and, cohesionless soils based upon average SPT N-values.

The computer program EMBANK requires inputs for C_c, C_r and e_o. To evaluate the settlement of granular layers, we must calculate equivalent consolidation parameters from C'.

$$\frac{1}{C'} = \frac{C_c}{1+e_o}$$

Say $e_o = 1.0$ in this case

$$\frac{1}{C'} = \frac{C_c}{1+1.0} \longrightarrow C' = \frac{2.0}{C_c}$$

$$\boxed{C_c = \frac{2}{C'}}$$

When $C' = 43$, $C_c = \frac{2}{43} = 0.0465$

From EMBANK $\delta_{c_{max}} = 7.03''$

Estimated Differential Settlement (DS)

$$DS = \frac{7.03'' - 0.41''\left(\frac{1 ft}{12''}\right)}{83' - 0'} = 0.0066 = 0.66\%$$

US 52 Ramp B Rear Abutment Settlement

Sheet 5 of 9

ÚÄÄÄÄÄ ONE DIMENSIONAL SETTLEMENT ANALYSIS/Federal Highway Administration ÄÄÄÄÄ¿

INCREMENT OF STRESSES BENEATH THE END OF FILL CONDITION

Project Name	: SCI-823 Portsmouth	Client	: TranSystems
File Name	: US 52 Ramp B Rear A	Project Manager	: NIX
Date	: 10/20/10	Computed by	: SJR
		Checked	: GWT

Settlement for X-Direction

Embank. slope, x direc. =	68.00 (ft)	Height of fill H =	34.00 (ft)
y direc. =	68.00 (ft)	Unit weight of fill =	120.00 (pcf)
Embankment top width =	30.00 (ft)	p load/unit area =	4080.00 (psf)
Embankment bottom width =	166.00 (ft)	Foundation Elev. =	542.80 (ft)
Ground Surface Elev. =	542.80 (ft)		
Water table Elev. =	539.80 (ft)	Unit weight of Wat. =	62.40 (pcf)

N§.	LAYER TYPE	THICK. (ft)	COEFFICIENT COMP.	RECOMP.	SWELL.	UNIT WEIGHT (pcf)	SPECIFIC GRAVITY	VOID RATIO
1	INCOMP.	3.0	Required MSE Embedment			120.00	----	----
2	COMP.	5.5	0.220	0.000	0.000	120.00	2.65	0.59
3	COMP.	5.0	0.046	0.000	0.000	120.00	2.65	1.00

N§.	SUBLAYER THICK. (ft)	ELEV. (ft)	SOIL STRESSES INITIAL (psf)	MAX.PAST PRESS. (psf)
1 INCOMP.	Required MSE Embedment			
2	5.50	537.05	518.40	518.40
3	5.00	531.80	820.80	820.80

Layer	X = 0.00 Stress (psf)	Sett. (in.)	X = 8.30 Stress (psf)	Sett. (in.)	X = 16.60 Stress (psf)	Sett. (in.)	X = 24.90 Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	47.04	0.34	252.68	1.57	497.51	2.67	746.10	3.54
3	100.24	0.07	277.61	0.17	507.11	0.29	748.58	0.39
		0.41		1.75		2.96		3.92

Settlement at TOE of MSE Wall

Layer	X = 33.20 Stress (psf)	Sett. (in.)	X = 41.50 Stress (psf)	Sett. (in.)	X = 49.80 Stress (psf)	Sett. (in.)	X = 58.10 Stress (psf)	Sett. (in.)
1	INCOMP.	INCOMP.	INCOMP.	INCOMP.				
2	991.79	4.24	1234.69	4.83	1478.38	5.35	1722.03	5.80
3	992.60	0.48	1236.36	0.55	1477.40	0.62	1708.59	0.67
		4.72		5.38		5.97		6.48

Layer	X = 66.40 Stress (psf)	Sett. (in.)	X = 74.70 Stress (psf)	Sett. (in.)	X = 83.00 Stress (psf)	Sett. (in.)

US 52 Ramp B Rear Abutment Settlement

Sheet 6 of 9

1	INCOMP.	INCOMP.	INCOMP.			
2	1942.77	6.18	2008.06	6.28	2012.85	6.29
3	1898.88	0.72	1985.07	0.74	2001.48	0.74
		------		------		------
		6.90		7.02		7.03

Settlement at ℄ of Ramp

ÀÄÄÄÄÄ Hit arrow keys to display next screen. <F8> Print. <F10> Main Menu ÄÄÄÄÄÙ

* From lab testing rock core samples $q_u \simeq 10{,}209$ psi (TR-71A)

End Bearing FHWA-IF-99-025 Eq$^{\underline{n}}$ 11.6 $q_{max}(MPa) = 4.83[q_u(MPa)]^{0.51}$
For RQD between 70-100 percent and $q_u > 0.5$ MPa (52 tsf)

$q_u = 10{,}209$ psi $= 70.39$ MPa

* Equation valid for Competent Rock; RQD > 70%
RQD Range: 11% - 78%
RQD Average: 50.2%

[Eq$^{\underline{n}}$: 11.6] $q_{max} = 4.83[q_u(MPa)]^{0.51}$

$q_{max} = 4.83[70.39\ MPa]^{0.51} = 42.28\ MPa$

$q_{max} = 42.28\ MPa = 6132\ psi = 883\ ksf$

$q_{allow} = \frac{q_{max}}{F.S.} = \frac{883\ ksf}{3.0} = 294\ ksf$

* For this type & quality rock we typically use **$q_{allow} = 80$ ksf (40 tsf)**

Side Friction FHWA-IF-99-025 Eq$^{\underline{n}}$ 11.24 $f_{max} = 0.65 p_a [q_u/p_a]^{0.5} \leq 0.65 p_a [f_c'/p_a]^{0.5}$
- Assumes Smooth Rock Socket

* From lab testing rock core samples; $q_u \simeq 10{,}209$ psi (TR-71A)
$f_c' \simeq 4{,}500$ psi

[Eq$^{\underline{n}}$ 11.24] $f_{max} = 0.65 p_a [q_u/p_a]^{0.5} \leq 0.65 p_a [f_c'/p_a]^{0.5}$

$f_{max} = 0.65(14.70\ psi)\left[\frac{10{,}209\ psi}{14.70\ psi}\right]^{0.5} \leq 0.65(14.70\ psi)\left[\frac{4500\ psi}{14.70\ psi}\right]^{0.5}$

$f_{max} = 251.8\ psi \leq 167.2\ psi$ Use $f_{max} = 167$ psi

$f_{allow} = \frac{167\ psi}{3.0} = 55.6\ psi = 8006\ psf$ **Use $f_{allow} = 7{,}500$ psf**

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=39'
2 It is assumed that abutment is supported on deep foundations
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

Wall Properties

H+D	=	42	feet
γ_{mse}	=	120	pcf
L	=	33.6	feet
L factor	=	0.80	
ϕ	=	30	deg

Foundational Soil Properties

c	=	3500	psf	Cohesion
ϕ'	=	29	deg	Friction angle
ω_T	=	240	psf	Traffic loading

Length factor-range (0.7 - 1.0)

