SCI-823-0.00

PID No. 77366

S.R. 823 over S.R. 335 and

Little Scioto River

Preliminary Design Report Submittal

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

February 22, 2008

Prepared by:

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February 22, 2008

Mr. Jawdat Siddiqi, PE
Office of Structural Engineering
Ohio Department of Transportation
1980 W. Broad Street
Columbus, Ohio 43223

SUBJECT: **Preliminary Design Report Submittal**
SR 823 over S.R. 335 and Little Scioto River
SCI-823-0.00 Portsmouth Bypass
PID#77366

Dear Mr. Siddiqi:

Submitted for review and comment is the Preliminary Design Report for SR 823 over S.R. 335 and the Little Scioto River. Included are the TS&L drawings and the Final Geotechnical Report by DLZ Ohio, Inc., dated February 20, 2008. Information regarding special embankment construction methods/controls (such as wick drain spacing) has been prepared by DLZ and is included in both their 2/12/08 Report and 8/2/07 Highland Bend Embankment Report. These controls are also mentioned in the Stage 1 submittal. Please find below our disposition to the December 13, 2007 comments by Jeff Crace, PE regarding the STS submittal.

√1) *We recommend that Alternative 5 be advanced to detail design. We deem it more prudent to utilize our limited funds on a more traditional solution (alt.5) than an alternate which includes a retaining wall that is nearly 50 feet tall (alt. 4b). This is especially true when for all practical purposes the two alternates have the same estimated Total Relative Ownership Cost, which includes Life Cycle Maintenance cost [$31,156,000 (alt. 4b) vs. $31,475,000 (alt. 5)] and the same estimated Total Construction Cost [$21,160,000 (alt. 4b) vs. $20,830,000(alt. 5)].*

Alternative 5 has been carried forward to Stage I design.

√2) *Is it possible to utilize a spread footing for the left bridge forward abutment/retaining wall since the footing will be founded on bedrock?*

Pier 4R of the right bridge and the forward abutment/retaining wall of the left bridge are located in the steep hillside north of S.R. 335. Approximate top of rock profiles estimated from available boring information and contour mapping for this area reveal a sloping bedrock surface. Due to this sloping surface, the bearing depth below top of rock for a spread footing at Pier 4R varies from 2' to over 20' (these numbers are based on DLZ's recommended bottom of footing elevation of 557.6'). Weathering and strength characteristics of the rock differ across the footing because of this variable depth and excavations of 20' or more into rock will be needed to construct the spread footing. Such excavations could undermine the foundations of the nearby proposed forward abutment and retaining wall of the left structure, regardless of whether they are spread footings or drilled shafts. To eliminate deep footing excavations and thus prevent/minimize degradation and destabilization of rock near the left structure forward abutment, DLZ recommends that Pier 4R be supported on a system of drilled shafts founded in the underlying bedrock. Due to the sloping and irregular bedrock surface in the hillside, DLZ recommends supporting the left forward abutment on drilled shafts founded in competent bedrock. When founded in such material, the drilled shafts will support superstructure dead and live loads through either end bearing or side friction and will also provide sufficient resistance to the high lateral loads generated by proposed retained fill. The retaining wall that ties into the left forward abutment and is positioned along the right fascia of the left (southbound) roadway should also be supported on drilled shafts founded in bedrock, however, as the wall height shortens (due to the slope of the underlying bedrock and proposed roadway profile elevations), lateral earth pressures on the wall decrease and the foundation system may be transitioned from drilled shafts to spread footing founded in bedrock. The spread footing will be wide enough to generate large vertical earth loads that will prevent, or minimize, rotation and sliding of the retaining wall system.

✓ 3) *We agree that the abutment/retaining wall for the left structure should be design utilizing active earth pressure. To allow this design methodology considers reducing the shoulder width across the length of thee structure by 1 inch on each side. This will result in a 3 inch separation between the median barriers.*

A 3" separation has been provided, as recommended, to allow for the use of active earth pressures.

✓ 4) *Can the spans for the right bridge (5 spans) be adjusted (shortened) while maintaining a maximum abutment/retaining wall height is 30 feet or less?*

Generally the design of the structure should be optimized, in this case we have narrowed this optimization down to the span length versus abutment/retaining wall height/foundation type. This can be finalized by the phase 2 (detail design) consultant.

TranSystems recognizes that additional refinement and optimization of this structure may occur during final (Stage 2 and 3) design. TranSystems has discussed this comment with the District and, with their concurrence, has proceeded with the span arrangements as presented in the 11/27/07 submittal. Any subsequent revisions to the span arrangements/configurations will need to be incorporated into an updated hydraulic analysis (particularly if Piers 2 and 3 are moved closer to the Little Scioto River). The final design consultant will also need to consider whether additional subsurface investigations are required due to further span revisions. The results of current subsurface investigations can be found in DLZ's report dated 2/20/08. The Hydraulic Report including electronc files on CD were included in the 7/12/06 Type Study submittal.

Please don't hesitate to call me or Dr. Michael Lenett (513 621 1981) if there are any questions.

Sincerely,

Michael D. Weeks by PGP

Michael D. Weeks, P.E., P.S.
Project Manager

Cc: T. Barnitz, P.E.

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PRELIMINARY DESIGN REPORT NARRATIVE

1. Introduction

TranSystems is providing engineering services to the Ohio Department of Transportation for the design of new left and right overpass structures that carry the proposed S.R. 823 bypass over the existing S.R. 335 and Little Scioto River. As requested by the Scope of Services, a Preliminary Design Report is to be submitted as part of Step 8 of a Major project within ODOT's Project Development Process (PDP). The purpose of this report is to summarize the structure type selected for final design. Initially, a Type Study that incorporated updated roadway geometry for this site and recommended a 5-span alternative (5-span left structure, 5-span right structure) was submitted on 7/12/06. ODOT Office of Structural Engineering (OSE) comments pertaining to this Type Study were received 8/11/06. As a result of these comments, the Type Study was revised to include a 4-span alternative (4-span left structure, 4-span right structure) as well as present the results of additional pier evaluations. The 4-span alternative was submitted 1/15/07 and involved the use of a tall forward abutment and tall turnback wingwall (i.e., retaining wall). In order to develop this 4-span system, the forward abutment was relocated downstation closer to S.R. 335. To satisfy the required 15'-0" horizontal clearance along the northern edge of traveled way of S.R. 335, the top of the built-up 2:1 embankment at the far-east corner of the forward abutment was positioned at an elevation of approximately 573' (which is essentially the ground/rockline elevation at this corner). Using 573' as the approximate top of embankment elevation required a bottom of footing elevation around 568'. To minimize rock excavation and concrete costs associated with this abutment, the footing was stepped (using 11' vertical steps) to follow the grade of the existing groundline which is exposed rock. If a higher footing elevation were to be used at the far-east corner of the forward abutment, the toe of the resulting 2:1 embankment would violate the 15'-0" horizontal clearance (please refer to the 1/15/07 submittal). The retaining wall tied into the forward abutment at this same corner and therefore the same footing elevation was used at this point. The retaining wall footing was stepped in an effort to minimize rock excavation. In summary, footing elevations – and thus the heights of the forward abutment and turnback wingwall/retaining wall – were dictated by the far-east corner of the forward abutment as well as the horizontal clearance requirements of S.R. 335. Furthermore, in an effort to minimize rock excavation, both this abutment and wingwall/retaining wall were founded on stepped footings and a single row of drilled shafts socketed into underlying rock. This 4-span alternative also provided lower total ownership costs than the original 5-span alternative, so, in comments dated 1/31/07, ODOT OSE agreed that the 4-span alternative should be taken into Step 8 for further development. However, foundation evaluations performed at a later date by DLZ Ohio, Inc. revealed excessively high shears and moments within individual shafts positioned below the forward abutment and retaining wall (due to high lateral earth pressures). Such internal load effects resulted in impractical and unreasonable reinforcing patterns within the drilled shafts. Consequently, to reduce the internal shears/moments within individual shafts, DLZ recommended using 2 rows of drilled shafts beneath the forward abutment and retaining wall. However, ODOT OSE commented on 11/02/07 that it may be more economical to use a 4-span left structure, 5-span right structure at this site rather than a 4-span alternative comprised of a nearly 50' tall forward abutment and retaining wall (both supported on 2 rows of drilled shafts). OSE additionally requested a cost comparison of these respective structure types. The layout of a 4-span left, 5-span right alternative and the results of a cost comparison with the 4-span alternative were submitted to OSE on 11/27/07 and OSE, in comments dated 12/13/07, recommended that the 4-span left, 5-span right alternative be advanced to detail design. This 4-span left, 5-span right alternative is henceforth presented throughout this Preliminary Design Report.

2. Design Criteria

The proposed structure is designed using Load Factor (LFD) techniques in accordance with the 2004 version of the Ohio Department of Transportation Bridge Design Manual (including all respective revisions and updates) and the 2002 AASHTO Standard Specifications for Highway Bridges, 17th Edition. Vertical and horizontal clearances, as well as clear zone widths and horizontal sight distances, are based on the Ohio Department of Transportation Location and Design (L&D) Manual, Volume One – Roadway Design.

3. Subsurface Conditions and Foundation Recommendation

DLZ Ohio, Inc. performed the subsurface exploration for the Highland Bend region which is where the proposed left and right overpass structures are located. A Subsurface Exploration report dated 6/8/06 and an addendum to this report (dated 6/29/06) provide foundation recommendations for these proposed structures based on preliminary borings and include several stability analyses for the rear abutment embankments. In summary, with the rear abutment positioned in the vicinity of Station 131+35.00 and the toe of the associated 2:1 embankment at approximately Station 132+23.00, the global stability analyses for undrained and drained conditions yield factors of safety below minimum required values (this also applies when the rear abutment is positioned near Station 132+00.00). Changing the slope of the embankment to 2.5:1 also results in insufficient factors of safety. Consequently, it was determined that stable rear abutment embankments can be achieved through two different solutions:

1) The rear abutment can be relocated downstation (behind Station 131+00.00) and positioned on embankments constructed with 2.5:1 slopes using wick drains and staged construction. This solution provides adequate drained and seismic global stability.
2) A drilled shaft retaining wall can be used to stabilize the existing ground profile. The drilled shafts would be installed through the soil failure zone to improve embankment stability. This solution permits the rear abutment to be located upstation (forward Station 131+00.00) and positioned on embankments with 2:1 slopes. Wick drains and staged construction would not be required and overall bridge length would be less than that obtained through the first solution.

Step 7 Type Studies revealed that a more feasible alternative – from both a construction and economic standpoint – is developed when using solution 1). The Final Geotechnical Report for this site, dated 2/20/08, also summarizes these embankment issues at the rear abutment.

Analayses/calculations presented in DLZ's 2/20/08 report also indicate that settlement of the rear abutment spill through embankments is a concern. The calculations displayed in Appendix IV of the 2/20/08 report reveal that a waiting period of 99% primary consolidation reduces embankment settlement to less than 0.4 inches which prevents mobilization of downdrag on any rear abutment pile foundations. DLZ recommends that construction of the rear abutment foundations not proceed until a minimum of 99% of the calculated primary consolidation has occurred. As mentioned earlier, wick drains are recommended for use with staged construction to provide adequate global stability for the rear abutment embankments, however, wick drains are also recommended for use at the rear abutment to accelerate embankment consolidation. DLZ presents multiple triangular spacing options for the wick drains and has calculated the time rate of consolidation for each spacing (see DLZ's 2/20/08 report). Waiting periods to reach 99% consolidation are therefore a function of the wick drain spacing. The final design should incorporate requirements or waiting periods associated with the spacing selected if the contractor is allowed to select the wick drain spacing. Additional information regarding embankment construction is available in the DLZ report for the Highland Bend Embankments dated 8/2/07. DLZ has also prepared plans to indicate the locations of wick drain treatment and settlement monitoring and they are included in this submittal and the 8/2/07 Highland Bend Embankment Report.

In addition, the 2/20/08 Final Geotechnical Report provides a summary of 13 test borings (TR-30 through TR-35 and TR-35A and B-39 through B-44) that were drilled for the proposed left and right overpass structures. Logs reveal that the borings encountered sandstone and/or sandstone interbedded with shale at various depths across the site. From S.R. 335 and to the north, the subsurface conditions are comprised of shallow overburden underlain by sandstone (in some instances, several inches of topsoil underlain by decomposed/weathered sandstone). South of S.R. 335, the subsurface conditions involve thick overburden underlain by sandstone. Overburden layers typically consist of cohesive and granular soil deposits such as stiff clays (A-7-6), sandy silts (A-4a), gravels with sand and silt (A-2-4), and fine sands (A-3). Due to the variable subsurface conditions at this site, no single foundation type is best suited to support the proposed substructures. At the rear abutment and Pier 1 locations, DLZ recommends HP14x73 piles driven to rock. Although static analyses of these locations indicate that friction piles can develop the required ultimate resistance, top of bedrock is only within 9 to 16 feet below the estimated friction pile tip elevations. Consequently, DLZ recommends using HP14x73 piles driven to the top of bedrock at the rear abutment and Pier 1 locations. Within the floodplain of the Little Scioto River, the soils lying over the sandstone exhibit low blow counts and, due to the possibility of scour, these weak soils cannot provide sufficient bearing for foundations. As a result, DLZ recommends that drilled shafts with rock sockets in competent sandstone be used to found Piers 2 and 3 (which are located within the floodplain). For Pier 4 of the right bridge located in the steep hillside north of S.R. 335, approximate top of rock profiles estimated from available boring information and contour mapping reveal a sloping bedrock surface. Due to this sloping surface, the bearing depth below top of rock for a spread footing varies from 2' to over 20'. Weathering and strength characteristics of the rock differ across the footing because of this variable depth and excavations of 20' or more into rock will be needed to construct the spread footing. Such excavations could undermine the foundations of the nearby proposed forward abutment and retaining wall of the left structure. To eliminate deep footing excavations and thus prevent/minimize degradation and destabilization of rock near the left structure forward abutment, DLZ recommends that Pier 4R be supported on a system of drilled shafts founded in the underlying sandstone bedrock. The forward abutments for the left and right structures are also positioned in this hillside. Due to the sloping and irregular bedrock surface, DLZ recommends supporting these abutments on drilled shafts founded in competent sandstone bedrock. When founded in such material, the drilled shafts will support superstructure dead and live loads through either end bearing or side friction and will also provide sufficient resistance to the high lateral loads generated by proposed retained fill. The retaining wall that ties into the left forward abutment and is positioned along the right fascia of the left (southbound) roadway should also be supported on drilled shafts founded in bedrock, however, as the wall height shortens (due to the slope of the underlying bedrock and proposed roadway profile elevations), lateral earth pressures on the wall decrease and the foundation system may be transitioned from drilled shafts to spread footing founded in sandstone bedrock. For additional information regarding the various substructure foundation types discussed above as well as the subsurface conditions at this site, please refer to DLZ's Final Geotechnical Report of 2/20/08.

4. Roadway

The purpose of this project is to construct a new bypass state route around the town of Portsmouth, Ohio. The proposed alignment will carry two lanes of traffic, 15 plus miles in either direction, from an interchange with US 52 just east of Portsmouth to another interchange with US 23 located north of Portsmouth in Valley Township. For the proposed mainline structures over S.R. 335 and the Little Scioto River, two lanes of northbound traffic and two lanes of southbound traffic are carried on separate bridge sections. The northbound (right) and southbound (left) bridge sections are separated from one another, along their inside fascia, by 3". This separation is required because of a retaining wall that runs parallel to the centerline survey and construction S.R. 823 and is needed along the inside fascia of the southbound bridge/roadway from the forward abutment of the southbound bridge to the forward abutment of the northbound bridge. The 3" separation between bridge sections permits the use of active, rather than at-rest, earth pressures when designing the retaining wall (see Section 5 for further discussion regarding this retaining wall). Because the median shoulder widths for all bridge structures on this proposed bypass are selected to match the roadway median width, the 3" of separation at this site requires that the median shoulder widths on the northbound and southbound bridge be reduced by 1" (all other bridge structures on this proposed bypass are separated along their inside fascias by 1"). Both the proposed northbound and southbound bridge sections therefore consist of 5'-11" median shoulders. In addition to the median shoulders, both bridges carry 2- 12'-0" travel lanes and a 12'-0" outside shoulder. Each bridge deck is 44'-10½" out-to-out with a 1'-6" outside straight face deflector parapet (SBR-1-99) and a 1'-5½" inside straight face deflector parapet (similar to the roadway concrete median barrier but using a base width of 1'-5½" and top width of 6⅝"). The profile grade line for both bridge sections is located at the inside edge of pavement which is 7'-6" from the centerline survey and construction S.R. 823. Horizontal and vertical sight distances, in accordance with the design standards, have been provided along the length of both bridges.

Alignment & Profile: The proposed horizontal geometry at this site lies within a horizontal curve that is part of a spiral-curve-spiral alignment. This spiral-curve-spiral alignment may be defined by the following parameters: TS = Station 126+95.51, SC = Station 129+20.51, CS = Station 165+64.71, ST = Station 167+89.71, Δ = 38°41'31" (Rt.), D_c (degree of curve) = 1°00'00", R (radius) = 5729.578', L_s = 225.00', θ = 1°07'30", LT = 150.00', ST = 75.00', x = 224.99', y = 1.47', k = 112.50', p = 0.37', Δ_c (deflection angle) = 36°26'31" (Rt.), L_c = 3644.19', T_s = 2124.26', and E_s = 343.27'. Because the proposed structures are positioned within the horizontally curved portion of this alignment, the northbound and southbound bridge decks are superelevated. The superelevation rate and layout are based on L&D Manual Figure 202-7E (using a degree of curve, D_c, of 1°00'00" and design speed of 70 mph) and Figure 205 of the ODOT Bridge Design Manual, respectively. Using these design references results in a superelevation rate of 0.036 ft/ft (3.6%) across the travel lanes. As previously mentioned, the proposed mainline profile grade line is located at the inside edge of pavement for both bridges. The northbound and southbound profiles follow a 1700' sag vertical curve with PVI= Station 131+00.00, PVI El. = 578.23, G_1 = -4.10% and G_2 = 5.00%.

The existing S.R. 335 will remain on its current existing grade and alignment and its cross-section will remain unchanged.

Vertical and Horizontal Clearances – The vertical alignment of the proposed mainline structures is dictated by the overall vertical design of the new bypass profile. According to L&D Manual Figure 302-1E, a preferred vertical clearance of 17'-0" (minimum of 16'-6") must be provided over S.R. 335 which is positioned directly below the S.R. 823 mainline structures at this site. The recommended 4-span left, 5-span right alternative provides more than the preferred 17'-0" clearance.

Due to the existing conditions along the southern and northern edges of S.R. 335, a horizontal clearance of 5'-6" minimum from the face of the existing guardrail to the face of the pier (or other type of obstruction) should be maintained on the southern edge of S.R. 335 whereas a horizontal clear zone width of 15'-0" minimum from the edge of traveled way to face of obstruction should be maintained along the northern edge of S.R. 335. The 5'-6" distance from the face of existing guardrail is based on using a Type 5 steel beam guardrail in Table 603-2E of the L&D Manual. The 15'-0" clear zone from edge of traveled way is based on Figure 600-1E of the L&D Manual. The information input into Figure 600-1E is as follows:

1. The existing S.R. 335 may be classified as a Rural Collector Street. From L&D Manual Figure 104-2E the recommended design speed is 50 mph.
2. From the ODOT Office of Technical Services, the 2030 ADT for S.R. 335 is 6600.
3. The existing groundline along the northern edge of S.R. 335 forms a backslope with an approximate slope of 2:1, which is steeper than 4:1.

Using the identified parameters of items 1) through 3) in Figure 600-1E results in the minimum horizontal clear zone width of 15'-0". The proposed substructure layout for the recommended 4-span left, 5-span right alternative satisfies the 5'-6" minimum horizontal clearance for use with guardrail while simultaneously keeping substructure units out of the Little Scioto River.

Pavement Drainage – The profiles of the proposed mainline structures lie within a vertical curve and are on a positive grade. The profile high point is beyond the forward abutment of both the northbound and southbound structure. Stormwater runoff therefore drains from this high point towards each bridge. Due to the span lengths, and thus overall bridge lengths, as well as the shoulder widths and superelevation of the bridge decks, preliminary pavement spread calculations indicate that the spread from stormwater runoff cannot be contained within the median shoulders of the proposed northbound and southbound decks. The collection of stormwater runoff within these shoulders must therefore be addressed through the use of scuppers. Furthermore, scuppers are positioned in the outside shoulders of each bridge just upstation of the rear abutment to reduce the runoff depth and spread that flows over the rear abutment expansion joint. These scupper positions and other drainage features such as catch basins are displayed in the accompanying site and general plans of this Stage 1 design submittal. Calculations verifying the need for scuppers are included with this submittal as well.

Utilities - No utilities will be placed on the bridge. Lighting and ITS conduits will be provided as necessary. There are no known underground (as well as above ground) utilities that can interfere with construction at this site and therefore no utility relocations are anticipated.

Maintenance of Traffic - While the new bridges are under construction, traffic will be maintained on existing S.R. 335. A temporary tied-back sheet pile wall will be needed to support S.R. 335 during construction of Pier 3L (Pier 3 of the southbound bridge) and its drilled shafts/shaft cap. It is anticipated that there will be limited closures of S.R. 335 (or lane shifts) during construction of this temporary wall as well as during beam setting for superstructure construction. For more information regarding the temporary tied-back sheet pile wall, please refer to DLZ's 2/20/08 Report.

5. Proposed Structure Configuration

The locations of the Little Scioto River and existing S.R. 335 influence the pier positions at this site. The positioning of the rear abutment is dictated by embankment stability – DLZ's evaluations of the proposed Highland Bend embankments reveal unsatisfactory embankment stability for the rear abutment when positioned upstation of Station 131+00.00 (refer to previous discussion in Section 3 of this report). Pushing the rear abutment further downstation – behind Station 131+00.00 – and using 2.5:1 slopes with wick drains and staged construction results in embankments with adequate drained and seismic global stability. Such a location also eliminates the need to stabilize the rear abutment embankments with a drilled shaft retaining wall embedded through the soil failure zone.

Through the use of the pier positions, the concept of symmetrical spans, and the span ratios of ODOT BDM 205.6, the rear abutment position helps dictate the position of the forward abutment. However, to construct the forward abutment and satisfy both the grading at this location and horizontal clearances with S.R. 335, rock must be cut from the hill and 2:1 embankments must be built at the forward abutment position. Rock cuts will add to construction costs and, depending on the location of the forward abutment, significant abutment height may be required which results in large material/construction costs. The span configurations for the proposed mainline structures will therefore be based on an optimal combination that simultaneously addresses: a) rear abutment embankment stability, b) forward abutment height and rock cuts, c) horizontal clearances with respect to S.R. 335, d) keeping piers out of the Little Scioto River, and e) economic feasibility and constructability. When these factors are considered, the resulting/recommended configurations for the proposed mainline structures involve a 4-span southbound (left) structure and a 5-span northbound (right) structure.

Span Configuration: The proposed 5-span northbound structure has spans of 150'-2"±, 200'-2"±, 250'-0", 199'-10"±, and 149'-10"± for an overall length of 950'-0" from centerline bearing rear abutment to centerline bearing forward abutment. These lengths are measured along the centerline survey and construction S.R. 823 and satisfy the span ratios of ODOT BDM 205.6 (0.8 x 250' = 200', 0.75 x 200' = 150'). The centerline bearing rear abutment is positioned at Station 130+75.00 thus ensuring the stability of 2.5:1 embankments when not using a drilled shaft retaining wall. Piers for the northbound structure are located so that horizontal clearances with S.R. 335 as well as ODOT span ratios are satisfied. Moreover, the piers are positioned outside the Little Scioto River which minimizes disruption to the river and its bed. The forward abutment is positioned at Station 140+25.00 which satisfies span ratios, span symmetry, and minimizes rock cutting/removal at the forward abutment location. All substructures for this 5-span structure are oriented perpendicular to the reference line that runs from Station 130+75.00 to Station 140+25.00. Using this orientation results in low skew angles at each substructure unit which is ideal for a horizontally curved structure – the low skew helps minimize torsional effects on I-shaped plate girders and permits parallel girder segments to be fabricated at the same length.

The proposed 4-span southbound structure has spans of 162'-11"±, 203'-7"±, 254'-6"±, and 203'-2"± for an overall bridge length of 824'-3"± from centerline bearing rear abutment to centerline bearing forward abutment. These lengths are also measured along the centerline survey and construction S.R. 823 and satisfy the span ratios of ODOT BDM 205.6. As with the 5-span northbound structure (and for the same reasons), the centerline bearing rear abutment is at Station 130+75.00 – the southbound and northbound structures share the same rear abutment. Piers for the southbound structure are outside the Little Scioto River and satisfy horizontal clearance requirements. The centerline bearing forward abutment is positioned at Station 138+99.20. This station was established during development of the 4-span alternative which was in response to OSE comments dated 8/11/06. The reference line for the 5-span northbound structure is used for the southbound structure as well and all southbound substructures are oriented perpendicular to this line (for the same reasons discussed earlier with the northbound structure).

Although the northbound and southbound structures share the same rear abutment, the piers and forward abutments are staggered along the centerline survey and construction S.R. 823. The forward abutments associated with this layout require less concrete and less rock excavation than the forward abutment for a 4-span alternative (i.e., 4-span northbound, 4-span southbound alternative), however, a retaining wall is required along the right fascia of the southbound roadway from the southbound bridge forward abutment to the northbound bridge forward abutment. The median barrier along the right fascia of the southbound roadway must be positioned on this retaining wall. To permit the use of active earth pressure when designing the retaining wall, a 3" separation between the retaining wall and the left fascia of the 5-span northbound structure is provided. This separation is used along the entire length of the proposed structures.

Substructure:

Abutments: Due to the horizontal curvature and bearing-to-bearing lengths of 950' and 824'-3"± (each larger than 400' total length), conventional stub-type abutments (ODOT Standard Drawing A-1-69) are used at the rear and forward abutments of both the northbound and southbound bridge. DLZ recommends founding the rear abutment on HP14x73 driven piles. The proposed forward abutments are located in the steep hillside north of S.R. 335 and due to the sloping and irregular bedrock surface within this hillside, these abutments are founded on drilled shafts embedded in competent bedrock (sandstone) with 80 ksf end bearing capacity. If loads carried by the shafts exceed this capacity, shaft design can be based on side resistance rather than end bearing (and the resulting shafts will be friction-type). Embedment lengths of the shafts into bedrock should be of proper length to allow the shafts to resist moments and shears generated by high lateral loads associated with proposed retained fill. The proposed retaining wall located along the right fascia of the left (southbound) structure/roadway is, along part of its length, founded on drilled shafts embedded in bedrock. As the wall height decreases, the foundation system transitions to a spread footing bearing on rock. As with the forward abutment shafts, the retaining wall shafts are sufficiently embedded in bedrock to provide adequate resistance to laterally induced loads, moments, and shears. The spread footing is wide enough to generate large vertical earth loads that will prevent, or minimize, rotation and sliding of the retaining wall system. To minimize the quantity of rock excavation at the forward abutment and retaining wall locations, the shaft caps/footings are stepped to follow, as best as possible, the steep slope of the existing groundline/hillside (and bedrock surface) in this vicinity. For further information regarding the foundations of the abutments and retaining wall, refer to Section 3 of this report as well as DLZ's 2/20/08 Final Geotechnical Report.

Turnback wingwalls are used at the rear and forward abutments except at the east (right) wingwall of the southbound bridge forward abutment. This particular wingwall is the (cast-in-place) retaining wall discussed earlier. Basic wingwall and abutment details will follow ODOT Standard Drawing A-1-69.

Piers: The northbound bridge requires four piers and the southbound bridge three piers. The following is a description of the pier type selected at each location.

Pier 1 (L&R): Pier 1 is T-type supported on pile foundations. The wide stem of a T-type pier is useful to minimize/eliminate slenderness effects anticipated for the 42' and 39' tall piers. A 20' wide x 3' thick stem cross-section will provide sufficient stiffness for the Pier 1L and Pier 1R "expansion" piers. According to the boring logs and foundation recommendations of DLZ, both Pier 1L and Pier 1R can be founded on HP14x73 piles driven to rock.

Piers 2 and 3 (L&R): Piers 2 and 3 are positioned outside the waterway of the Little Scioto River but still within the floodplain. The weak soils at these locations lie above bedrock which was encountered approximately 35'-50' below existing groundline. Due to very low blow counts and the possibility of scour, the weak soils above the bedrock cannot provide sufficient bearing, therefore drilled shafts with rock sockets in competent bedrock should be used to found Piers 2 and 3. DLZ's 9/27/06 Preliminary Structural Foundation Recommendations (Addendum) states that drilled shafts can be designed as end-bearing shafts in rock with an allowable (gross) bearing pressure of 80 ksf (this is also discussed in the 2/20/08 Final Geotechnical Report). A *preliminary* design using this bearing capacity results in five (5) drilled shafts per pier, each having 6'-0" diameter above rock and 5'-6" diameter within the rock socket. The pier footing cap at the top of the five drilled shafts requires a minimum thickness of 5' to accommodate two-way shear action (AASHTO 8.16.6.6).

The anticipated heights of these piers, measured from bottom of footing to top of cap, range from approximately 90' to 97'. ODOT BDM Section 303.3.1 indicates that piers should be designed/evaluated as "free-standing" – in other words, a piers ability to resist horizontal loads and forces does not depend upon its attachment to the superstructure. When Piers 2 & 3 are treated as "free-standing" piers, large displacements due to longitudinal forces (such as longitudinal wind load on superstructure, longitudinal wind load on live load, wind on substructure, etc.) are possible. Therefore, stiffer stems comprised of variable size that limit the deflections to magnitudes compatible with the superstructure (expansion joints and bearings) are recommended for final design. Two variable stem types, with the largest section at the base of the stem and the smallest at the stem-cap interface, were investigated in the 1/15/07 addendum to the 7/12/06 Type Study. The preliminary designs focused on limiting the displacements to amounts that would have minimal impact on the expansion and rotation requirements at the bearings and expansion joints. The first stem type consisted of solid telescoped sections whereas the second involved a hollow tapered stem with constant wall thickness. Following review of the addendum, ODOT recommended that the telescoped pier stem be developed for final design. Further refinement of the pier stiffness and the movements that can be tolerated by the expansion devices is recommended for final design.

Piers 2 and 3 have been designated as "fixed" piers so that longitudinal loads are distributed to both piers and expansion lengths are reduced/minimized at each abutment. The use of two fixed piers on one structure is considered to be consistent with Section 303.3.1 of the BDM which discusses designing slender columns to bend sufficiently to permit the superstructure to expand and contract without inducing significant stress in the piers. Additionally, the tall piers at Piers 2 and 3 are almost 80% of the expansion length of Span 3. Therefore, designing the piers to accommodate the thermal movements is also consistent with other parts of section 303.3.1 that allow for pier flexibility to accommodate the thermal movements when the height of the pier is more than 50% of the length of the superstructure from the point of zero movement to such pier.

Pier 4R: Pier 4R is an approximately 40' tall T-type pier with a 20' wide x 3' thick stem that minimizes/eliminates anticipated slenderness effects. The borings drilled by DLZ reveal highly variable bedrock surfaces near the location of Pier 4R which is in the steep hillside north of S.R. 335. Therefore, the foundations DLZ recommends are either drilled shafts that penetrate through the layers of native soil and bear on rock sockets in competent sandstone bedrock or spread footings at the bedrock elevation. A precursory cost comparison between a drilled shaft group and a spread footing reveals small differences in cost between these two foundation systems. However, due to the proximity of Pier 4R to the left forward abutment (and retaining wall), the additional excavation for the spread footing would require significant undercutting to maintain a stable foundation surface at the left forward abutment. Therefore, when this undercutting and its associated costs are considered, drilled shafts are deemed the more economically viable and stable foundation system for Pier 4R.

Superstructure:

I. Girders and Deck: The superstructure for both the left and right bridge of the proposed structure consists of 5-continuous welded steel plate girders, Grade 50W. The left bridge uses 108" deep webs and the right bridge 105" deep webs. The plate girders are dog-legged at splice locations to accommodate the horizontal curvature of the bridge and are placed parallel to one another between the splices. Accompanying bridge deck drainage calculations reveal that scuppers are required for the collection and removal of stormwater runoff. In accordance with ODOT BDM Section 205.6, a minimum overhang of 1'-6" is provided between centerline of fascia girder and deck fascia to place the scuppers inside the fascia beams. When scupper positions, splice locations, and dog-legging and parallel placement of straight girder segments are taken into consideration, a center-to-center girder spacing of 10'-0$^3/_4$"$\pm$ results (spacing between splice points actually varies from 10'-0$^{15}/_{16}$"$\pm$ to 10'-0$^5/_8$"$\pm$ - refer to the framing plan). With such spacing, the 5-continuous welded steel plate girders discussed above satisfy the HS-25 (Case I) and Alternate Military Loading as well as a Future Wearing Surface loading of 60 psf.

Both the left and right bridge have a 41'-11" width from toe-to-toe of parapet with an overall bridge deck width of 44'-10$^1/_2$". Deck thickness, including a 1" monolithic wearing surface, is 9".

II. Expansion Devices and Bearings: A simple preliminary evaluation of expansion devices involves designating Piers 2 and 3 as "fixed" piers and ignoring, for now, the effects of horizontal curvature and pier deflection. At the left bridge, this results in a rear abutment expansion length of 366'-6"± and a forward abutment expansion length of 203'-2"±. At the right bridge, this results in a rear abutment expansion length of 350'-4"± and a forward abutment expansion length of 349'-8"±. Section 306.3.3 of the ODOT BDM and ODOT Standard Drawing EXJ-4-87 reveal that 3" strip seal can be used at the left forward abutment and a 5" strip seal expansion joint can be used at the remaining three locations. These analyses do not include the deflections of the tall piers (Piers 2 and 3) and it is recommended that these deflections also be incorporated into the final expansion joint design.

A preliminary bearing evaluation results in a recommendation of pot bearings. The large vertical reactions and thermal displacements/rotations at the abutments and piers make it difficult to simultaneously satisfy the shear, compressive stress, rotation, and stability requirements of elastomeric bearing Methods A and B. When an elastomeric bearing does comply with these requirements, the resulting plan dimensions of the bearing are excessive and/or the thickness is significantly greater than 5". Pot bearings provide a more direct and simple solution, one that can support large vertical reactions as well as the multi-directional displacements/rotations that will develop due to the horizontal curvature of these bridges.

APPENDIX A

Structure Plans

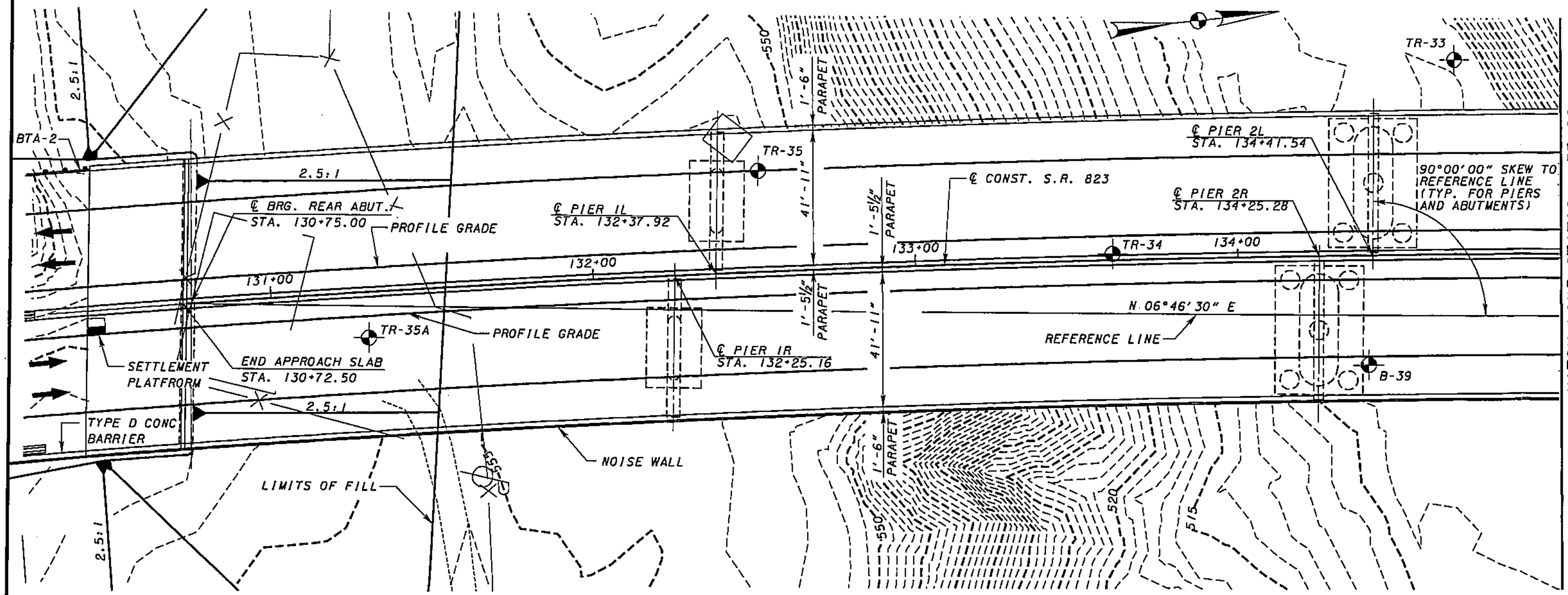
TranSystems

FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS	
LOCATION	STATION
REAR ABUT. (SB)	130+41.42
FWD. ABUT. (SB)	139+32.36

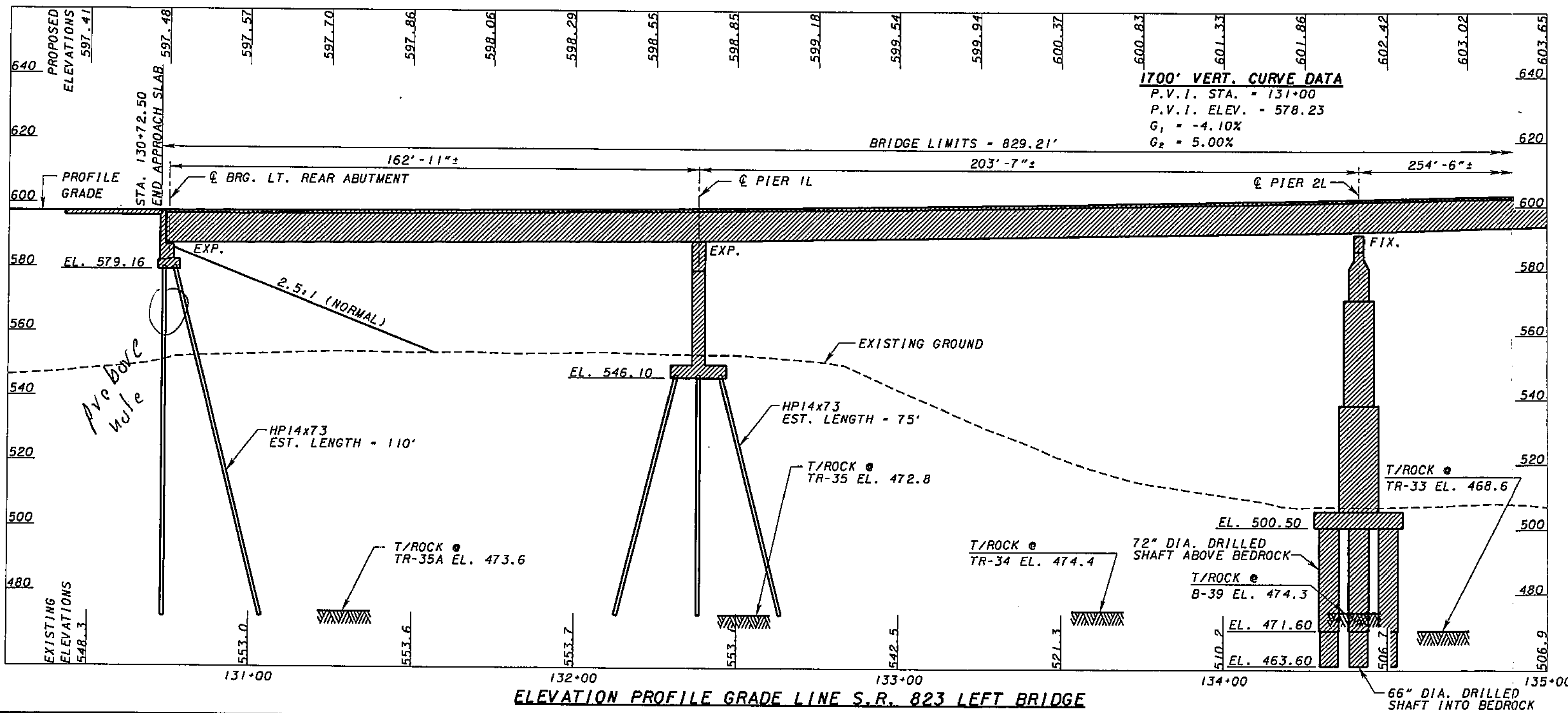
BENCHMARK 1	BENCHMARK 2
(TO BE PROVIDED LATER)	(TO BE PROVIDED LATER)

TRAFFIC DATA

S.R. 823
CURRENT YEAR ADT (2010) - 21,200
DESIGN YEAR ADT (2030) - 31,200
CURRENT YEAR ADTT (2010) - 2,970
DESIGN YEAR ADTT (2030) - 4,370



PLAN



ELEVATION PROFILE GRADE LINE S.R. 823 LEFT BRIDGE

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.