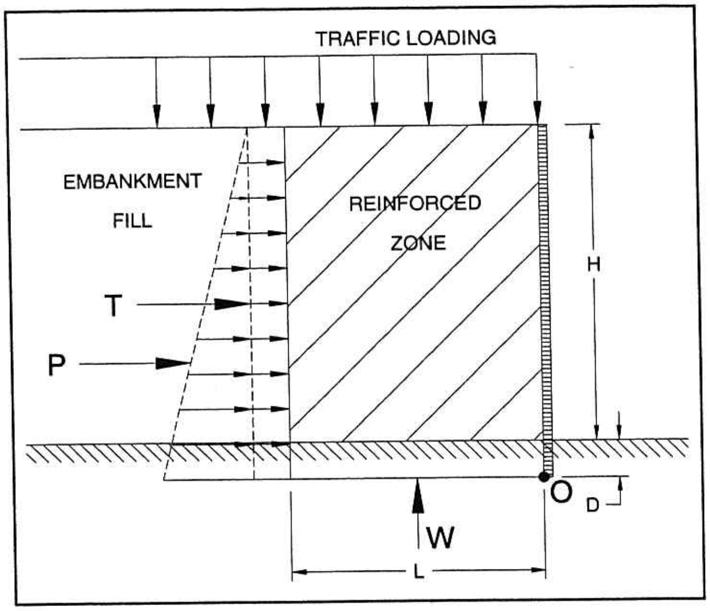
Friction Angle of Embankment Fill

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 = 38,254 lbs per foot of wall



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

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

0.67μ Max. = 0.35 {AASHTO, Bridge Design Manual, 303.4.1.1}

P_r = 59,270 lbs per foot of wall

USE THIS VALUE

$$P_r = L(c)$$ (Undrained)

P_r = 117,600 lbs per foot of wall

Use Drained Value

$$FS = \frac{P_r}{P_a}$$

Calculated FS = **1.55**

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

$\Sigma M_{resisting}$ = 2,844,979 lb-ft

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

$\Sigma M_{overturning}$ = 558,835 lb-ft

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

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturning}}$$

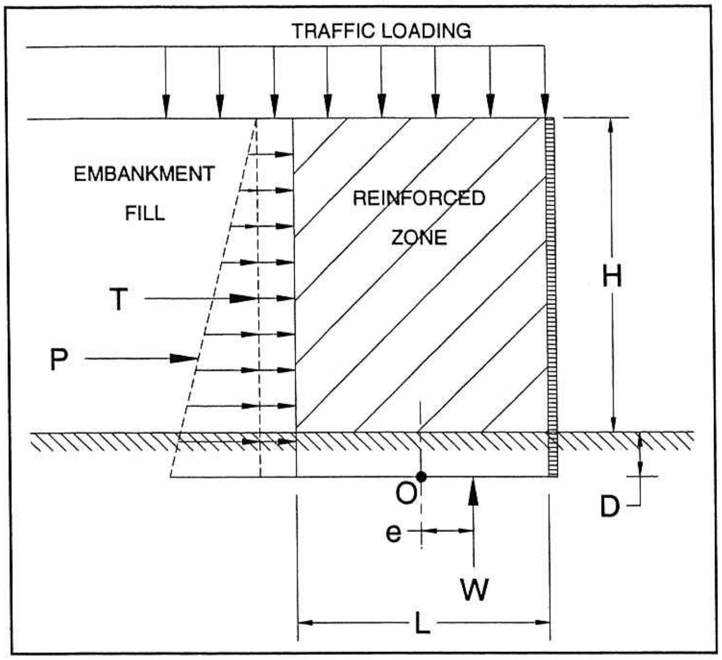
Calculated FS = **5.09**

Required FS = 2.00

Resistance Against Overturning is **OK**

BEARING CAPACITY OF A MSE WALL

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



Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	3500	psf	Cohesion	Foundation soil
ϕ	=	0	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	33.6	ft	Length of MSE reinforcement
L factor	=	0.8		Length factor-range (0.7 - 1.0)
D	=	3	ft	Embedment depth
Dw	=	3	ft	Groundwater depth
H+D	=	42	ft	
H	=	39	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	14	ft	Moment arm
Γ Wt	=	21	ft	Moment arm
B'	=	27.30	ft	
γ'	=	57.6	pcf	
W_t		8,064	lb/ft of wall	Weight from traffic
W_{mse}	=	169,344	lb/ft of wall	Weight from MSE wall

Effective Bearing Pressure

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

σ_v = 6,498 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 18,163 psf

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

q_{ALL} = 7,265 psf

Factor of Safety = **2.80** **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} = 18,047 psf

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

q_{ALL} = 7,219 psf

Factor of Safety = **2.78** **OK**

Bearing Capacity Factors for Equations (AASHTO)

Undrained		Drained	
N_c	5.14	N_c	27.86
N_q	1.00	N_q	16.44
N_γ	0.00	N_γ	19.34

Eccentricity of Resultant Force

e = 3.15 ft

Kern

e < L/6 = 5.60 ft

APPENDIX F

Retaining Wall Justification

TranSystems

RETAINING WALL JUSTIFICATION

1. Introduction

TranSystems is providing engineering services to the Ohio Department of Transportation for the design of new overpass structures for the proposed S.R. 823 ramps at the U.S. 52 interchange over Ohio River Road (CR-503). As part of this Structure Type Study submittal we will investigate the justification of retaining walls along Ramp US 52 B in accordance with Sections 1404.2 of the L&D Manual and 204.6 of the Bridge Design Manual. The retaining wall justification is prepared at this time due to the change in alignment of the ramp that has occurred since the 7/15/2005 PAVR submittal. The change in alignment was to provide additional clearance for the railroad. Additional discussion of the project is available in the main body of this study.

2. Retaining Wall Narrative

Several roadways, properties and two Norfolk Southern tracks are closely aligned in the proposed U.S. 52-S.R. 823 interchange. The roadways are the existing U.S. 52, the existing Ohio River Road, the proposed Ramp A carrying traffic from westbound U.S. 52 to northbound S.R. 823, and the proposed Ramp B carrying traffic from southbound S.R. 823 to eastbound U.S. 52. The close proximity of these roadways/tracks and their differences in elevation at various locations require the use of MSE walls to satisfy both grading continuity and safe/proper embankment limits. MSE walls that prevent the embankment encroaching onto either Ohio River Road, Ramp A, US 52 or Norfolk Southern property are considered required and therefore a justification not included. It is important to note that the District indicated that Norfolk Southern is considering additional tracks at this location and therefore permanent takes of their property are not considered. The Retaining Wall Justification will focus on the area where MSE walls can transition to 2:1 embankment sections from stations 22+00 to 30+00. The embankment from sta. 22+00 to 30+00 will allow for adequate clearances to US 52 or the Norfolk Southern right of way as well as allowing for drainage. However, the embankment will require taking 3 properties in the area between the tracks and Ramp B. The affected properties are residential with owners as follows: James & Pamela Kurtz, Raymond G. & Linda M. Brown and William L. & Hilda M. Spence. Plan drawings showing the affected properties and the fill limits; as well as cross sections, are included in this appendix.