LEGEND

BTA-1 - BRIDGE TERMINAL ASSEMBLY TYPE 1
BTA-2 - BRIDGE TERMINAL ASSEMBLY TYPE 2
⊕ - BORING LOCATION

PROPOSED STRUCTURE

TYPE: 4 SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W, DOG LEGGED AT SPLICES, WITH COMPOSITE REINFORCED CONCRETE DECK ON STUB ABUTMENTS AND T-TYPE PIERS

SPANS: 162'-11"±, 203'-4"±, 254'-6"±, 203'-2"± (MEASURED ALONG € CONST. S.R. 823)

ROADWAY: 2 - 41'-11" TOE TO TOE PARAPETS

LOADING: HS-25 (CASE 1) AND ALTERNATE MILITARY LOADING, FWS=60 PSF

SKEW: 0°00'00" WITH RESPECT TO THE REFERENCE LINE (ALSO SEE FRAMING PLAN)

SUPERELEVATION: 0.036 FT/FT ACROSS TRAVEL LANES

ALIGNMENT: Dc = 1°00'00" (TO THE RIGHT)

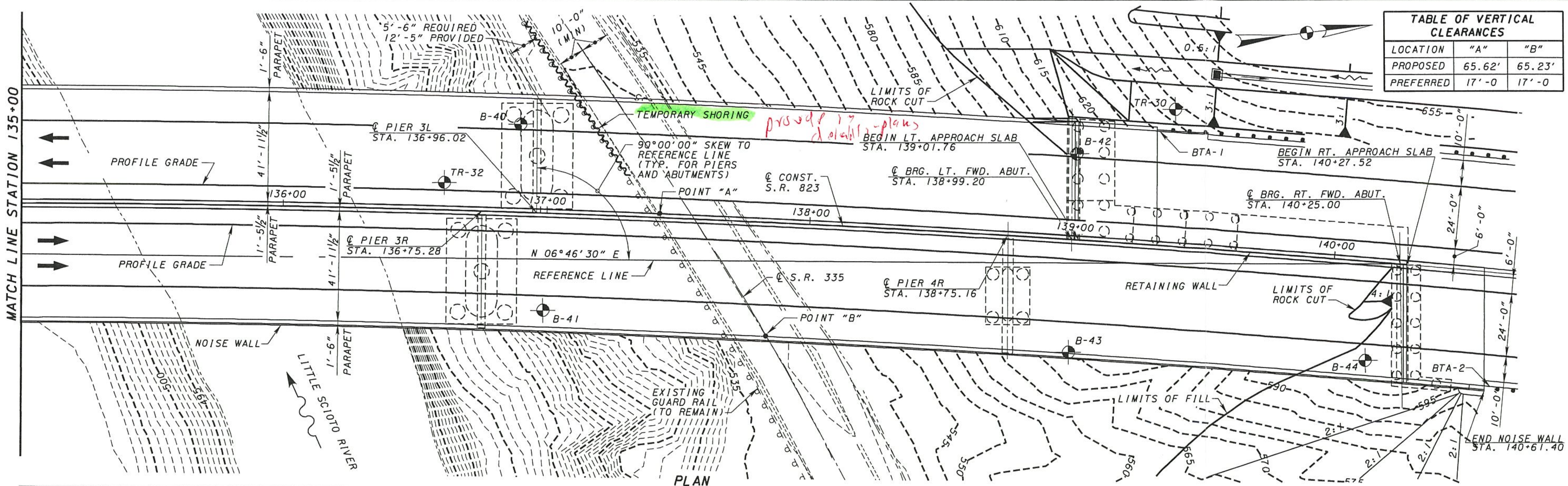
WEARING SURFACE: MONOLITHIC CONCRETE

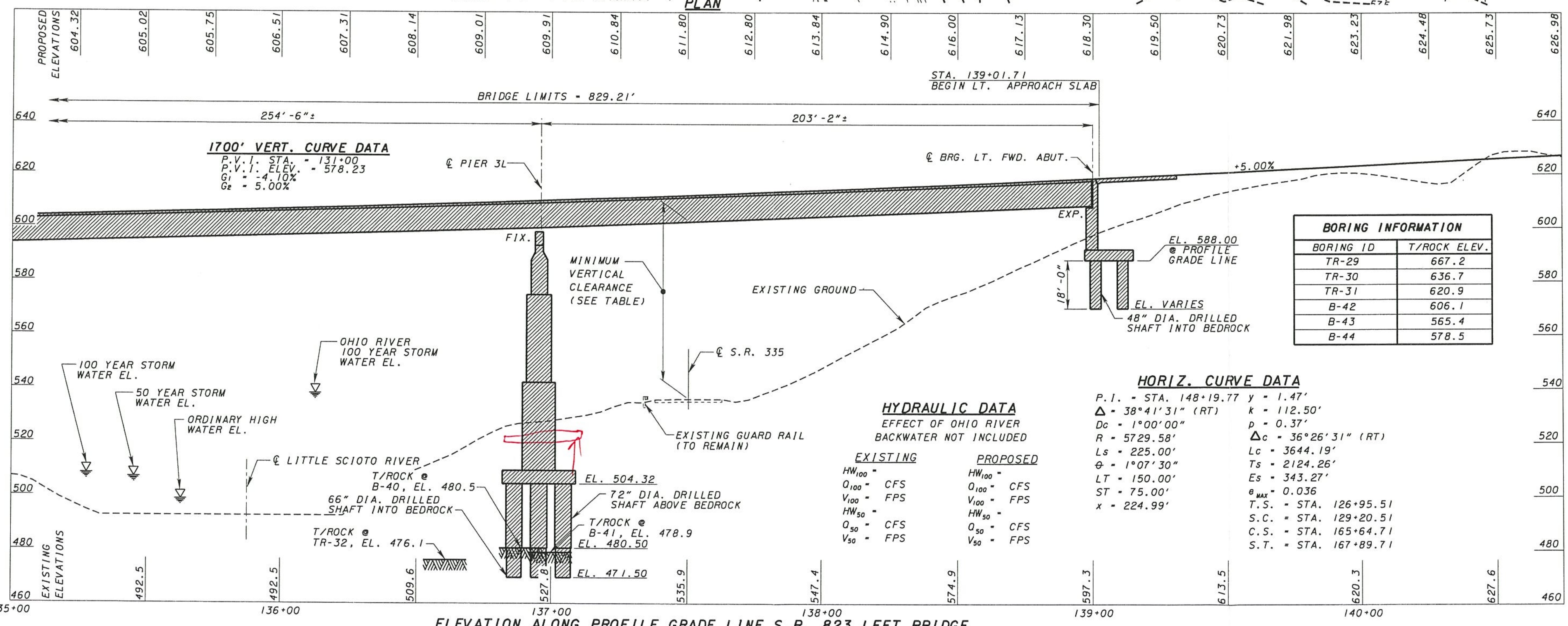
APPROACH SLABS: AS-1-81 (30' LONG)

LATITUDE: 38°46'28" N

LONGITUDE: 82°51'52" W

DESIGN AGENCY: TranSystems, 5747 PERIMETER DRIVE, SUITE 240, DUBLIN, OHIO 43017
DESIGNED MTN | CHECKED PJP | DRAWN MTN | REVISED | REVIEWED MSL | DATE 02/21/08 | STRUCTURE FILE NUMBER 7306369
SCIOTO COUNTY STA. 130+72.50 STA. 139+01.71
SITE PLAN
BRIDGE NO. SCO-823-0248 L
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER
SCI-823-0.00
PID 77366





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

TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"
PROPOSED	65.62'	65.23'
PREFERRED	17'-0	17'-0

BORING INFORMATION

BORING ID	T/ROCK ELEV.
TR-29	667.2
TR-30	636.7
TR-31	620.9
B-42	606.1
B-43	565.4
B-44	578.5

HYDRAULIC DATA

EFFECT OF OHIO RIVER BACKWATER NOT INCLUDED

EXISTING	PROPOSED
HW_{100} -	HW_{100} -
Q_{100} - CFS	Q_{100} - CFS
V_{100} - FPS	V_{100} - FPS
HW_{50} -	HW_{50} -
Q_{50} - CFS	Q_{50} - CFS
V_{50} - FPS	V_{50} - FPS

HORIZ. CURVE DATA

P.I. - STA. 148+19.77
Δ - 38°41'31" (RT)
Dc - 1°00'00"
R - 5729.58'
Ls - 225.00'
θ - 1°07'30"
LT - 150.00'
ST - 75.00'
x - 224.99'
y - 1.47'
k - 112.50'
p - 0.37'
Δc - 36°26'31" (RT)
Lc - 3644.19'
Ts - 2124.26'
Es - 343.27'
e_{MAX} - 0.036
T.S. - STA. 126+95.51
S.C. - STA. 129+20.51
C.S. - STA. 165+64.71
S.T. - STA. 167+89.71

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

DESIGNED MTN | CHECKED PJP | DRAWN MTN | REVISED | REVIEWED MSL | DATE 02/21/08 | STRUCTURE FILE NUMBER 7306369

SCIOTO COUNTY
STA. 130+72.50
STA. 139+01.71

SITE PLAN
BRIDGE NO. SCI-823-0248 L
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366

2/15

836/847

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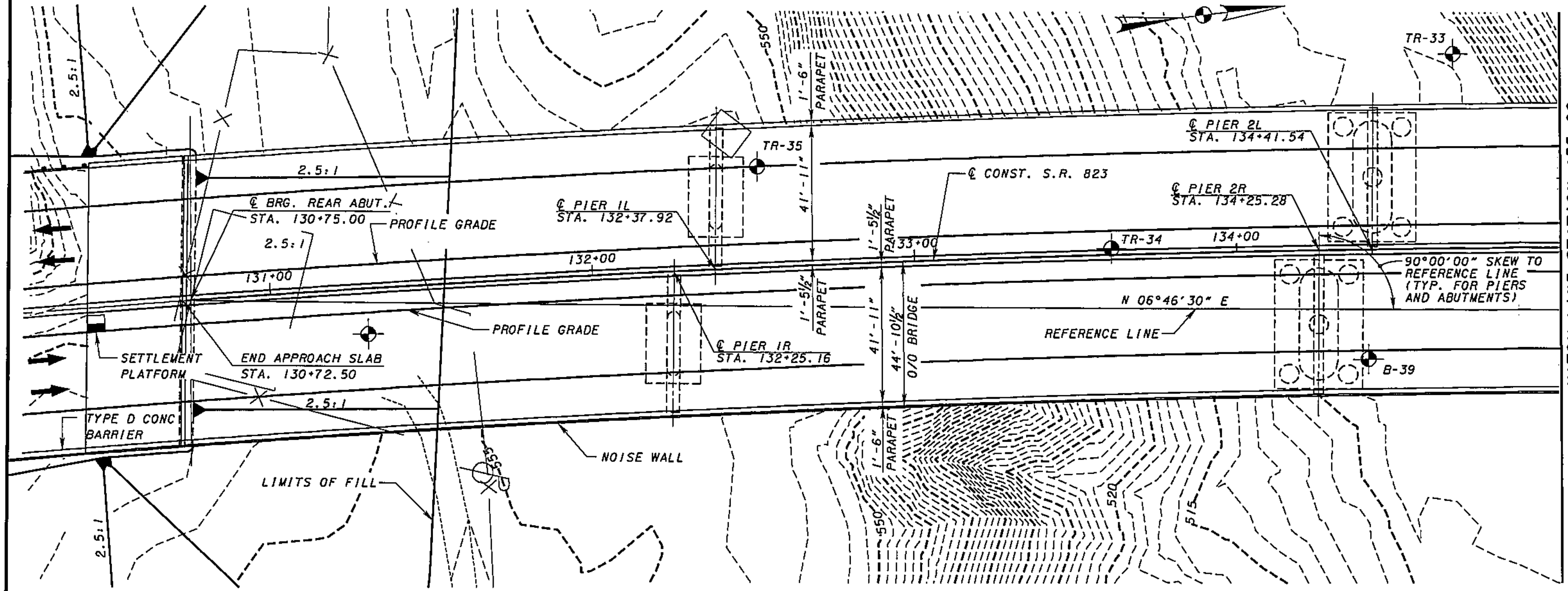

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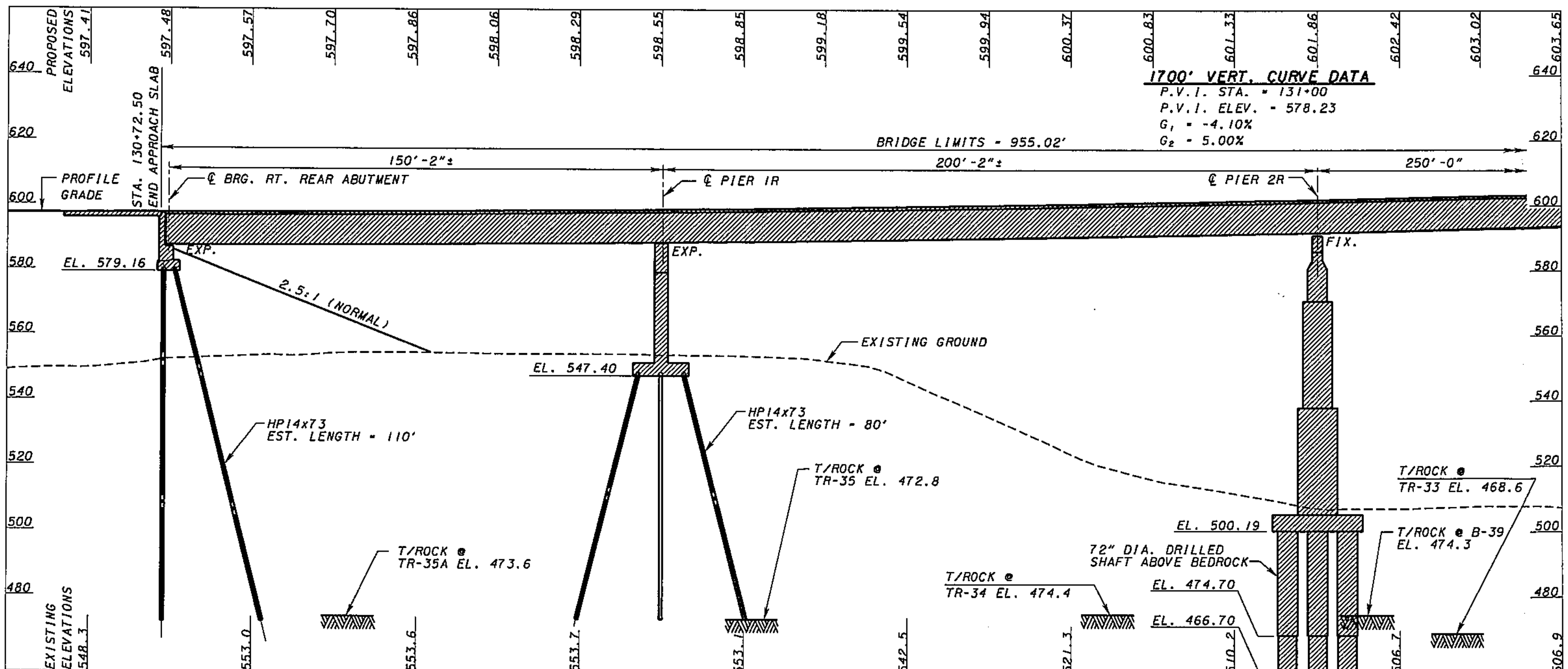

ELEVATION PROFILE GRADE LINE S.R. 823 RIGHT BRIDGE

FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS	
LOCATION	STATION
REAR ABUT. (NB)	109+95.85
FWD. ABUT. (NB)	140+66.33

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

TRAFFIC DATA

S.R. 823
CURRENT YEAR ADT (2010) = 21,200
DESIGN YEAR ADT (2030) = 31,200
CURRENT YEAR ADTT (2010) = 2,970
DESIGN YEAR ADTT (2030) = 4,370

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.

LEGEND

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

PROPOSED STRUCTURE

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

SPANS: 150'-2"±, 200'-2"±, 250'-0", 199'-10"±, 149'-10"± C/C BEARINGS (MEASURED ALONG ℄ CONST. S.R. 823)

ROADWAY: 2 - 41'-11" TOE TO TOE PARAPETS

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

SKEW: 0°00'00" WITH RESPECT TO THE REFERENCE LINE (ALSO SEE FRAMING PLAN)

SUPERELEVATION: 0.036 FT/FT ACROSS TRAVEL LANES

ALIGNMENT: Dc = 1°00'00" (TO THE RIGHT)

WEARING SURFACE: MONOLITHIC CONCRETE

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

LATITUDE: 38°46'28" N

LONGITUDE: 82°51'52" W

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

DESIGNED MTN | CHECKED PJP | DRAWN MTN | REVISED | REVIEWED MSL | DATE 02/21/08 | STRUCTURE FILE NUMBER 7306377

SCIOTO COUNTY
STA. 130+72.50
STA. 140+27.52

SITE PLAN
BRIDGE NO. SCO-823-0248 R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366

3/15

837/847

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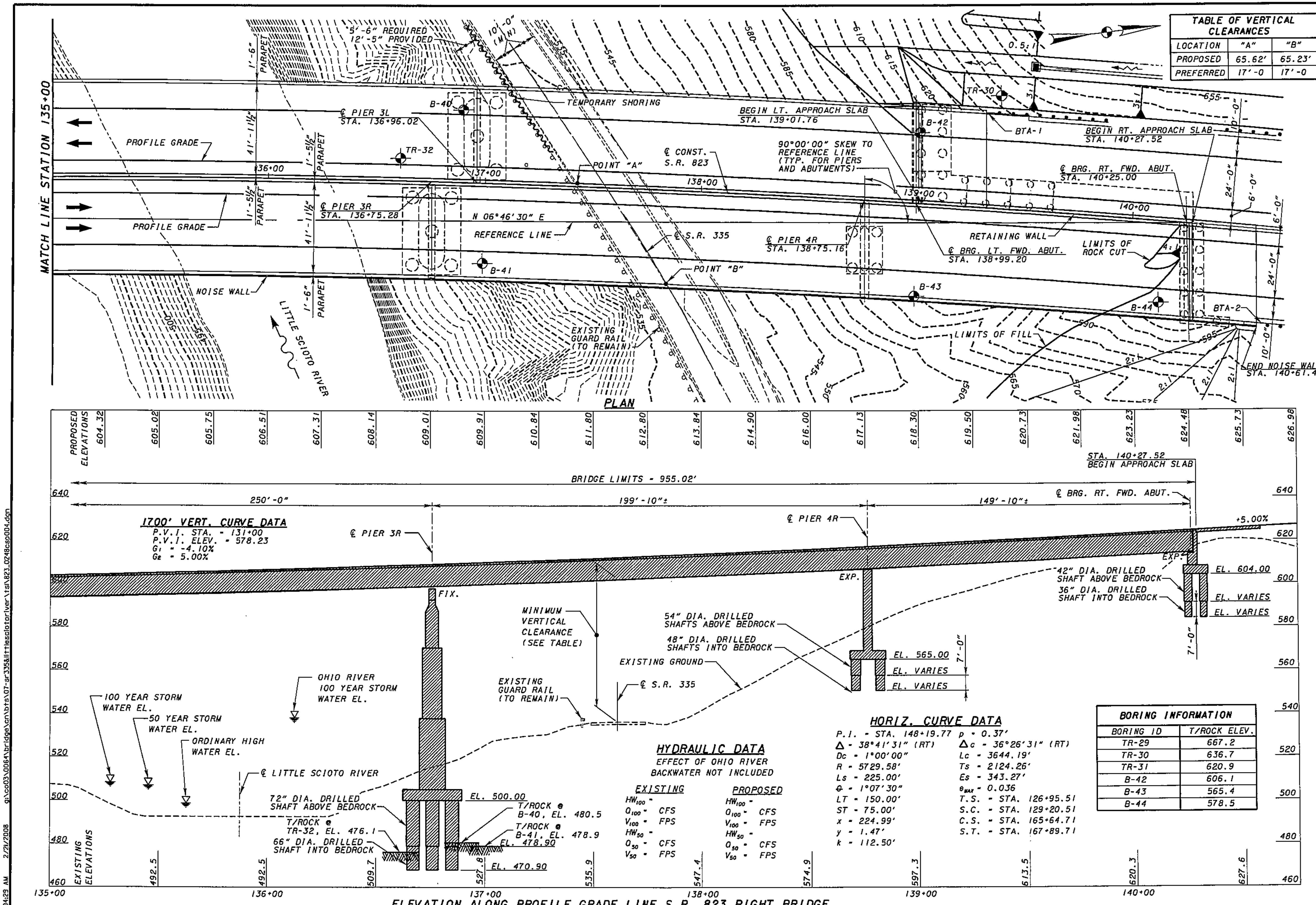


TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"
PROPOSED	65.62'	65.23'
PREFERRED	17'-0	17'-0

HYDRAULIC DATA
EFFECT OF OHIO RIVER BACKWATER NOT INCLUDED

EXISTING	PROPOSED
HW_{100} -	HW_{100} -
Q_{100} - CFS	Q_{100} - CFS
V_{100} - FPS	V_{100} - FPS
HW_{50} -	HW_{50} -
Q_{50} - CFS	Q_{50} - CFS
V_{50} - FPS	V_{50} - FPS

HORIZ. CURVE DATA

P.I. - STA. 148+19.77	p - 0.37'
Δ - 38°41'31" (RT)	Δc - 36°26'31" (RT)
Dc - 1°00'00"	Lc - 3644.19'
R - 5729.58'	Ts - 2124.26'
Ls - 225.00'	Es - 343.27'
θ - 1°07'30"	e_{MAX} - 0.036
LT - 150.00'	T.S. - STA. 126+95.51
ST - 75.00'	S.C. - STA. 129+20.51
x - 224.99'	C.S. - STA. 165+64.71
y - 1.47'	S.T. - STA. 167+89.71
k - 112.50'	

BORING INFORMATION

BORING ID	T/ROCK ELEV.
TR-29	667.2
TR-30	636.7
TR-31	620.9
B-42	606.1
B-43	565.4
B-44	578.5

DESIGN AGENCY: TranSystems

DESIGNED	CHECKED	DRAWN	REVISED	REVIEWED	DATE
MTN	PJP	MTN		MSL	02/21/08

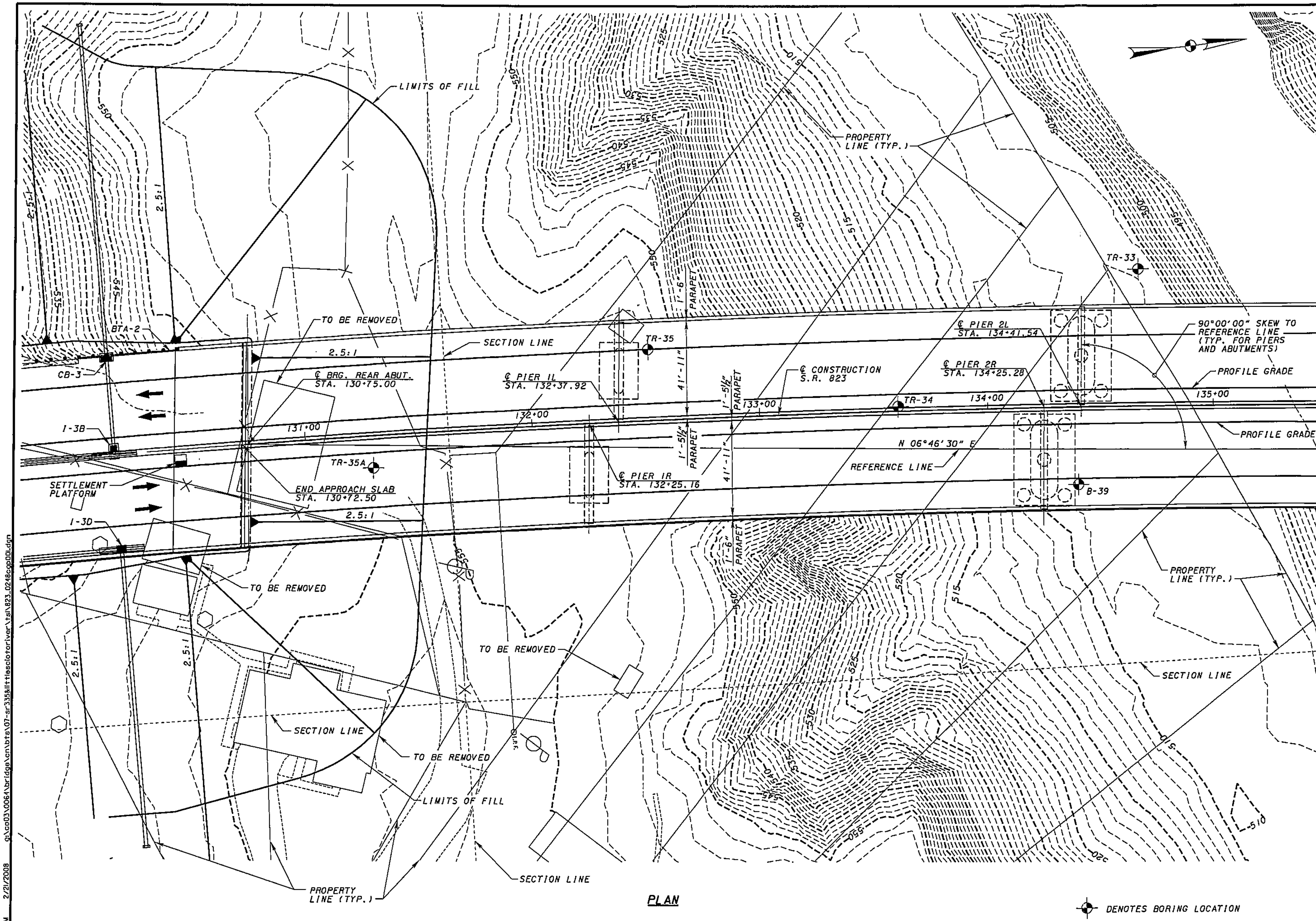
STRUCTURE FILE NUMBER 7306369

SCIOTO COUNTY
STA. 130+72.50
STA. 140+27.52

SITE PLAN

BRIDGE NO. SCI-823-0248 R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366



PLAN

DENOTES BORING LOCATION

GENERAL PLAN
BRIDGE NO. SCO-823-0248 L&R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

DESIGNED	DRAWN	REVIEWED	DATE
MTN	MTN	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

DESIGN AGENCY: TranSystems

SCI-823-0.00
PID 77366

5/15

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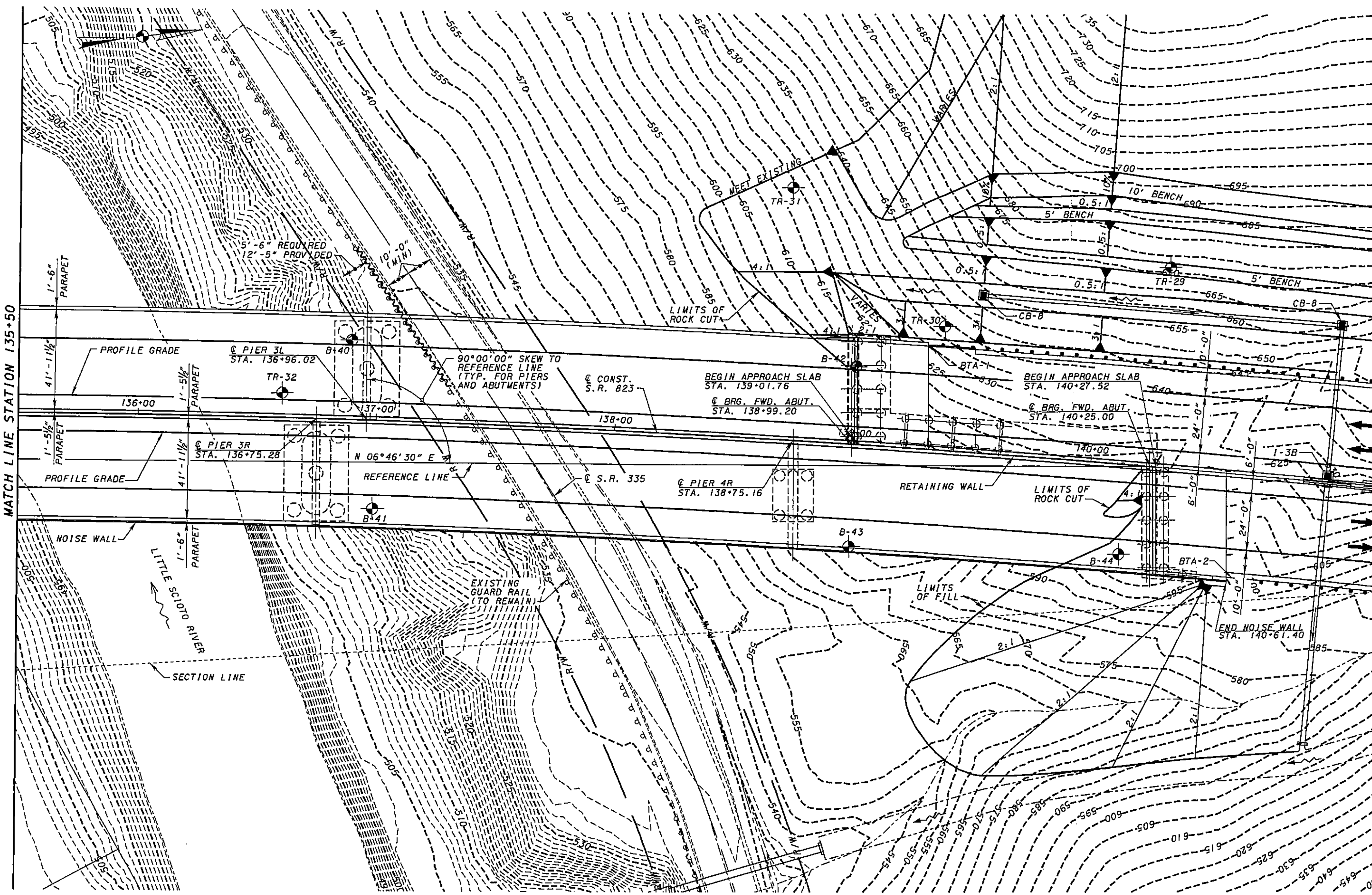

PLAN

DENOTES BORING LOCATION

GENERAL PLAN

BRIDGE NO. SCO-823-0248 L&R

S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

DESIGNED	DRAWN	REVIEWED	DATE
MTN	MTN	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
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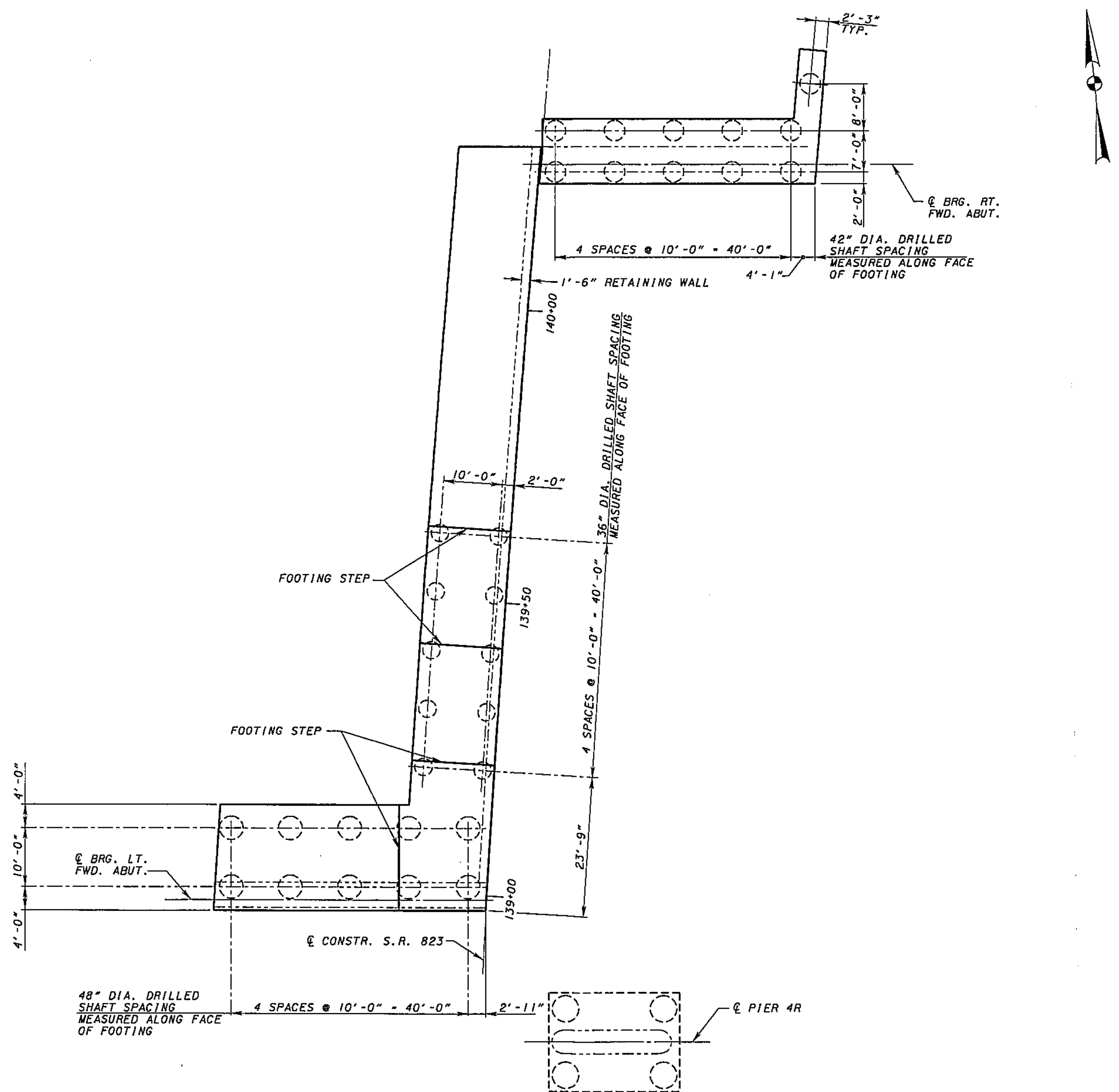
DESIGN AGENCY: TranSystems

SCI-823-0.00

PID 77366



PLAN

DESIGNED	DRAWN	REVIEWED	DATE
MTN	JDG	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

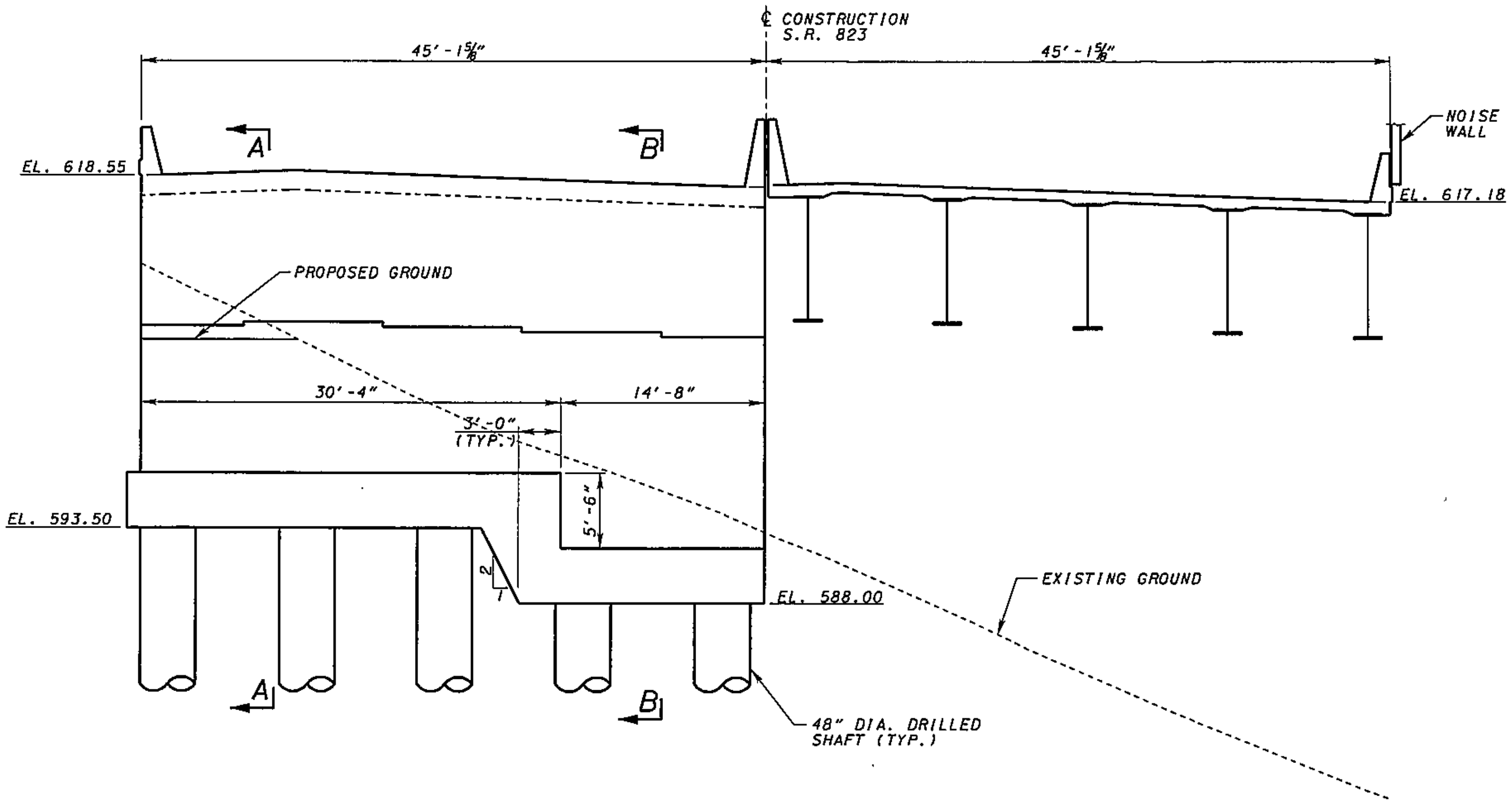
DESIGN AGENCY
TranSystems
5747 PERIMETER DRIVE, SUITE 240
DUBLIN, OHIO 43017