3. Retaining Wall Type

Areas of retaining wall will be greater than 5000sf and, therefore, MSE walls are assumed throughout the justification. The use of MSE walls throughout the calculations is consistent with Section 204.6.2 of the BDM and their use on the bridge.

4. Cost Analysis

Cost analysis is included on the following sheets and summarized below:
The estimated construction cost for the retaining wall is $1,141,500

The estimated embankment construction cost and property cost is $279,600

5. Recommendations

Due to the lower construction costs, it is recommended that the embankment be constructed from stations 30+00 to 22+00 on the left side of Ramp US 52 B. As mentioned above, the retaining walls from station 30+00 to the bridge abutment are considered required. It is recommended that MSE walls be used due to the large area to be constructed.

Made By	PJP	Date	11/10/06	Job No.	P403030064
Checked By	MTN	Date	11/10/06	Sheet No.	

TranSystems

RETAINING WALL JUSTIFICATION

Job Name SCI-823-0.00 **Structure**

Description S.R. 823 Ramp B OVER US 52 **PID #** 77366

Retaining Wall Justification Study Economic Analysis	***Location: Ramp US 52 B STA 30+00 to 22+00 Lt.***
With Retaining Wall	

MSE Wall Construction Cost

Average Wall Height	=	16.5	ft.
Wall Length	=	800	ft.
Wall Area	=	11300	sf
MSE Wall Unit Price	=	$55	per sf
TOTAL Wall Cost	**=**	**$621,500**	

Concrete Railing with Moment Slab Construction Cost

Railing Length	=	800	ft.
Railing Unit Price	=	$400	per ft
TOTAL Barrier Cost	**=**	**$320,000**	

Noise Barrier Construction Cost

Noise Barrier Length	=	800	ft.
Estimated height	=	10	ft.
Noise Barrier Area	=	8000	sf
Noise Barrier Unit Price	=	$25.00	per sf
TOTAL Barrier Cost	**=**	**$200,000**	

TOTAL Construction Cost with Wall

$1,141,500

Made By	*PJP*	**Date**	*11/10/06*	**Job No.**	*P403030064*
Checked By	*MTN*	**Date**	*11/10/06*	**Sheet No.**	

TranSystems

RETAINING WALL JUSTIFICATION

Job Name *SCI-823-0.00* **Structure**

Description *S.R. 823 Ramp B OVER US 52* **PID #** *77366*

Retaining Wall Justification Study Economic Analysis	***Location: Ramp US 52 B STA 30+00 to 22+00 Lt.***
Without Retaining Wall	

Embankment Construction Cost

Estimated Volume	=	11,400	cy
Embankment Unit Price	=	$9	per cy
TOTAL Embank. Cost	**=**	**$102,600**	

Property Costs (3 takes)

Total Parcels	=	3
Unit Cost per parcel	=	$52,000
Total Property Costs	**=**	**$156,000**

Building Demilition Costs

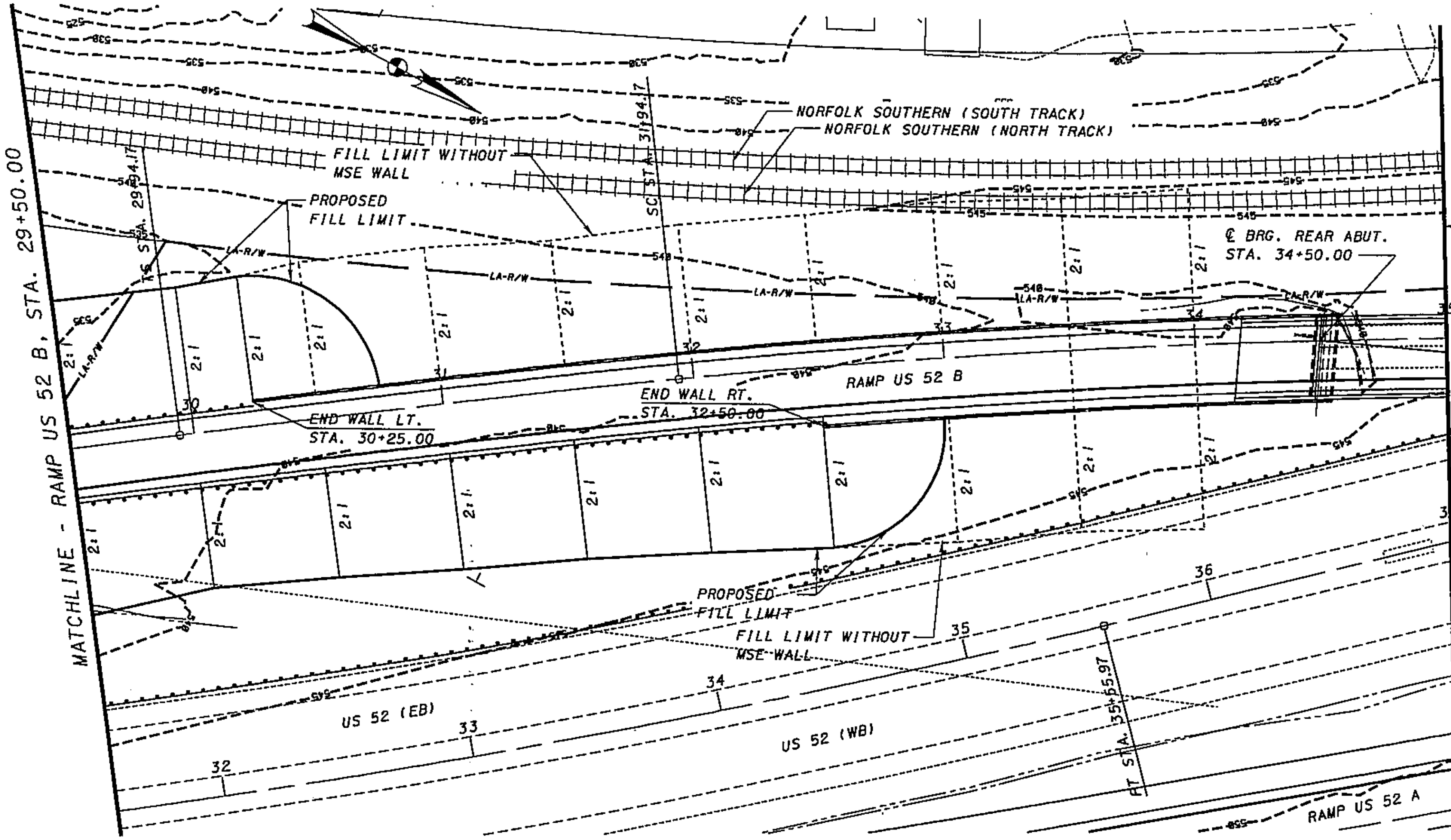
Total Buildings	=	4
Unit Price per bldg.	=	$4,000
TOTAL Building Demo	**=**	**$16,000**

Misc. Roadway Construction Cost (GR etc.)