FORWARD ABUTMENT FOUNDATION PLAN
BRIDGE NO. SCI-823-0248 L&R
SR823 OVER SR335 & LITTLE SCIOTO RIVER

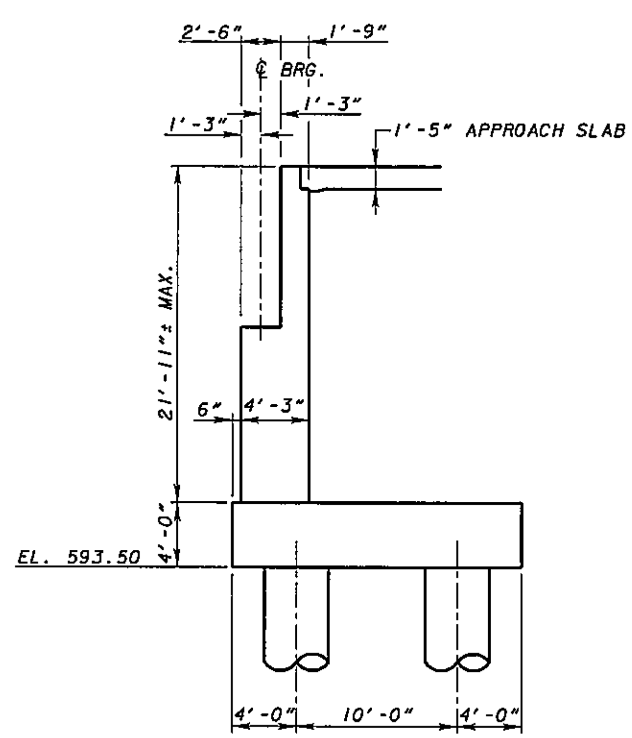
SCI-823-0.00
PID 77366

7 / 15

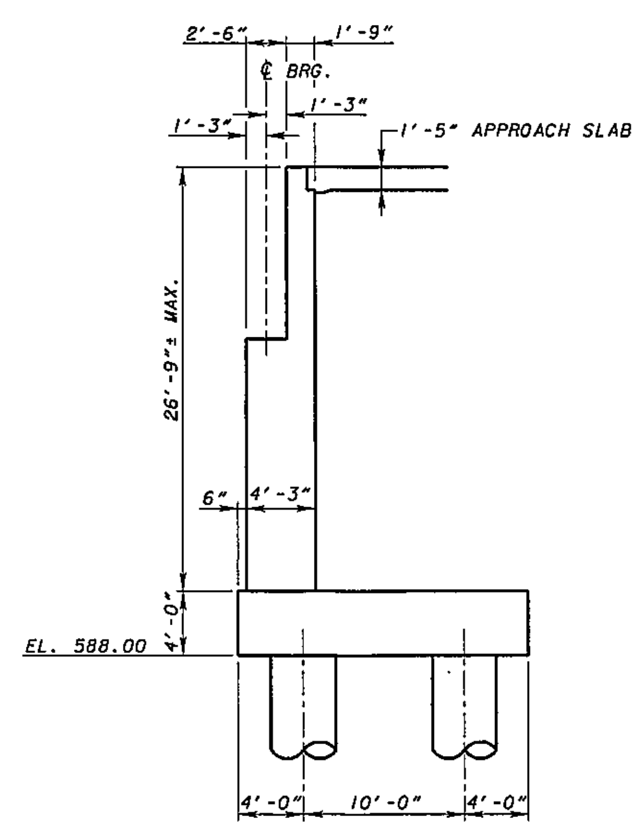
841 / 847



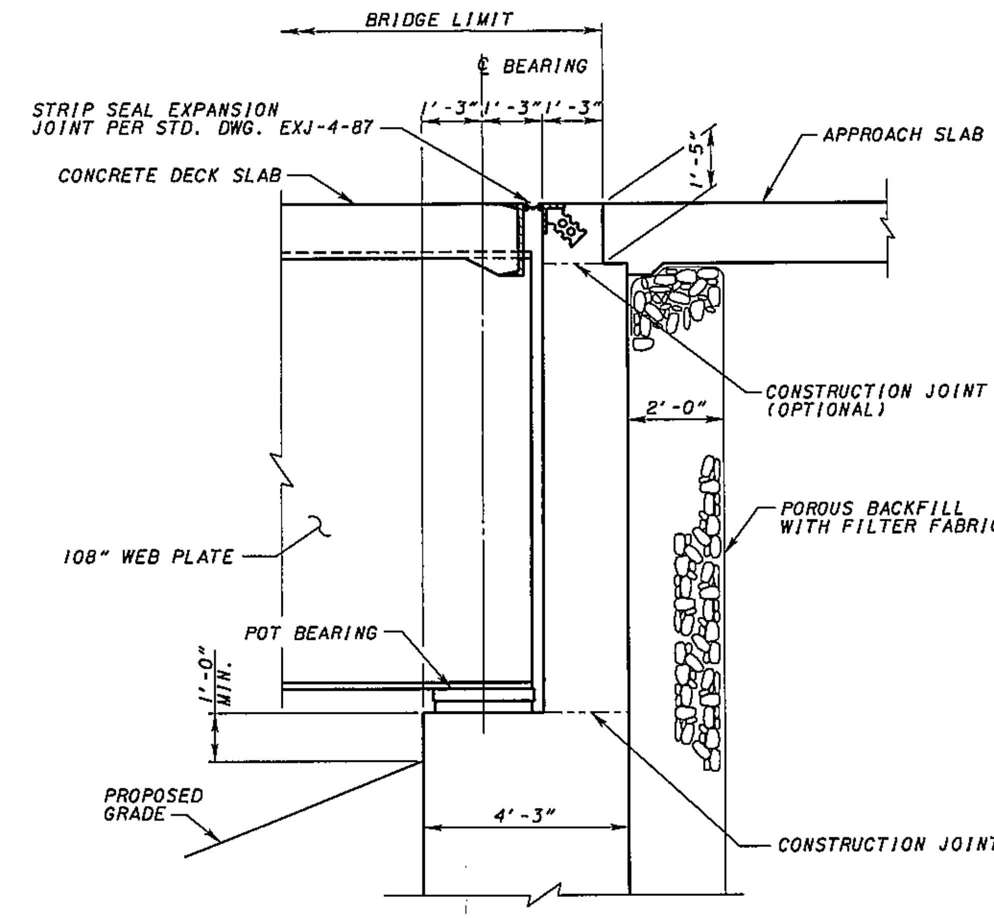
ELEVATION
(ALONG FACE OF ABUTMENT)



SECTION A-A



SECTION B-B



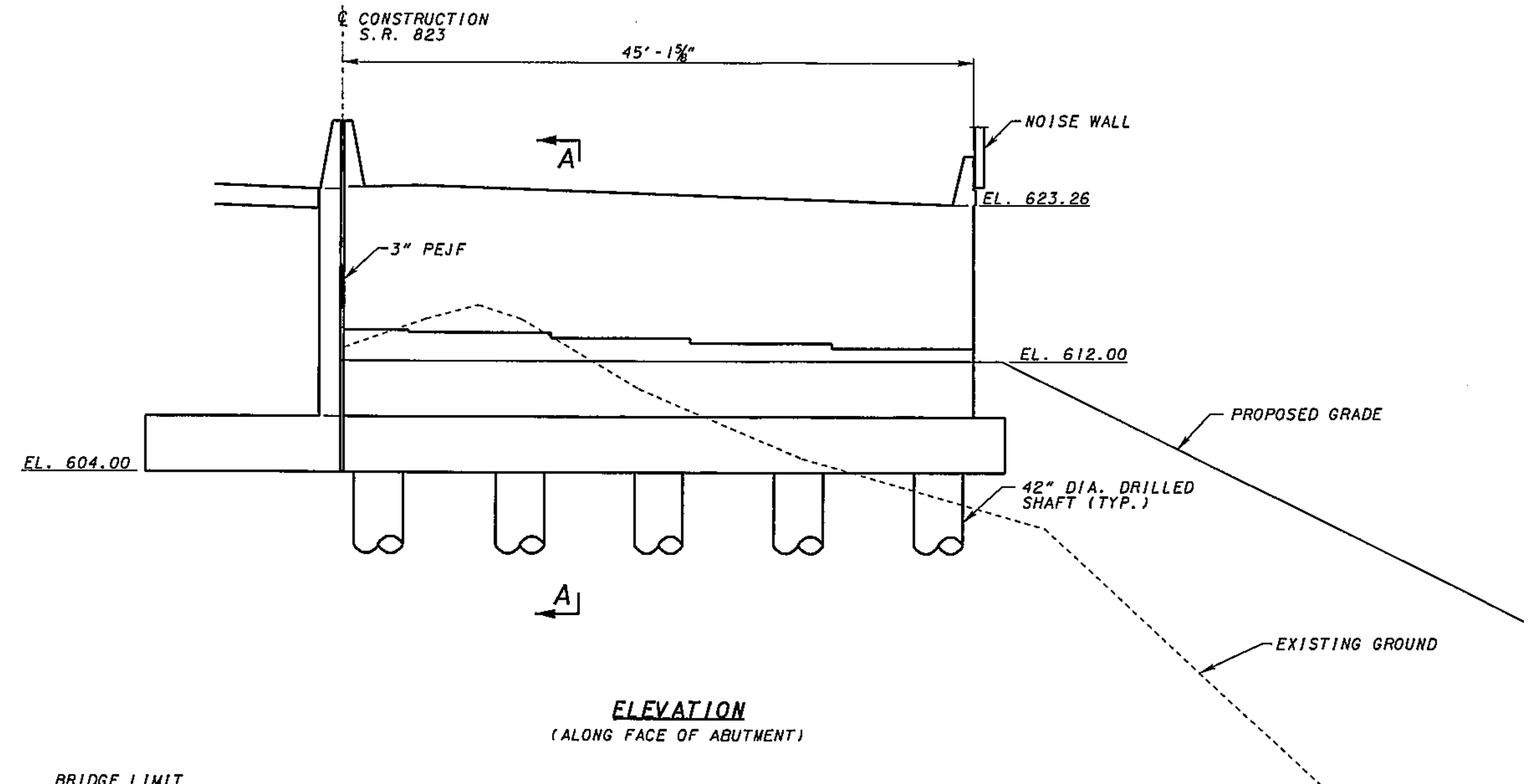
TYPICAL FORWARD ABUTMENT DETAIL

DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
MTN	JDG	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

FORWARD ABUTMENT DETAILS LEFT BRIDGE
BRIDGE NO. SCI-823-0248 L
SR823 OVER SR335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366



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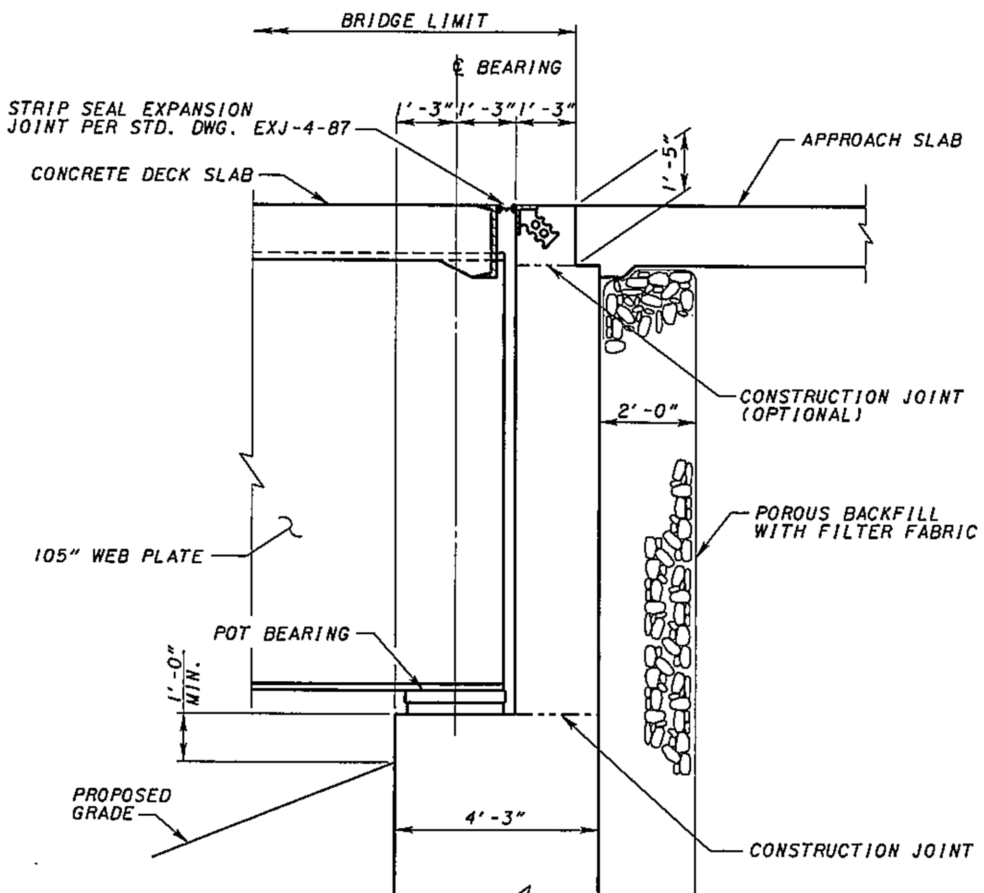
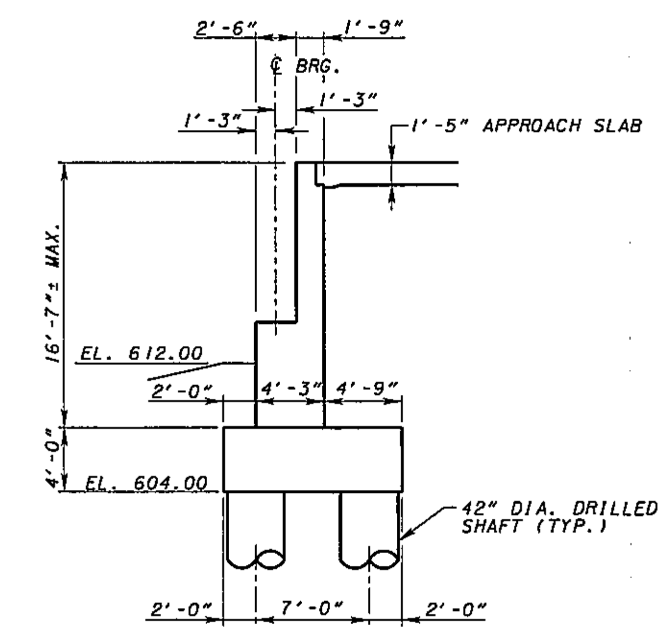
(ALONG FACE OF ABUTMENT)



TYPICAL FORWARD ABUTMENT DETAIL



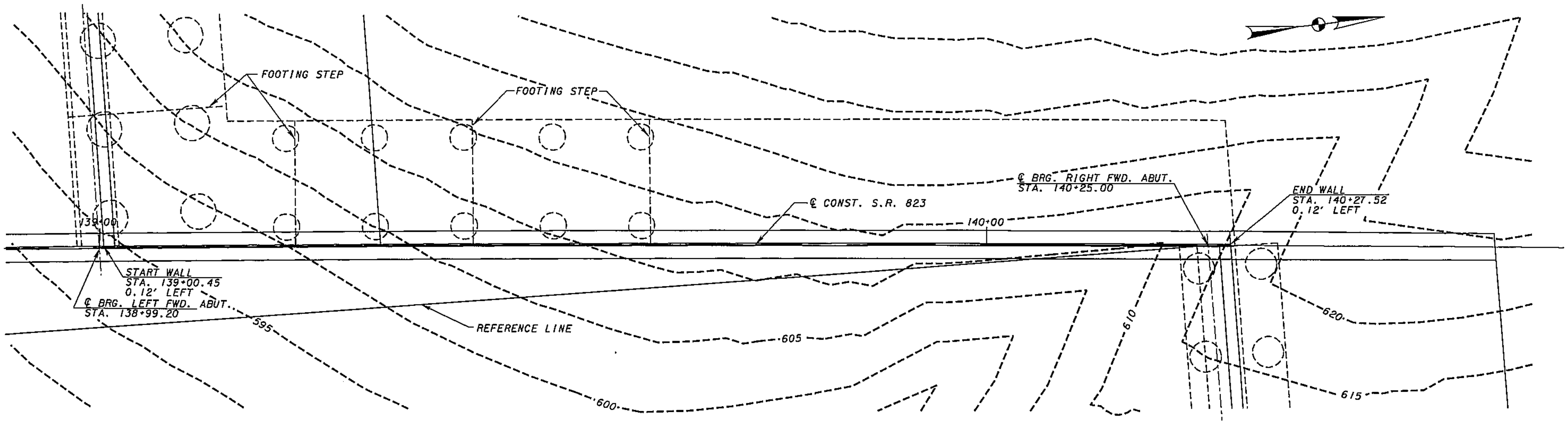
SECTION A-A

FORWARD ABUTMENT DETAILS RIGHT BRIDGE
BRIDGE NO. SCI-823-0248 R
SR823 OVER SR335 & LITTLE SCIOTO RIVER

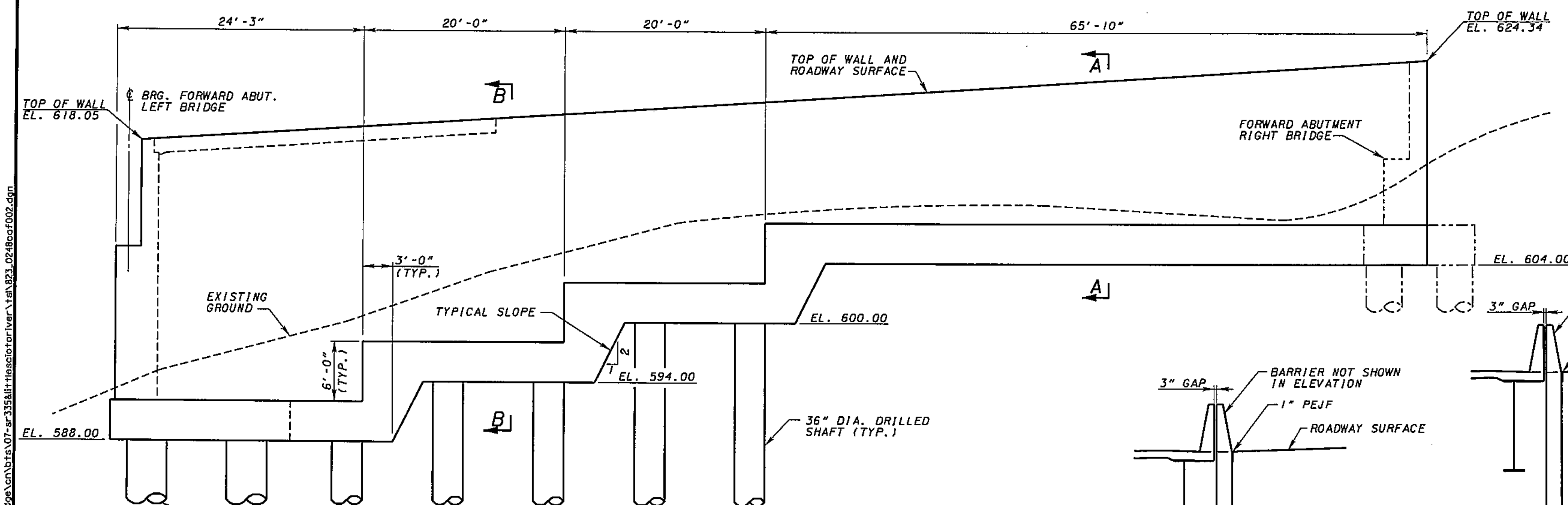
DESIGNED	DRAWN	REVIEWED	DATE
MTN	JDG	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

DESIGN AGENCY: TranSystems

SCI-823-0.00
PID 77366

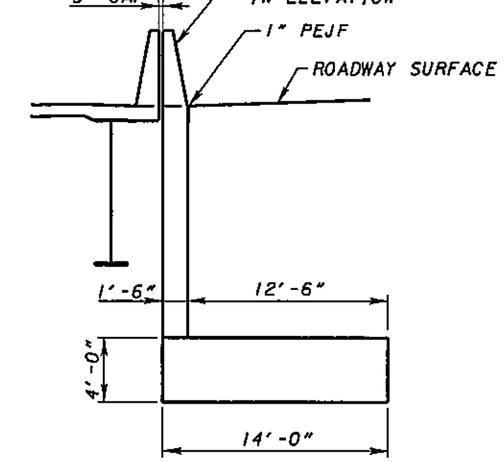


PLAN

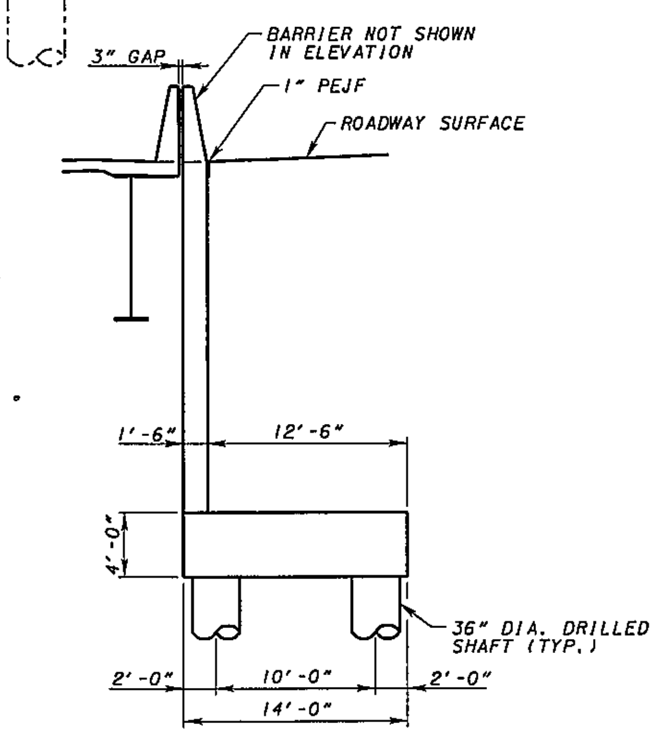


ELEVATION

(BARRIER ON WALL NOT SHOWN)