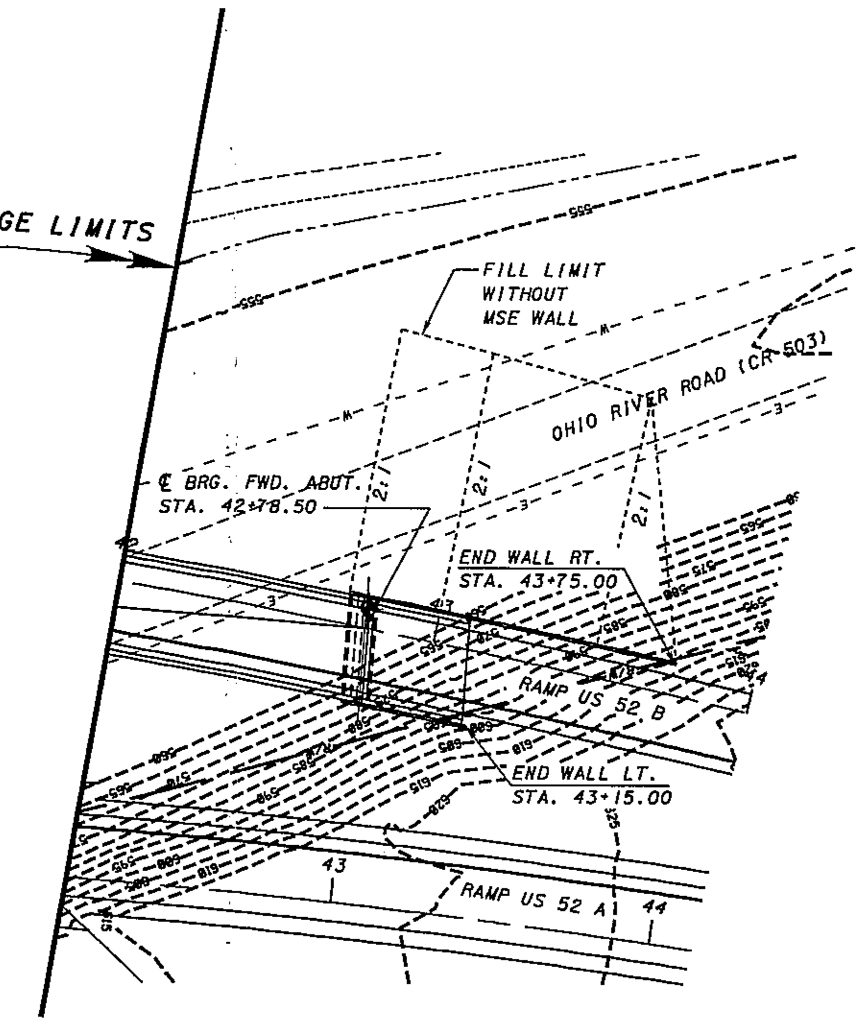
$5,000

TOTAL Construction Cost without Wall

$279,600



PLAN-RAMP B REAR MSE WALL



PLAN-RAMP B FORWARD MSE WALL

DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
PJP	MTN	RN	11/16/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	
JRC			

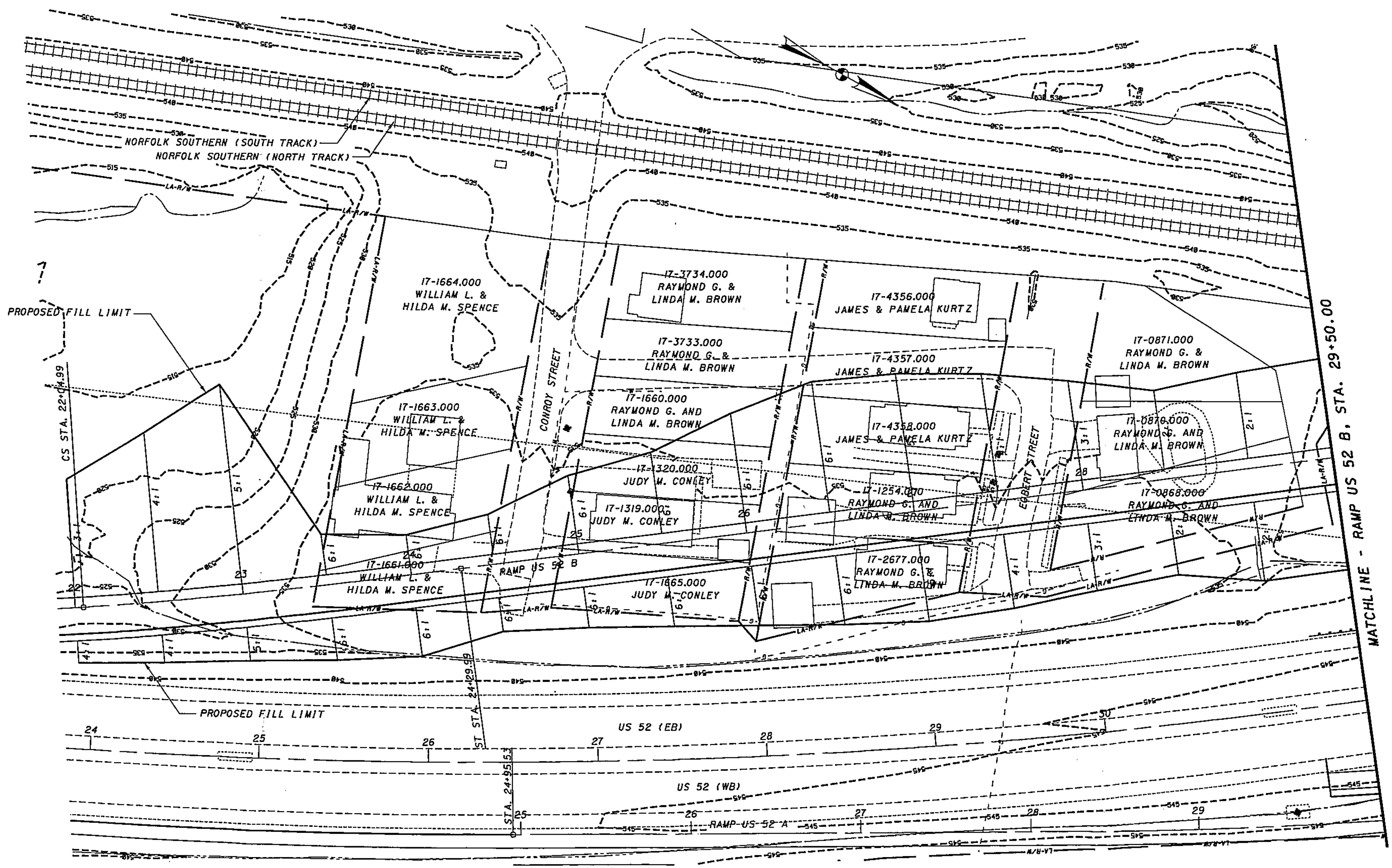
RETAINING WALL JUSTIFICATION EXHIBIT

BRIDGE NO. SCI-823-XXXX

SR 823 RAMP US 52 B OVER US 52 & OHIO RIVER ROAD (CR 503)