SECTION A-A



SECTION B-B

DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
JDG	MTN	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

FWD. ABUT. RETAINING WALL DETAILS

BRIDGE NO. SCI-823-0248 L

SR823 OVER SR335 & LITTLE SCIOTO RIVER

SCI-823-0.00

PID 77366

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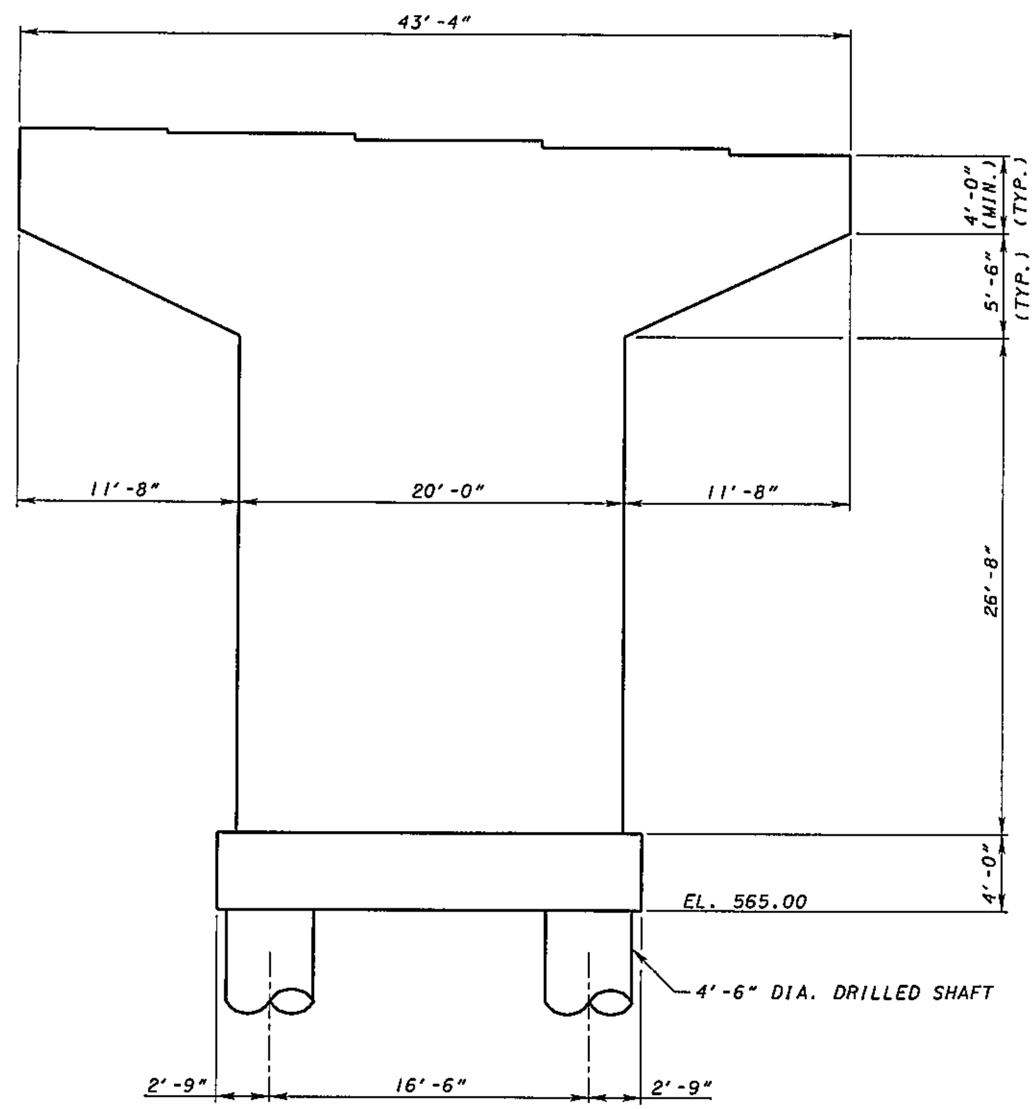
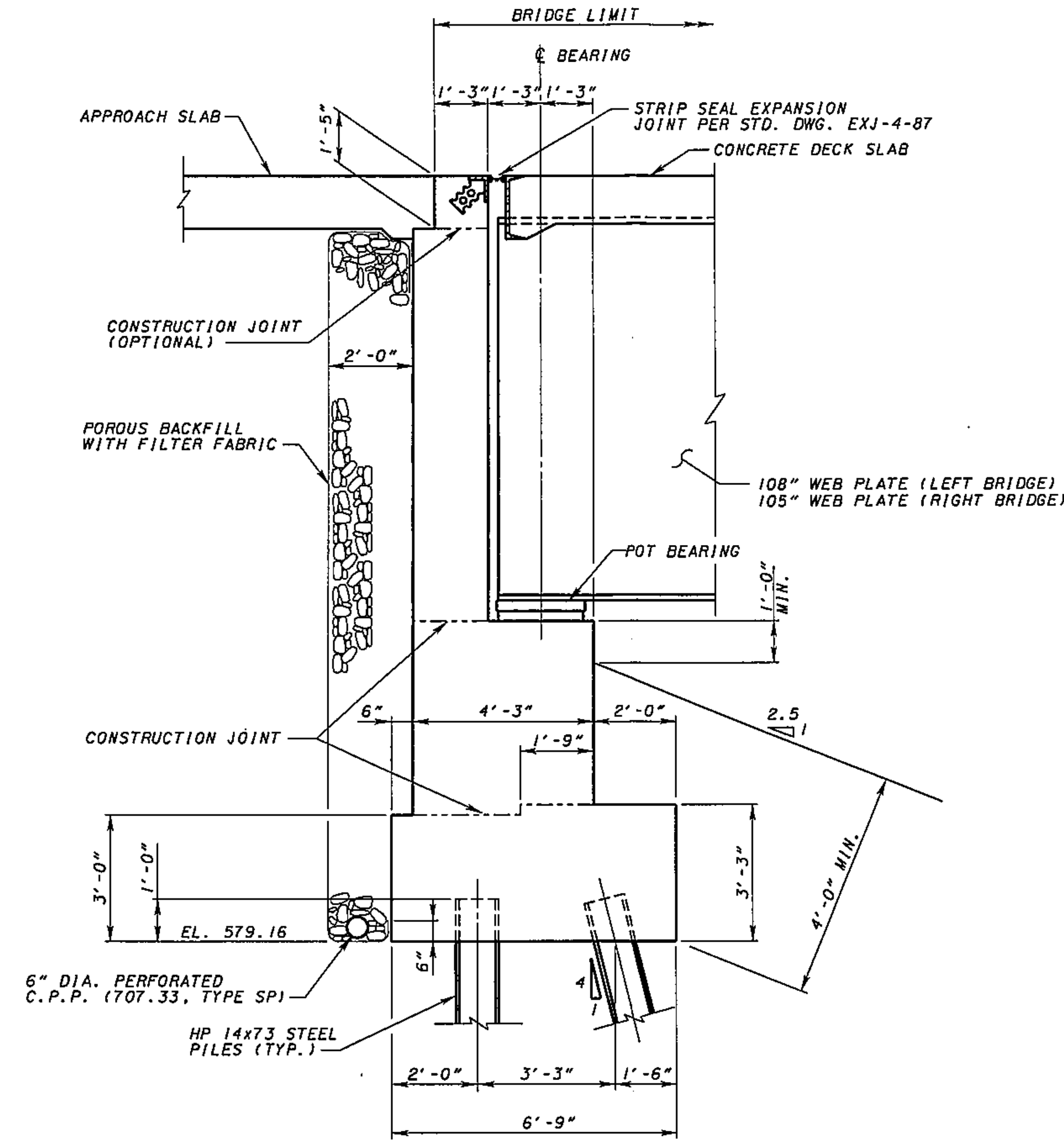


ELEVATION

PIER 4R
STA. 138+75.16



REAR ABUTMENT SECTION

NOTES:

1. WICK DRAINS AND SETTLEMENT MONITORING ARE REQUIRED FOR THE PROPOSED EMBANKMENT CONSTRUCTION. SEE WICK DRAIN AND INSTRUMENTATION PLANS FOR MORE DETAILS.

2. CONSTRUCTION CONSTRAINTS: PRIOR TO CONSTRUCTING THE PROPOSED PILE FOUNDATIONS, CONSTRUCT THE BRIDGE APPROACH EMBANKMENTS BEHIND THE ABUTMENT UP AT A 1:1 SLOPE FROM THE BOTTOM OF THE HEEL OF THE FOOTING TO SUBGRADE ELEVATION AND FOR A MINIMUM DISTANCE OF 250 FEET BEHIND THE ABUTMENTS. CONSTRUCTION OF THE PIER AND ABUTMENT FOUNDATIONS CAN PROCEED AFTER THE GEOTECHNICAL DESIGN COORDINATOR HAS DETERMINED THAT 99% CONSOLIDATION HAS BEEN REACHED. THE ESTIMATED TIME TO 99% CONSOLIDATION DEPENDS UPON THE WICK DRAIN SPACING SELECTED TO CONSTRUCT THE EMBANKMENT. AFTER THE ABUTMENT FOOTING AND BREASTWALL ARE COMPLETED AND PRIOR TO SETTING SUPERSTRUCTURE MEMBERS, CONSTRUCT THE EMBANKMENT IMMEDIATELY BEHIND THE ABUTMENT UP TO THE BEAM SEAT ELEVATION AND ON A 1:1 SLOPE UP TO THE SUBGRADE ELEVATION, WITH TYPE B GRANULAR MATERIAL CONFORMING TO 703.16.C.

3. ITEM 203 EMBANKMENT, AS PER PLAN: PLACE AND COMPACT EMBANKMENT MATERIAL IN 6 INCH LIFTS FOR THE CONSTRUCTION OF THE APPROACH EMBANKMENT BETWEEN STATIONS 129+75 TO 132+00.

DESIGN AGENCY
TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
MSL	MTN	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

REAR ABUTMENT AND PIER 4R DETAILS

BRIDGE NO. SCI-823-0248 L&R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366

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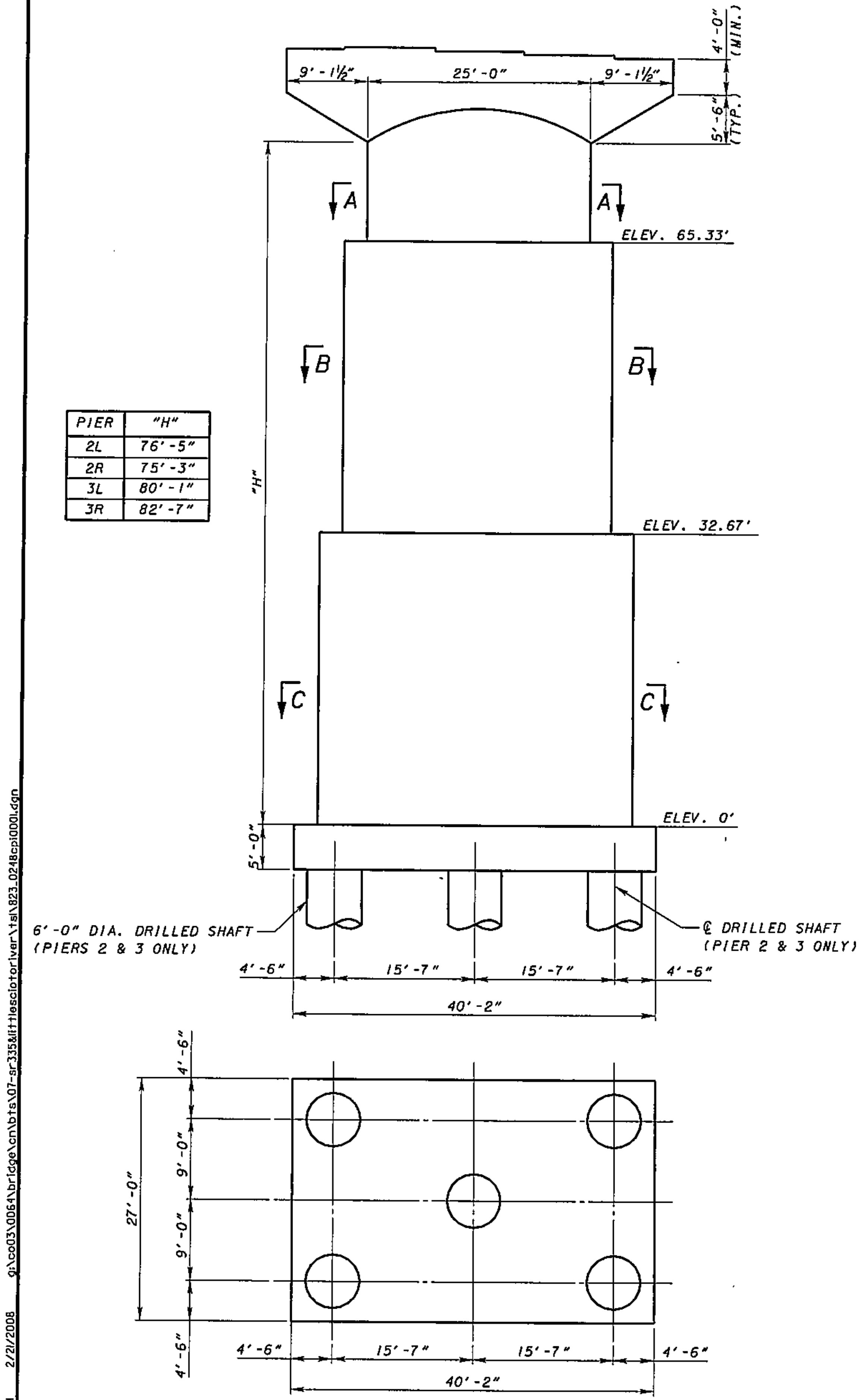
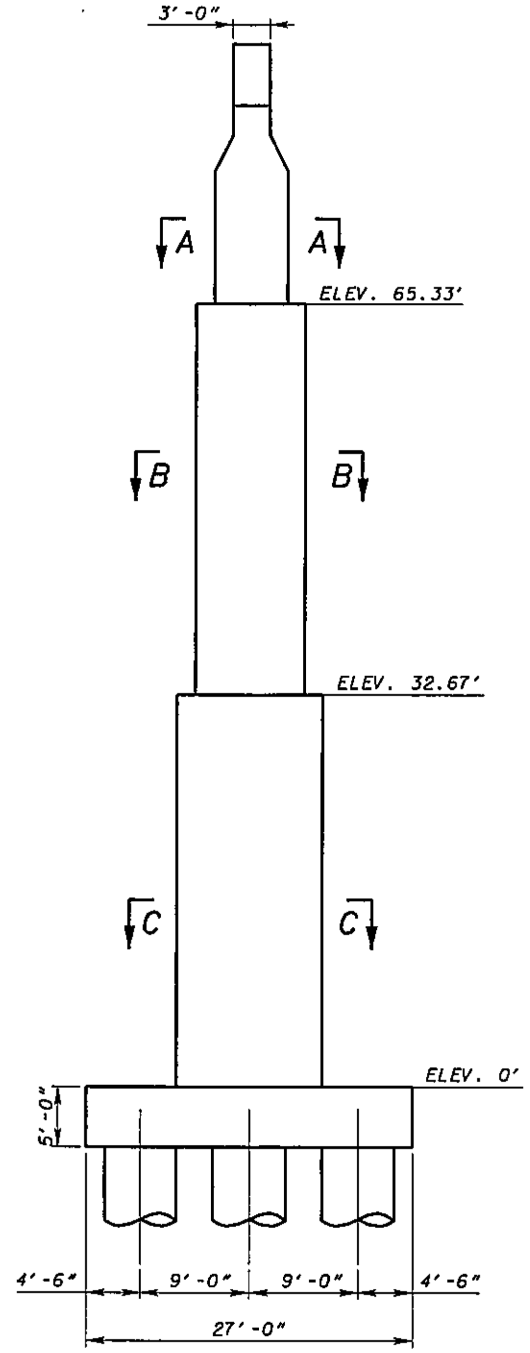
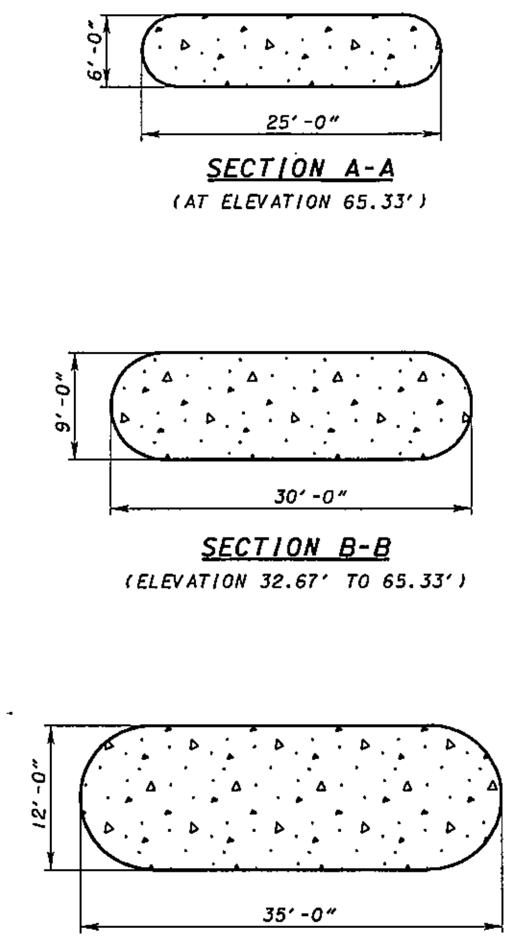
PIER	"H"
2L	76'-5"
2R	75'-3"
3L	80'-1"
3R	82'-7"







SECTION A-A
(AT ELEVATION 65.33')

SECTION B-B
(ELEVATION 32.67' TO 65.33')

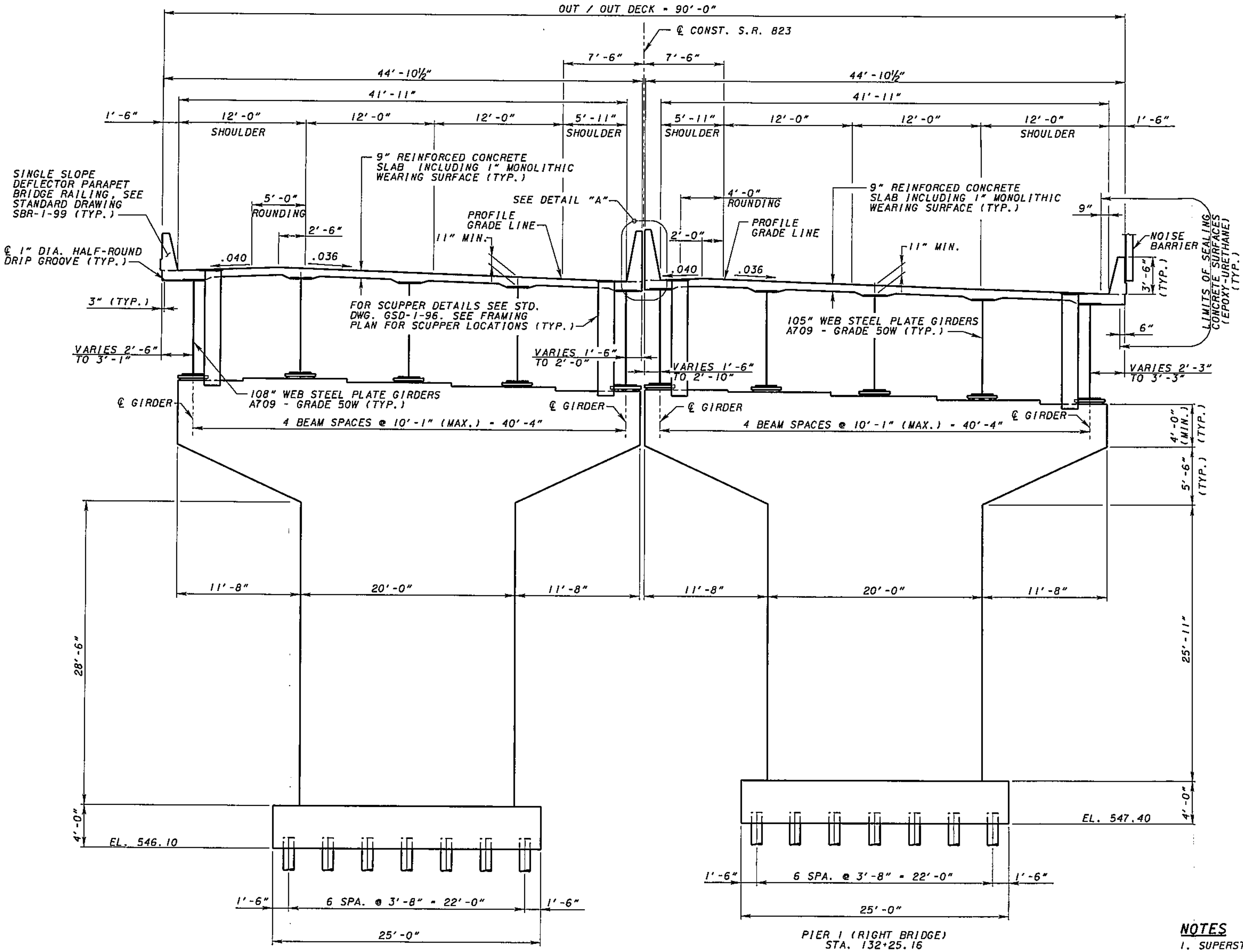
SECTION C-C
(AT THE TOP OF FOOTER ELEV. = 0' TO 32.67')