SCI-823-0.00

PID 77366



PLAN - RAMP B REAR MSE WALL

DESIGN AGENCY: TranSystems

DESIGNED: PJP | CHECKED: JRC | DRAWN: CAS | REVIEWED: RN | DATE: 11/16/06

STRUCTURE FILE NUMBER

REVISED

RETAINING WALL JUSTIFICATION EXHIBIT

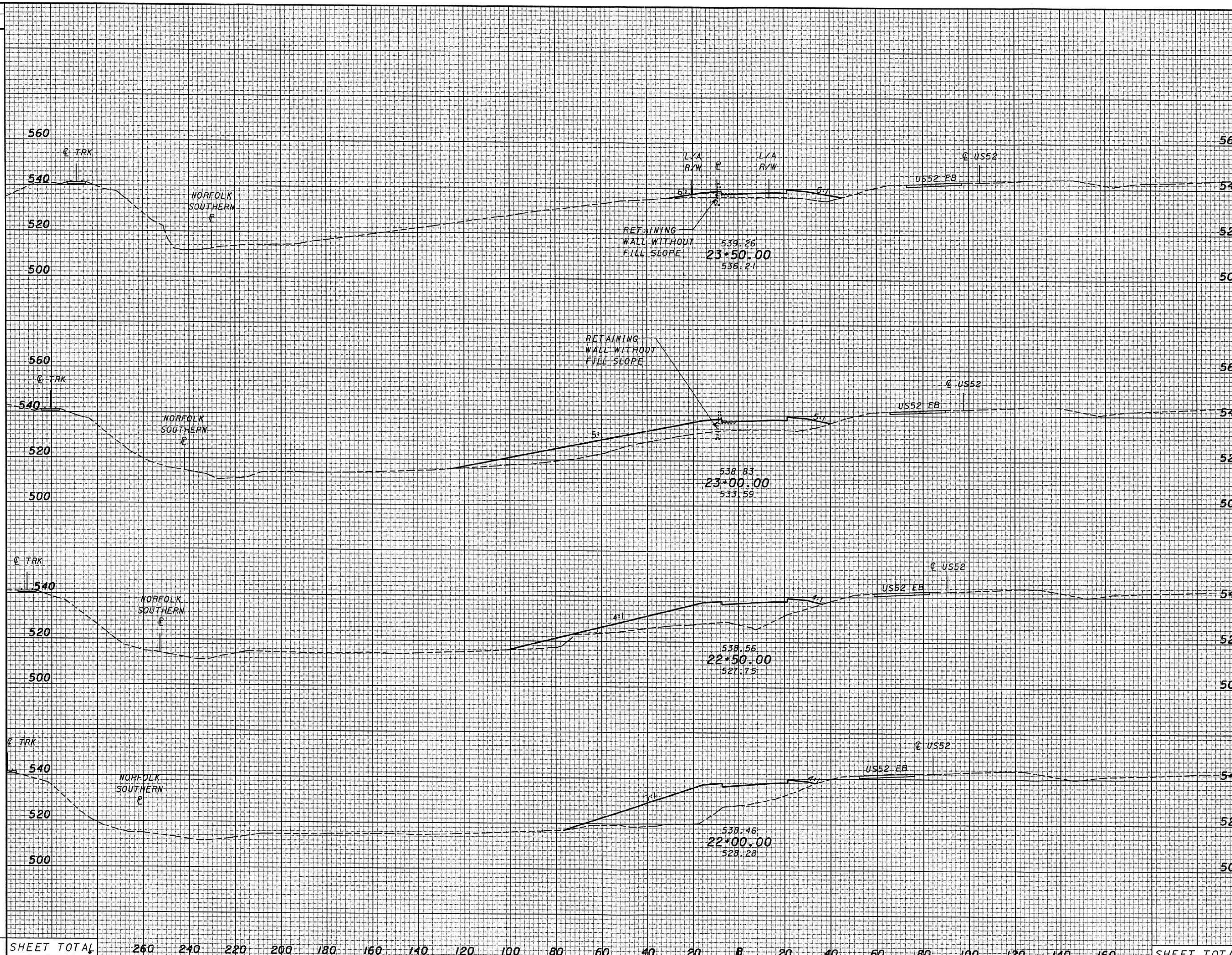
BRIDGE NO. SCI-823-XXXX

SR 823 RAMP B OVER US 52 & OHIO RIVER ROAD (CR 503)

SCI-823-0.00

PID 77366

SEEDING	
END WIDTH	SQ. YDS.
SHEET TOTAL	



END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED CAS

CHECKED PJP

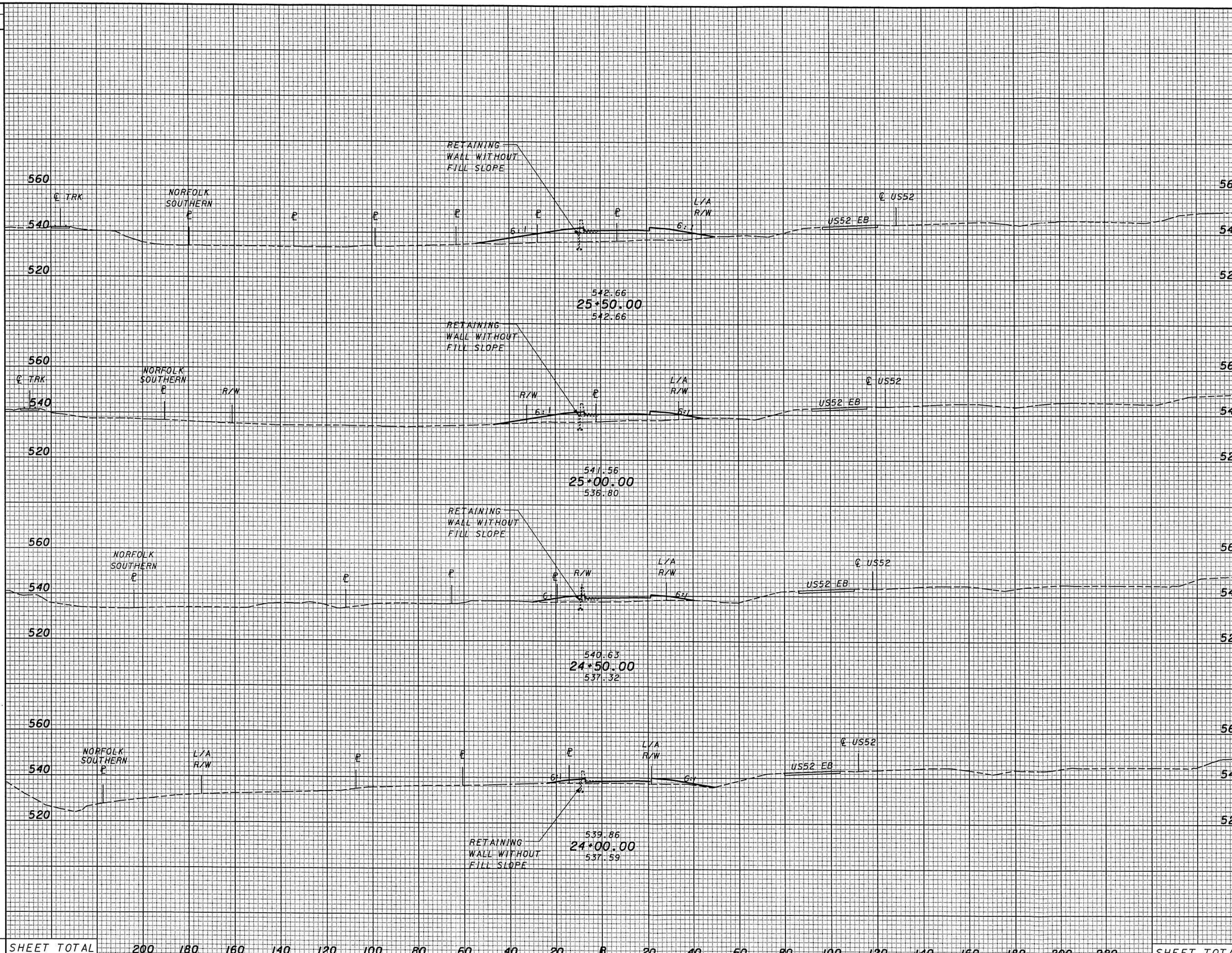
CROSS SECTIONS

US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

1

SEEDING	
END WIDTH	SQ. YDS.
SHEET TOTAL	



END AREA		VOLUME	
CUT	FILL	CUT	FILL
SHEET TOTAL			

CALCULATED CAS

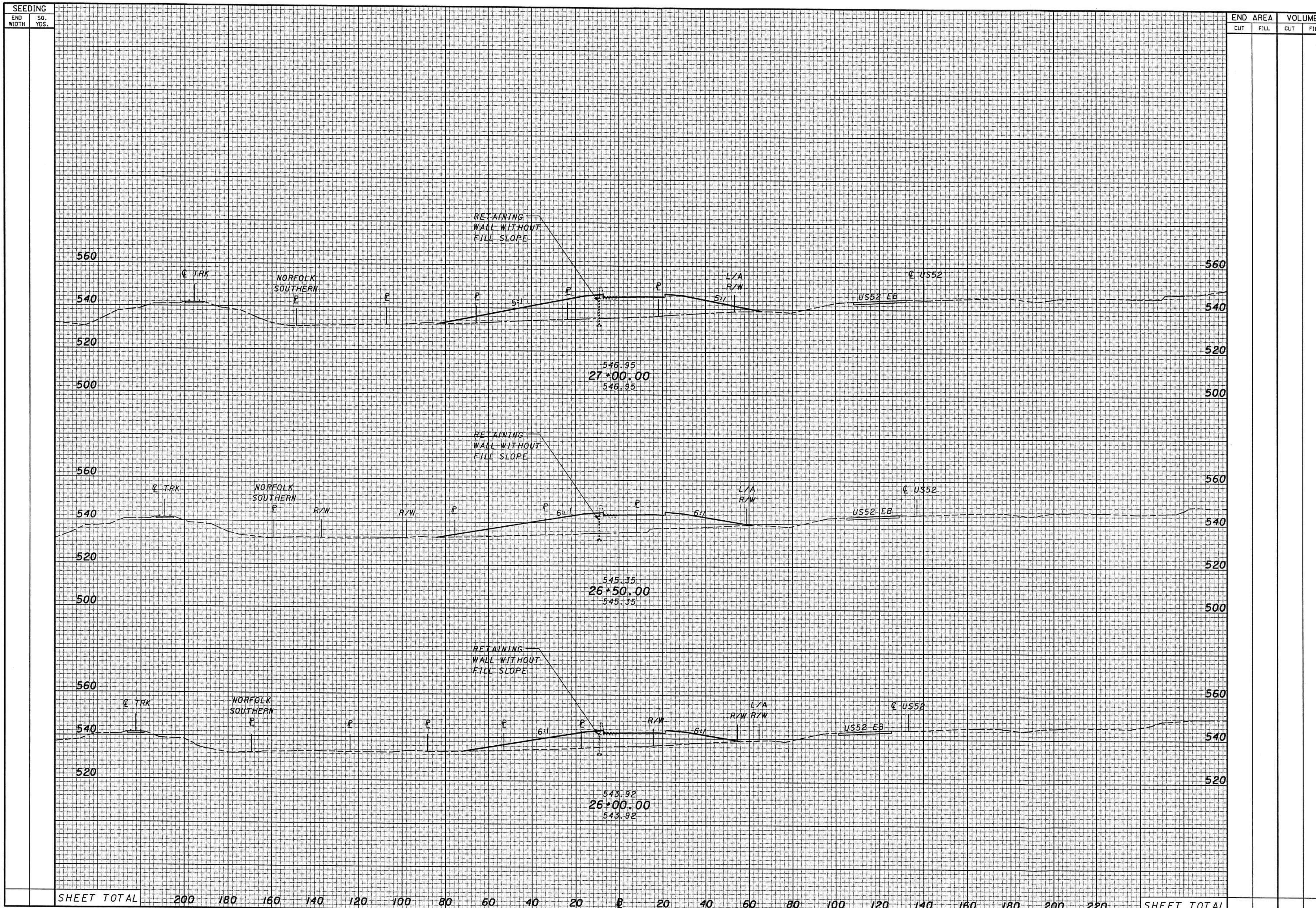
CHECKED PJP

CROSS SECTIONS