PIER 2 AND PIER 3 DETAILS
BRIDGE NO. SCI-823-0248 L&R
SR823 OVER SR335 & LITTLE SCIOTO RIVER

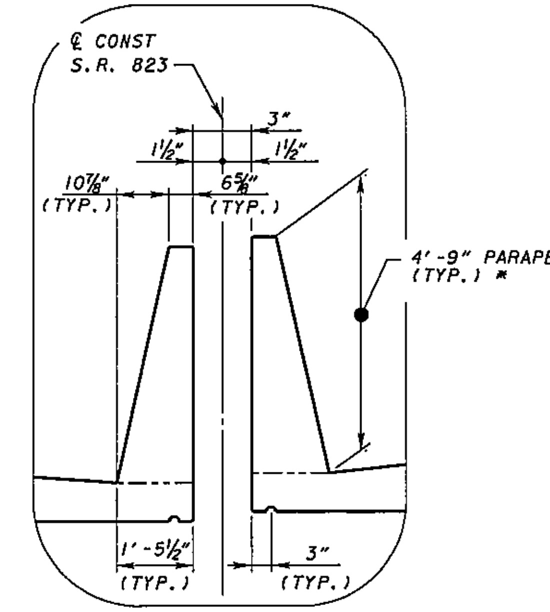
DESIGN AGENCY: TranSystems

DESIGNED	DRAWN	REVIEWED	DATE
MSL	MTN	MSL	02/21/08
CHECKED	REVISED	STRUCTURE FILE NUMBER	
PJP		7306369L, 7306377R	

SCI-823-0.00
PID 77366



TYPICAL TRANSVERSE SECTION



DETAIL "A"

(NOT SHOWN TO SCALE)

* PARAPETS ARE SIMILAR TO TYPE A1 BARRIER FROM ROADWAY STANDARD DRAWING RM-4.3

NOTES

1. SUPERSTRUCTURE DIMENSIONS ARE MEASURED PERPENDICULAR TO ℄ OF CONST. S.R. 823.
2. PIER 1 DIMENSIONS SHOWN. PIER 1 DIMENSIONS ARE MEASURED ALONG ℄ PIER.

DESIGN AGENCY: Burgess & Niple / TranSystems, 5747 PERIMETER DRIVE, SUITE 240, DUBLIN, OHIO 43017

DESIGNED MSL | CHECKED PJP | DRAWN MTN | REVISED | REVIEWED MSL | DATE 02/21/08 | STRUCTURE FILE NUMBER 7306369L, 7306377R

TYPICAL SECTION AND PIER 1 DETAILS
BRIDGE NO. SCI-823-0248 L&R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366

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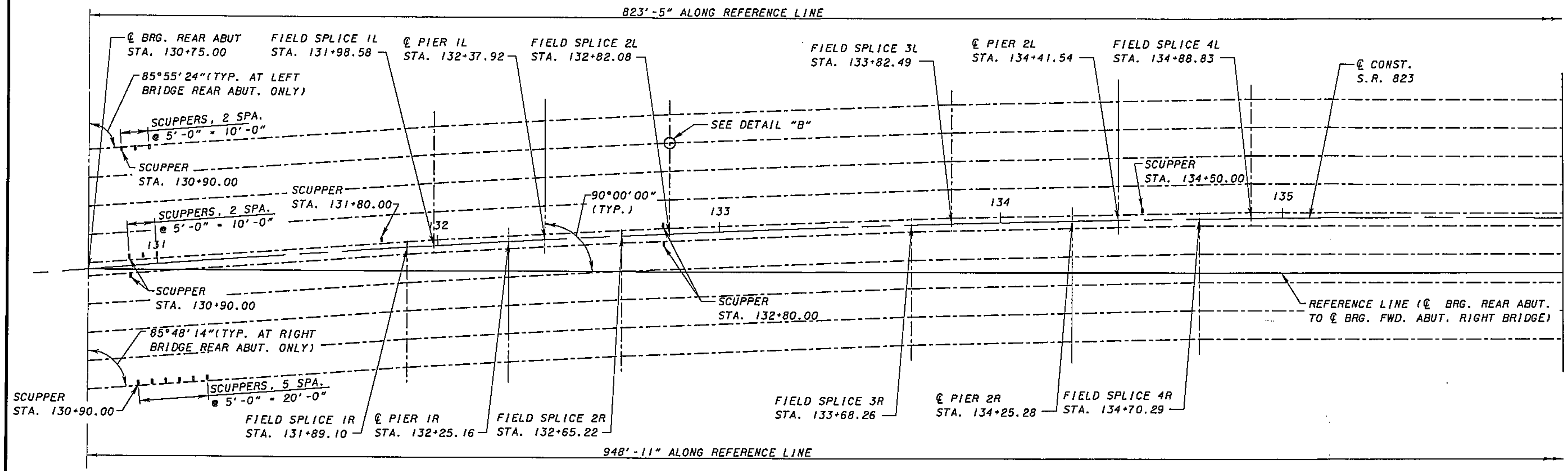


LEFT (SOUTHBOUND) BRIDGE

LOCATION	STATION	θ
℄ BRG. R. ABUT.	STA. 130+75.00	N/A
SPLICE 1	STA. 131+98.58	0.898°
℄ PIER 1	STA. 132+37.92	N/A
SPLICE 2	STA. 132+82.08	1.000°
SPLICE 3	STA. 133+82.49	1.037°
℄ PIER 2	STA. 134+41.54	N/A
SPLICE 4	STA. 134+88.83	1.288°
SPLICE 5	STA. 136+40.49	1.320°
℄ PIER 3	STA. 136+96.02	N/A
SPLICE 6	STA. 137+52.76	1.294°
℄ BRG. FWD. ABUT.	STA. 138+99.20	N/A

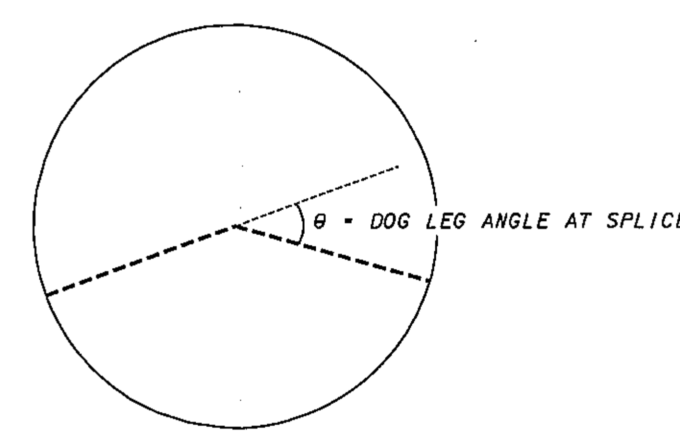
FROM	TO	GIRDER LENGTH	GIRDER SPACING*
℄ BRG. R. ABUT.	SPLICE 1	123.57'	4 SPACES @ 10'-0 5/8"± = 40.2192'
SPLICE 1	SPLICE 2	83.50'	4 SPACES @ 10'-0 3/4"± = 40.2592'
SPLICE 2	SPLICE 3	100.41'	4 SPACES @ 10'-0 7/8"± = 40.2921'
SPLICE 3	SPLICE 4	106.34'	4 SPACES @ 10'-0 15/16"± = 40.3132'
SPLICE 4	SPLICE 5	151.66'	4 SPACES @ 10'-0 15/16"± = 40.3211'
SPLICE 5	SPLICE 6	112.26'	4 SPACES @ 10-0 7/8"± = 40.3080'
SPLICE 6	℄ BRG. FWD. ABUT.	146.44'	4 SPACES @ 10'-0 13/16"± = 40.2745'

* GIRDER SPACINGS ARE NORMAL TO GIRDER CENTERLINE

RIGHT (NORTHBOUND) BRIDGE

LOCATION	STATION	θ
℄ BRG. R. ABUT.	STA. 130+75.00	N/A
SPLICE 1	STA. 131+89.10	0.955°
℄ PIER 1	STA. 132+25.16	N/A
SPLICE 2	STA. 132+65.22	0.899°
SPLICE 3	STA. 133+68.26	1.029°
℄ PIER 2	STA. 134+25.28	N/A
SPLICE 4	STA. 134+70.29	1.315°
SPLICE 5	STA. 136+30.28	1.315°
℄ PIER 3	STA. 136+75.28	N/A
SPLICE 6	STA. 137+32.30	1.043°
SPLICE 7	STA. 138+38.11	0.893°
℄ PIER 4	STA. 138+75.16	N/A
SPLICE 8	STA. 139+10.23	0.508°
℄ BRG. FWD. ABUT.	STA. 140+25.00	N/A

FROM	TO	GIRDER LENGTH	GIRDER SPACING*
℄ BRG. R. ABUT.	SPLICE 1	114.10'	4 SPACES @ 10'-0 5/8"± = 40.2083'
SPLICE 1	SPLICE 2	76.12'	4 SPACES @ 10'-0 3/4"± = 40.2519'
SPLICE 2	SPLICE 3	103.04'	4 SPACES @ 10'-0 7/8"± = 40.2827'
SPLICE 3	SPLICE 4	102.03'	4 SPACES @ 10'-0 15/16"± = 40.3058'
SPLICE 4	SPLICE 5	159.98'	4 SPACES @ 10'-0 15/16"± = 40.3164'
SPLICE 5	SPLICE 6	102.03'	4 SPACES @ 10-0 5/16"± = 40.3057'
SPLICE 6	SPLICE 7	105.81'	4 SPACES @ 10'-0 7/8"± = 40.2822'
SPLICE 7	SPLICE 8	72.12'	4 SPACES @ 10'-0 3/4"± = 40.2514'
SPLICE 8	℄ BRG. FWD. ABUT.	114.72'	4 SPACES @ 10'-0 11/16"± = 40.2295'



DETAIL "B"

DESIGN AGENCY: Trans Systems, 720 EAST PETE ROSE WAY, SUITE 360, CINCINNATI, OHIO 45202

DESIGNED MTN | CHECKED PJP | DRAWN MTN | REVISED | REVIEWED MSL | DATE 02/21/08 | STRUCTURE FILE NUMBER 7306369L, 7306377R

FRAMING PLAN
BRIDGE NO. SCI-823-0248 L&R
S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00
PID 77366

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847B
847

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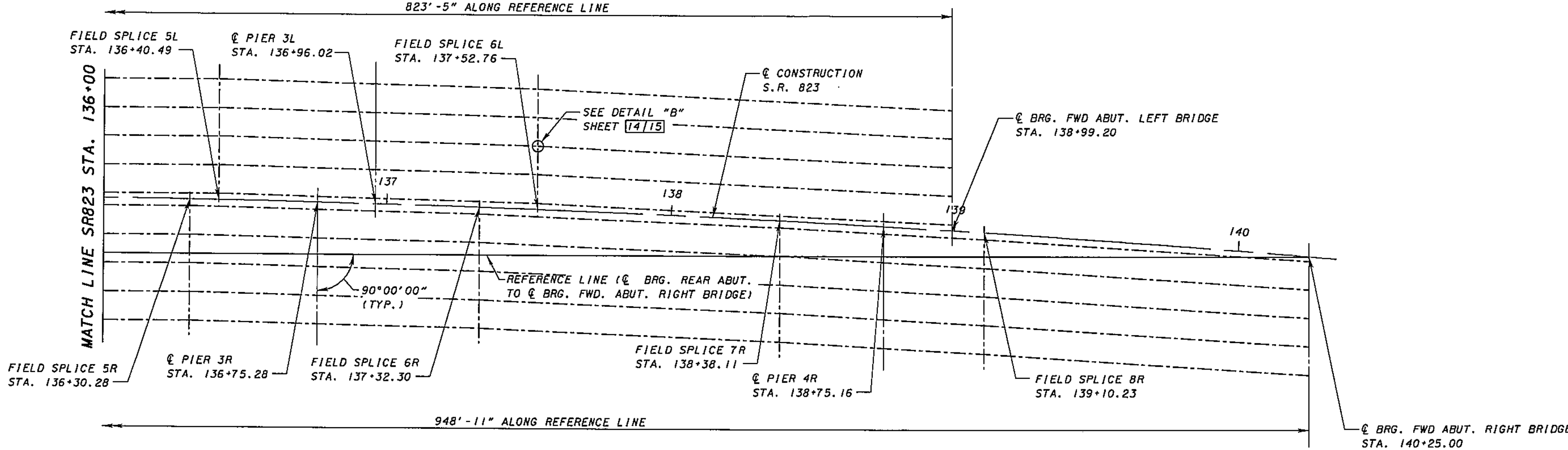

LEFT (SOUTHBOUND) BRIDGE

LOCATION	STATION	θ
℄ BRG. R. ABUT.	STA. 130+75.00	N/A
SPLICE 1	STA. 131+98.58	0.898°
℄ PIER 1	STA. 132+37.92	N/A
SPLICE 2	STA. 132+82.08	1.000°
SPLICE 3	STA. 133+82.49	1.037°
℄ PIER 2	STA. 134+41.54	N/A
SPLICE 4	STA. 134+88.83	1.288°
SPLICE 5	STA. 136+40.49	1.320°
℄ PIER 3	STA. 136+96.02	N/A
SPLICE 6	STA. 137+52.76	1.294°
℄ BRG. FWD. ABUT.	STA. 138+99.20	N/A

FROM	TO	GIRDER LENGTH	GIRDER SPACING*
℄ BRG. R. ABUT.	SPLICE 1	123.57'	4 SPACES @ 10'-0 5/8"± = 40.2192'
SPLICE 1	SPLICE 2	83.50'	4 SPACES @ 10'-0 3/4"± = 40.2592'
SPLICE 2	SPLICE 3	100.41'	4 SPACES @ 10'-0 7/8"± = 40.2921'
SPLICE 3	SPLICE 4	106.34'	4 SPACES @ 10'-0 15/16"± = 40.3132'
SPLICE 4	SPLICE 5	151.66'	4 SPACES @ 10'-0 15/16"± = 40.3211'
SPLICE 5	SPLICE 6	112.26'	4 SPACES @ 10-0 7/8"± = 40.3080'
SPLICE 6	℄ BRG. FWD. ABUT.	146.44'	4 SPACES @ 10'-0 13/16"± = 40.2745'

* GIRDER SPACINGS ARE NORMAL TO GIRDER CENTERLINE

RIGHT (NORTHBOUND) BRIDGE

LOCATION	STATION	θ
℄ BRG. R. ABUT.	STA. 130+75.00	N/A
SPLICE 1	STA. 131+89.10	0.955°
℄ PIER 1	STA. 132+25.16	N/A
SPLICE 2	STA. 132+65.22	0.899°
SPLICE 3	STA. 133+68.26	1.029°
℄ PIER 2	STA. 134+25.28	N/A
SPLICE 4	STA. 134+70.29	1.315°
SPLICE 5	STA. 136+30.28	1.315°
℄ PIER 3	STA. 136+75.28	N/A
SPLICE 6	STA. 137+32.30	1.043°
SPLICE 7	STA. 138+38.11	0.893°
℄ PIER 4	STA. 138+75.16	N/A
SPLICE 8	STA. 139+10.23	0.508°
℄ BRG. FWD. ABUT.	STA. 140+25.00	N/A

FROM	TO	GIRDER LENGTH	GIRDER SPACING*
℄ BRG. R. ABUT.	SPLICE 1	114.10'	4 SPACES @ 10'-0 5/8"± = 40.2083'
SPLICE 1	SPLICE 2	76.12'	4 SPACES @ 10'-0 3/4"± = 40.2519'
SPLICE 2	SPLICE 3	103.04'	4 SPACES @ 10'-0 7/8"± = 40.2827'
SPLICE 3	SPLICE 4	102.03'	4 SPACES @ 10'-0 15/16"± = 40.3058'
SPLICE 4	SPLICE 5	159.98'	4 SPACES @ 10'-0 15/16"± = 40.3164'
SPLICE 5	SPLICE 6	102.03'	4 SPACES @ 10-0 15/16"± = 40.3057'
SPLICE 6	SPLICE 7	105.81'	4 SPACES @ 10'-0 7/8"± = 40.2822'
SPLICE 7	SPLICE 8	72.12'	4 SPACES @ 10'-0 3/4"± = 40.2514'
SPLICE 8	℄ BRG. FWD. ABUT.	114.72'	4 SPACES @ 10'-0 11/16"± = 40.2295'

DESIGN AGENCY: TranSystems

DESIGNED: MTN | CHECKED: PJP | DRAWN: MTN | REVISED | REVIEWED: MSL | DATE: 02/21/08

STRUCTURE FILE NUMBER: 7306369L, 7306377R

FRAMING PLAN

BRIDGE NO. SCI-823-0248 L&R

S.R. 823 OVER S.R. 335 & LITTLE SCIOTO RIVER

SCI-823-0.00

PID 77366

847C
847

APPENDIX B
Structure Cost Estimate

TranSystems

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8

By: MSL Date: 2/19/2008
Checked: PJP Date: 2/20/2008

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	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 Cost	Life Cycle Maintenance Cost	Total Relative Ownership Cost
5	4 (Left) 5 (Right)	162.92' - 203.58' - 254.5' - 203.17' 150.17' - 200.17' - 250' - 199.83' -	824.25 (L) 950.00 (R)	5 Steel Girders /per BRIDGE	108" Web Grade 50W (L) 105" Web Grade 50W (R)	$9,937,000	$5,358,000	$2,447,200	$0	$17,740,000	$0	$17,740,000

NOTES:

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

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (4-span Left bridge) - SUPERSTRUCTURE

By: MSL Date: 2/19/2008
Checked: PJP Date: 2/20/2008

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
5	4 (Left)	162.92' - 203.58' - 254.5' - 203.17'	824.25	826	1409	$773,300	$357,300	$58,800	$0	5 Steel Girders /per BRIDGE	108" Web Grade 50W	2,578,506	$3,411,400	$30,800	$4,632,000

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	4.7747	4.77

Slab:

	T (ft.)	W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Left Bridge	0.75	44.88	33.7	3.4	46.1

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 2005	Annual Escalation	Year 2007
Deck	$525.00	5.0%	$579.00
Parapets	$385.00	5.0%	$424.00
Weighted Average =			$549.00

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 2005	Annual Escalation	Year 2007
Deck Reinforcing	$0.81	5.0%	$0.89

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2007	
Rolled Beams - Grade 50	n/a	$0.95	5.0%	$1.05	
Level 4 Plate Girders - Grade 50W	n/a	$1.05	5.0%	$1.16	Straight Girders
level 5 Plate Girders - Grade 50W	n/a	$1.20	5.0%	$1.32	Curved Girders

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):
Length = 30 ft. Width = 45 ft
Area = 150 sq. yd.

	Year 2005	Annual Escalation	Year 2007
Approach Slabs	$178.00	5.0%	$196.00

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

	Cost Ratio	Year 2005	Annual Escalation	Year 2007
Modular Expansion Joints	1.00	$910.00	5.0%	$1,003.28
Strip Seal Expansion Joints	1.00	$310.00	5.0%	$341.78

Modular Expansion Joints Length 0 ft.
Strip Seal Expansion Joints Length 90 ft.