US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

2



CALCULATED CAS

CHECKED PJP

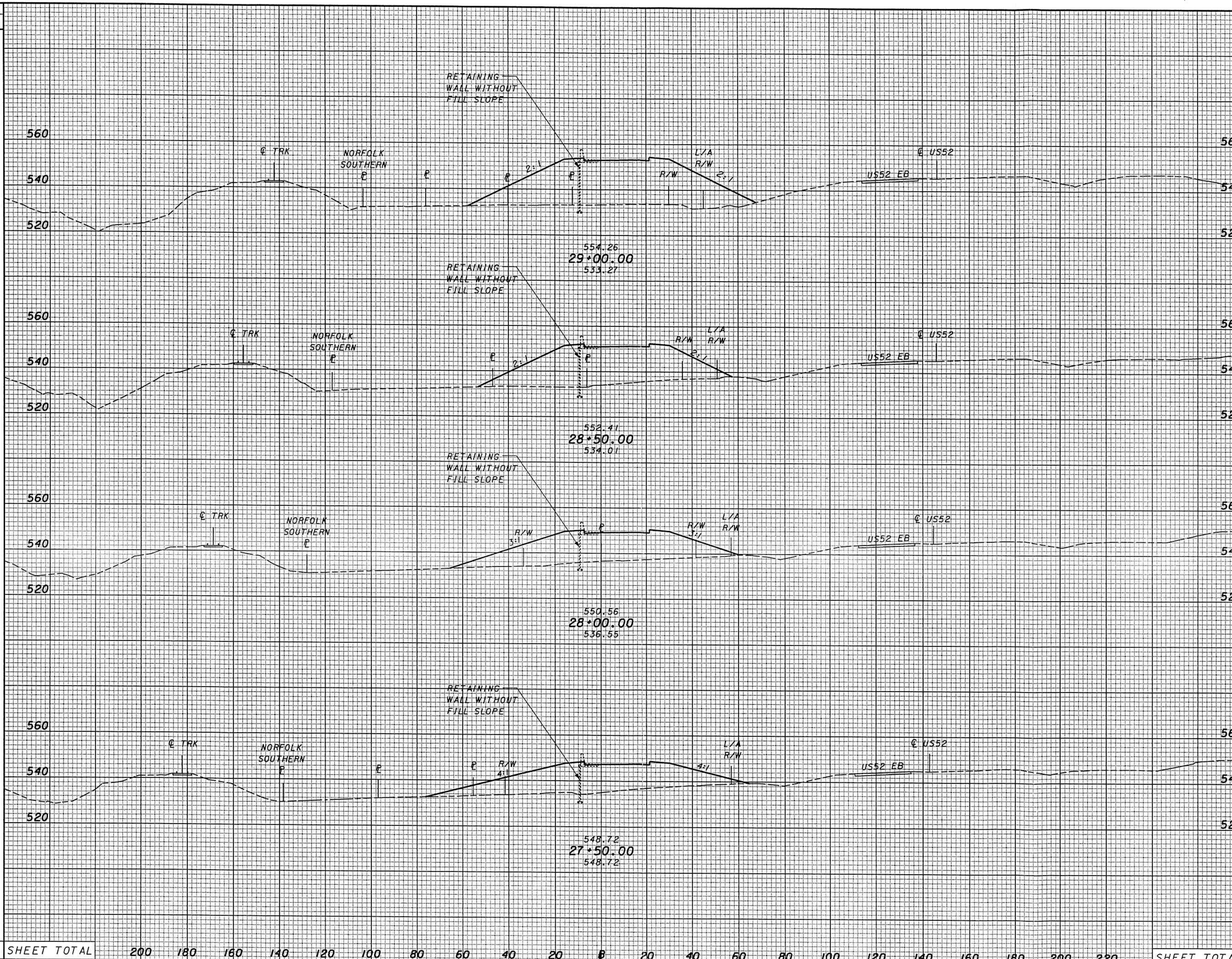
CROSS SECTIONS

US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

3

SEEDING	
END WIDTH	SQ. YDS.



END AREA		VOLUME	
CUT	FILL	CUT	FILL

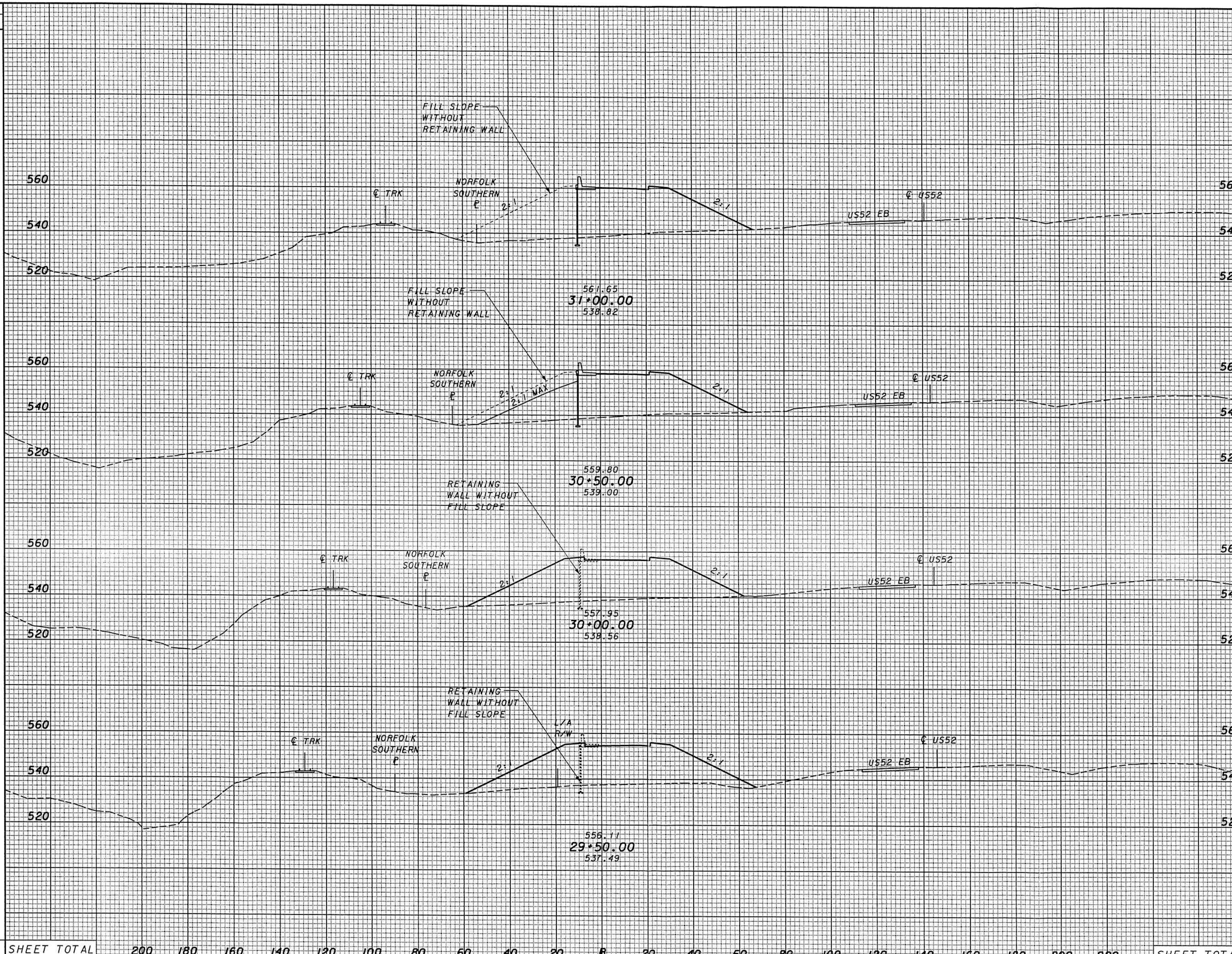
CALCULATED CAS
CHECKED PJP

CROSS SECTIONS
US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

4

SEEDING	
END WIDTH	SQ. YDS.



END AREA		VOLUME	
CUT	FILL	CUT	FILL

CALCULATED CAS

CHECKED PJP

CROSS SECTIONS

US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

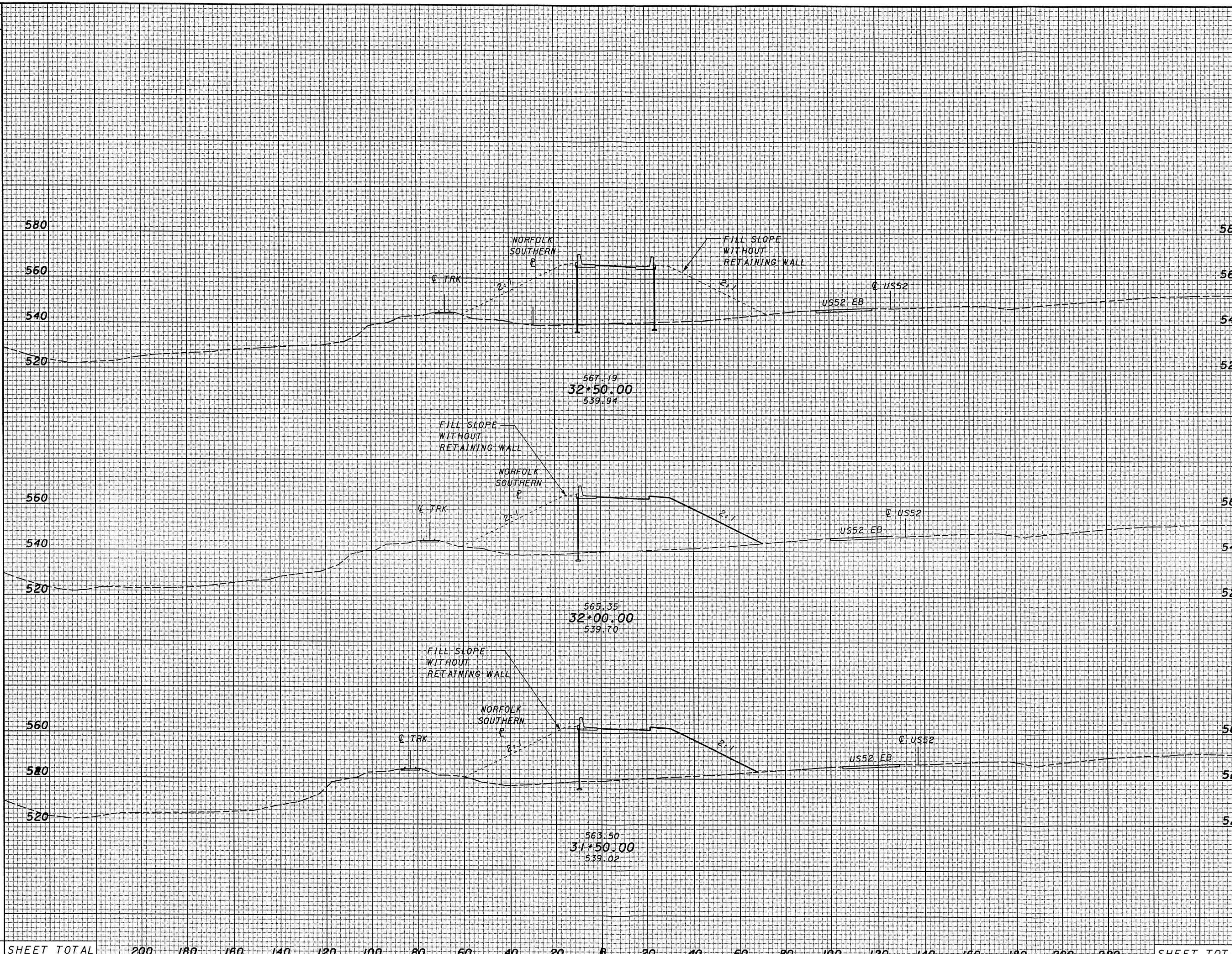
5

CROSS SECTIONS
US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

CALCULATED CAS
CHECKED PJP

SEEDING	
END WIDTH	SQ. YDS.

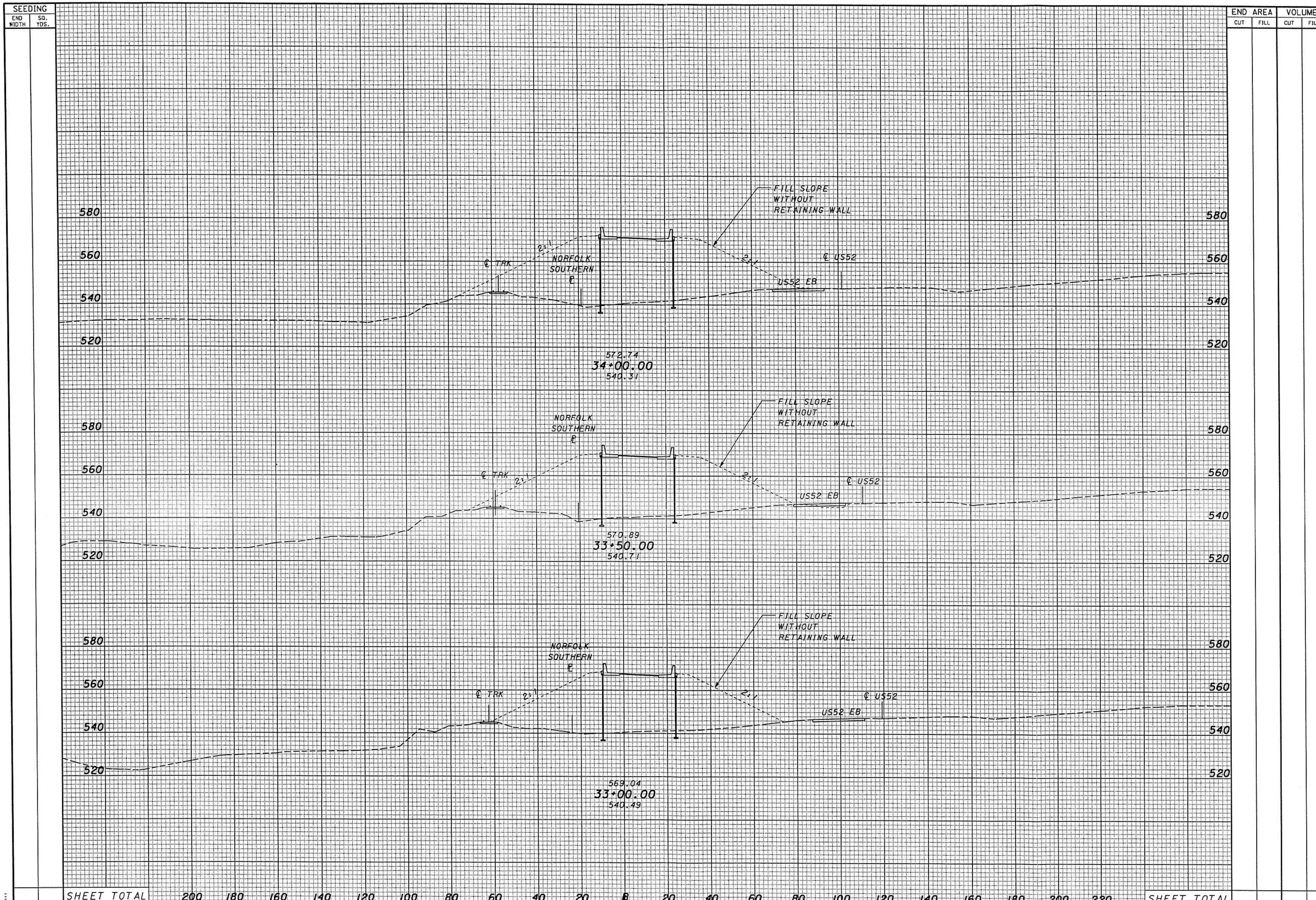


SHEET TOTAL

SHEET TOTAL

END AREA		VOLUME	
CUT	FILL	CUT	FILL

6



CALCULATED CAS
CHECKED PJP

CROSS SECTIONS
US52 RAMP B - RETAINING WALL JUSTIFICATION

SCI-823-0.00

7