Approach Roadway

	Quantity	Year 2005	Annual Escalation	Year 2007
Granular Embnkmnt.	0.00 cu.yd.	$10.00	5.0%	$11.03
Excavation- Rock	0.00 cu.yd.	$6.00	5.0%	$6.62
Wick Drains	0.00 ft.	$1.00	5.0%	$1.10
Roadway incl. base	0.00 sq.yd.	$26.00	5.0%	$28.67
Barrier (single faced)	0 ft.	$50.00	5.0%	$55.13
Barrier (dble faced)	0 ft.	$80.00	5.0%	$88.20

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (5-span Right bridge) - SUPERSTRUCTURE

By: MSL Date: 2/19/2008
Checked: PJP Date: 2/20/2008

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
5	5 (Right)	150.17' - 200.17' - 250' - 199.83' - 149.83'	950.00	952	1623	$891,100	$411,700	$58,800	$0	5 Steel Girders /per BRIDGE	105" Web Grade 50W	2,957,486	$3,912,800	$30,800	$5,305,000

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	4.7747	4.77

Slab:

	T (ft.)	W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Right Bridge	0.75	44.88	33.7	3.4	46.1

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 2005	Annual Escalation	Year 2007
Deck	$525.00	5.0%	$579.00
Parapets	$385.00	5.0%	$424.00
Weighted Average =			$549.00

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 2005	Annual Escalation	Year 2007
Deck Reinforcing	$0.81	5.0%	$0.89

Structural Steel
Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2007	
Rolled Beams - Grade 50	n/a	$0.95	5.0%	$1.05	
Level 4 Plate Girders - Grade 50W	n/a	$1.05	5.0%	$1.16	Straight Girders
level 5 Plate Girders - Grade 50W	n/a	$1.20	5.0%	$1.32	Curved Girders

Reinforced Concrete Approach Slabs (T=17")
Unit Cost ($/sq. yd.):
Length = 30 ft. Width = 45 ft
Area = 150 sq. yd.

	Year 2005	Annual Escalation	Year 2007
Approach Slabs	$178.00	5.0%	$196.00

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

	Cost Ratio	Year 2005	Annual Escalation	Year 2007
Modular Expansion Joints	1.00	$910.00	5.0%	$1,003.28
Strip Seal Expansion Joints	1.00	$310.00	5.0%	$341.78

Modular Expansion Joints Length 0 ft.
Strip Seal Expansion Joints Length 90 ft.

Approach Roadway

	Quantity	Year 2005	Annual Escalation	Year 2007
Granular Embnkmnt.	0.00 cu.yd.	$10.00	5.0%	$11.03
Excavation- Rock	0.00 cu.yd.	$6.00	5.0%	$6.62
Wick Drains	0.00 ft.	$1.00	5.0%	$1.10
Roadway incl. base	0.00 sq.yd.	$26.00	5.0%	$28.67
Barrier (single faced)	0 ft.	$50.00	5.0%	$55.13
Barrier (dble faced)	0 ft.	$80.00	5.0%	$88.20

SCI-823-0.00 - PORTSMOUTH BYPASS
S.R. 823 over S.R. 335 and Little Scioto River
T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (4-span Left bridge) - SUBSTRUCTURE

By: MSL — Date: 2/19/2008
Checked: PJP — Date: 2/20/2008

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	Drilled Shaft Foundation Cost	Pile Foundation Cost	Earthwork Cost	Temporary Shoring and Support Costs	Subtotal Substructure Cost
5	4 (Left)	162.92' - 203.58' - 254.5' - 203.17'	5 Steel Girders /per BRIDGE	108" Web Grade 50W	$1,336,500	$258,200	$427,200	$64,200	$556,900	$150,300	$0	$38,900	**$2,832,000**

COST SUPPORT CALCULATIONS

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

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Alt 5 Total Cost
Cap	120	$575.00	5.0%	$634.00	$76,080
Stem (Pier 1)	66	$575.00	5.0%	$634.00	$41,980
Stem (Pier 2 & 3)	1689	$575.00	5.0%	$634.00	$1,070,850
Footings	446	$300.00	5.0%	$331.00	$147,630
Total Cost	2321				$1,336,500

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

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Alt 5 Total Cost
Cap	0	$575.00	5.0%	$634.00	$0
Columns	0	$575.00	5.0%	$634.00	$0
Footings	0	$300.00	5.0%	$331.00	$0
Total Cost					$0

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Total Cost
R. Abutment	90	$420.00	5.0%	$463.00	$41,800
R. Abut Wingwall:	14	$420.00	5.0%	$463.00	$6,300
F. Abutment	258	$480.00	5.0%	$529.00	$136,300
F. Abut. Wingwall	14	$480.00	5.0%	$529.00	$7,200
F. Abut Ret. Wall	426	$502.00	5.0%	$553.00	$235,600

Shaft Foundation Unit Cost ($/ft.): Abutment Drilled Shafts

	Number of Shafts		Total Shaft Length
48" Into Bedrock	10	SEE QUANTITY CALCULATIONS	180
36" Into Bedrock (Ret. Wall)	10	SEE QUANTITY CALCULATIONS	150

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

	Number of Shafts		Total Shaft Length
72" Above Bedrock	10	SEE QUANTITY CALCULATIONS	265
66" Into Bedrock	10	SEE QUANTITY CALCULATIONS	85

Shaft Foundation Unit Cost ($/ft.):

	Year 2006 Unit Cost	Annual Escalation	Year 2007	Total Cost
48" Into Bedrock	$270.50	5.0%	$284.00	$51,120
36" Into Bedrock (Ret. Wall)	$260.00	5.0%	$273.00	$40,950
72" Above Bedrock	$1,400.00	5.0%	$1,470.00	$389,550
66" Into Bedrock	$842.60	5.0%	$885.00	$75,225
Total Drilled Shaft Cost				**$556,845**

Excavation and Embankment Costs:

Component	Quantity	Year 2005	Annual Escalation	Year 2007	Total Cost
Embankment	0	$10.00	5.0%	$11.00	$0
Rock Excavation	0	$6.00	5.0%	$6.62	$0
Wick Drains	0	$1.00	5.0%	$1.10	$0

Note: See Roadway Estimates for Excavation and Embankment Costs

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

Number of Piles		Total Pile Length
41	SEE QUANTITY CALCULATIONS	3,775

Pile Foundation Unit Cost ($/ft.):

	Year 2005 Unit Cost	Annual Escalation	Year 2007
Furnished	$26.47	5.0%	$29.20
Driven	$9.62	5.0%	$10.60
Total			$39.80

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

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 5	1050	$ -

	Year 2004 Unit Cost	Annual Escalation	Year 2007
Temporary Shoring	$22.50	5.0%	$26.00
Cofferdam	$32.00	5.0%	$37.00

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 2005	Annual Escalation	Year 2007
Pier	$0.81	5.0%	$0.89
Abutment	$0.81	5.0%	$0.89

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (5-span Right bridge) - SUBSTRUCTURE

By: MSL Date: 2/19/2008
Checked: PJP Date: 2/20/2008

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	Drilled Shaft Foundation Cost	Earthwork Cost	Subtotal Substructure Cost
5	5 (Right)	150.17' - 200.17' - 250' - 199.83' - 149.83'	5 Steel Girders /per BRIDGE	105" Web Grade 50W	$1,435,700	$281,200	$123,500	$21,400	$154,400	$510,100	$0	**$2,526,000**

COST SUPPORT CALCULATIONS

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

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Total Cost
Cap	159	$575.00	5.0%	$634.00	$100,810
Stem (Pier 1 & 4)	123	$575.00	5.0%	$634.00	$77,730
Stem (Pier 2 & 3)	1696	$575.00	5.0%	$634.00	$1,075,060
Footings	550	$300.00	5.0%	$331.00	$182,050
Total Cost	2527				$1,435,700

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

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Total Cost
Cap	0	$575.00	5.0%	$634.00	$0
Columns	0	$575.00	5.0%	$634.00	$0
Footings	0	$300.00	5.0%	$331.00	$0
Total Cost					$0

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2007	Total Cost
Abutment	232	$420.00	5.0%	$463.00	$107,400
Wingwalls	35	$420.00	5.0%	$463.00	$16,100

Excavation and Embankment Costs:

Component	Quantity	Year 2005	Annual Escalation	Year 2008	Total Cost
Embankment	0	$10.00	5.0%	$11.03	$0
Rock Excavation	0	$6.00	5.0%	$6.62	$0
Wick Drains	0	$1.00	5.0%	$1.10	$0

Note: See Roadway Estimates for Excavation and Embankment Costs

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 2005	Annual Escalation	Year 2007
Pier	$0.81	5.0%	$0.89
Abutment	$0.81	5.0%	$0.89

Shaft Foundation Unit Cost ($/ft.): Abutment Drilled Shafts

	Number of Shafts		Total Shaft Length
42" Above Bedrock	11	SEE QUANTITY CALCULATIONS	143
36" Into Bedrock	11	SEE QUANTITY CALCULATIONS	77

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

	Number of Shafts		Total Shaft Length
72" Above Bedrock	10	SEE QUANTITY CALCULATIONS	240
66" Into Bedrock	10	SEE QUANTITY CALCULATIONS	80
54" Above Bedrock	4	SEE QUANTITY CALCULATIONS	16
48" Into Bedrock	4	SEE QUANTITY CALCULATIONS	28

Shaft Foundation Unit Cost ($/ft.):

	Year 2006 Unit Cost	Annual Escalation	Year 2007	Total Cost
42" Above Bedrock	$340.00	5.0%	$357.00	$51,051
36" Into Bedrock	$260.00	5.0%	$273.00	$21,021
54" Above Bedrock	$380.00	5.0%	$399.00	$6,384
48" Into Bedrock	$270.50	5.0%	$284.00	$7,952
72" Above Bedrock	$1,400.00	5.0%	$1,470.00	$352,800
66" Into Bedrock	$842.60	5.0%	$885.00	$70,800
Total Drilled Shaft Cost				**$510,008**

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

Number of Piles		Total Pile Length
41	SEE QUANTITY CALCULATIONS	3,880

Pile Foundation Unit Cost ($/ft.):

	Year 2005 Unit Cost	Annual Escalation	Year 2007
Furnished	$26.47	5.0%	$29.20
Driven	$9.62	5.0%	$10.60
Total			$39.80

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

	Temp. Shoring Area (sq. ft.)	Temp. Girder Support (lump sum)
Alt. 5	0	$ -

	Year 2004 Unit Cost	Annual Escalation	Year 2007
Temporary Shoring	$22.50	5.0%	$26.00
Cofferdam	$32.00	5.0%	$37.00

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (4-span Left bridge) - QUANTITY CALCULATIONS

By: MSL Date: 2/19/2008
Checked: PJP Date: 2/20/2008

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	Depth	Area	Volume	Width	Height	Length		Volume	Width	Depth	Length		Volume	
Pier 1L	43.33	3	8.0217	24.07	1043	3	29.8	20.00		1788	12	4	25.00		1200	4031
Pier 2L(telescopi	43.25	3	8.4785	25.44	1100	9.832	76.42	30.00		22541	27	5	40.177		5424	29065
Pier 3L(telescopi	43.25	3	8.4785	25.44	1100	9.6	80.08	30.00		23063	27	5	40.177		5424	29587
Pier 4																0
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					3243					47392					12048	62683
Total (Cu.Yd.)					120					1755					446	2322

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	Depth	Area	Volume	Width	Height	Area		Volume	Width	Depth	Area	# Footin	Volume	
Rear Abut	45	1.75	10.563	18.48	832	4.25	3.22	13.69		616	6.75	3.25	21.938	1	987	2435
Fwd. Abut					865					2350					3744	6959
Total (Cu.Ft.)					1696					2966					4731	11828
Total (Cu.Yd.)					63					110					175	438

Retaining Wall Quantities

Abut Location	Length (feet)	End Wingwall				Middle Wall					Footing					Total Volume
		Width	Height	Area	Volume	Width	Height	Area	Length	Volume	Width	Depth	Area	# Footin	Volume	
Rear Abut	0	0	0	0.00	0	0	0	0.00	0	0	0	0	0	0	0	0
Fwd. Abut	0	0	0	0.00	0	0	0	0.00	0	4031	0	0	0	0	7462	11493
Total (Cu.Ft.)					0					4031					7462	11493
Total (Cu.Yd.)					0					149					276	426

Superstructure Steel Quantities

Location	Wt.of girder	# Girders	Span Length	Total Weight
Span 1	626	5	162.92	509713
Span 2	626	5	203.58	636922
Span 3	626	5	254.50	796231
Span 4	626	5	203.17	635639
Span 5	0	0	0.00	0
Span 6	0	0	0.00	0
Span 7	0	0	0.00	0
Span 8	0	0	0.00	0
Total			824.17	2578506

Drilled Shafts Above Bedrock

Location	Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Total Length
Rear Abut.	0	0.00	0.00	0.00	0
Pier 1	0	0.00	0.00	0.00	0
Pier 2	5	500.50	471.60	29.00	145
Pier 3	5	504.32	480.50	24.00	120
Pier 4	0	0.00	0.00	0.00	0
Pier 5	0	0.00	0.00	0.00	0
Pier 6	0	0.00	0.00	0.00	0
Pier 7	0	0.00	0.00	0.00	0
Fwd. Abut.	0	0.00	0.00	0.00	0
Total	10				265

Drilled Shafts Into Bedrock

Location	Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Total Length
Rear Abut.	0	0.00	0.00	0.00	0
Pier 1	0	0.00	0.00	0.00	0
Pier 2	5	471.60	463.60	8.00	40
Pier 3	5	480.50	471.50	9.00	45
Pier 4	0	0.00	0.00	0.00	0
Pier 5	0	0.00	0.00	0.00	0
Pier 6	0	0.00	0.00	0.00	0
Pier 7	0	0.00	0.00	0.00	0
Fwd. Abut.	10	0.00	0.00	18.00	180
F. A. Ret. W	10	0.00	0.00	15.00	150
Total	30				415

Steel H-Piles to Bedrock

Location	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Length
Rear Abut.	20	580.16	473.60	110.0	2200
Pier 1	21	547.1	472.80	75.0	1575
Pier 2	0	0	0	0.0	0
Pier 3	0	0	0	0.0	0
Pier 4	0	0	0	0.0	0
Pier 5	0	0	0	0.0	0
Pier 6	0	0	0	0.0	0
Pier 7	0	0	0	0.0	0
Fwd. Abut.	0	0	0	0.0	0
Total	41				3775

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over S.R. 335 and Little Scioto River

T,S&L Step 8 - STEEL PLATE GIRDER ALTERNATIVE 5 (5-span Right bridge)- QUANTITY CALCULATIONS

By: MSL
Checked: PJP

Date: 2/19/2008
Date: 2/20/2008

Pier Quantities

Pier Location	Length	Cap				Stem					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Length*		*Volume*	*Width*	*Depth*	*Length*		*Volume*	
Pier 1R (Pile)	43.33	3	8.02168	24.07	1043	3	28.5	20.00		1710	17	4	37.00		2516	5269
Pier 2R(telescop	43.25	3	8.4785	25.44	1100	9.91	75.25	30.00		22372	27	5	40.177		5424	28896
Pier 3R(telescop	43.25	3	8.4785	25.44	1100	9.45	82.58	30.00		23411	27	5	40.177		5424	29935
Pier 4R	43.33	3	8.02168	24.07	1043	3	26.67	20		1600	16.75	4	22.00		1474	4117
Pier 5																0
Pier 6																0
Pier 7																0
Total (Cu.Ft.)					**4286**					**49093**					**14838**	**68217**
Total (Cu.Yd.)					**159**					**1818**					**550**	**2527**

Drilled Shafts Above Bedrock

Location	Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Total Length
Rear Abut.	*0*	0.0	0.0	0.0	*0*
Pier 1	*0*	0	0	0.0	*0*
Pier 2	*5*	500.19	474.7	26.0	*130*
Pier 3	*5*	500	478.9	22.0	*110*
Pier 4	*4*	565	561.25	4.0	*16*
Pier 5	*0*	0	0	0.0	*0*
Pier 6	*0*	0	0	0.0	*0*
Pier 7	*0*	0	0	0.0	*0*
Fwd. Abut.	*11*	604	591	13.0	*143*
Total	**25**				**399**

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footi*	*Volume*	
Rear Abut	45	1.75	10.08	17.64	794	4.25	3.22	13.69		616	6.75	3.25	21.938	1	987	2397
Fwd. Abut	45	1.75	10.08	17.64	794	4.25	5.66	24.06		1082	11	4	44	1	1980	3856
Total (Cu.Ft.)					**1588**					**1698**					**2967**	**6253**
Total (Cu.Yd.)					**59**					**63**					**110**	**232**

Drilled Shafts Into Bedrock

Location	Total Shafts	Top Elev.	Bot Elev.	Shaft Length	Total Length
Rear Abut.	*0*	0	0	0.0	*0*
Pier 1	*0*	0	0	0.0	*0*
Pier 2	*5*	474.7	466.7	8.0	*40*
Pier 3	*5*	478.9	470.9	8.0	*40*
Pier 4	*4*	0	0	7.0	*28*
Pier 5	*0*	0	0	0.0	*0*
Pier 6	*0*	0	0	0.0	*0*
Pier 7	*0*	0	0	0.0	*0*
Fwd. Abut.	*11*	0	0	7.0	*77*
Total	**25**				**185**

Superstructure Steel Quantities

Location	Wt.of girder (lb)/ft	# Girders	Span Length	Total Weight
Span 1	623	5	150.17	467501
Span 2	623	5	200.17	623158
Span 3	623	5	250.00	778286
Span 4	623	5	199.83	622099
Span 5	623	5	149.83	466442
Span 6	0	0	0	0
Span 7	0	0	0	0
Span 8	0	0	0	0
Total			950.00	2957486

Steel H-Piles to Bedrock

Location	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Length
Rear Abut.	*20*	580.16	473.6	110.0	*2200*
Pier 1	*21*	548.4	472.8	80.0	*1680*
Pier 2	*0*	0	0	0.0	*0*
Pier 3	*0*	0	0	0.0	*0*
Pier 4	*0*	0	0	0.0	*0*
Pier 5	*0*	0	0	0.0	*0*
Pier 6	*0*	0	0	0.0	*0*
Pier 7	*0*	0	0	0.0	*0*
Fwd. Abut.	*0*	0	0	0.0	*0*
Total	**41**				**3880**

APPENDIX C

Scupper Justification

TranSystems

PHASE 3, PORTSMOUTH BYPASS, OUTSIDE SHOULDER INLET (SCUPPER)
BRIDGE OVER LITTLE SCIOTO RIVER

ARE SCUPPERS NEEDED ON OUTSIDE SHOULDERS?

$$L_o = \frac{43560\ Q_1}{(C)(i_{10})(W_P)}$$ location of first scupper

Q_1 = Total gutter flow, cfs

C = 0.9 (Run off coefficient) ✓

i_{10} = 5.39 in/hr (Area D, 10 yr for T_c = 10 min) ✓

W_P = Width of pavement contributing to gutter flow

$$Q_1 = \frac{0.56}{n} (S_x)^{\frac{5}{3}} (S_L)^{\frac{1}{2}} T^{8/3}$$

n = Manning's Roughness Coefficient
= 0.015

S_x = Cross slope, ft/ft

S_L = Longitudinal slope ft/ft

T = Design spread (allowable, shoulder width) ✓

* Since the bridge is on a vertical curve the instantaneous longitudinal slope (S_L) is taken at the end of the bridge where the flatter slope will yield the most conservative, lowest L_o value.

PHASE 3 PORTSMOUTH BYPASS, OUTSIDE SHOULDER INLET (SCUPPER)

BRIDGE OVER LITTLE SCIOTO RIVER

- Low end of bridge LT outside shoulder

$$Q = \frac{0.56}{0.015}(0.04)^{5/3}(.004)^{\frac{1}{2}}(9.5)^{8/3}$$

$$= 4.47 \text{ cfs}$$

$$\therefore L_o = \frac{(43560)(4.47)}{(0.9)(5.39)(11)}$$

$$= \underline{3651'} > \text{length of bridge } (829.26')$$

$\therefore$ No Scuppers

- Low end of bridge RT outside shoulder

$$Q = \frac{0.56}{0.015}(0.036)^{5/3}(.004)^{\frac{1}{2}}(12)^{8/3}$$

$$= 6.99 \text{ cfs}$$

$$\therefore L_o = \frac{(43560)(6.99)}{(0.9)(5.34)(\text{~~35~~}\ 39.5'^{\pm})}$$

$$= \underline{1589' \ (\text{~~1653'~~})} > \text{length of bridge } (955.02')$$

BOTH LT & RT OUTSIDE SHOULDERS OF BRIDGE OVER LITTLE SCIOTO RIVER <u>DO NOT REQUIRE SCUPPERS</u> SINCE THE L_o IS GREATER THAN THE LENGTH OF THE BRIDGE. $L_o >$ LENGTH OF BRIDGE

HOWEVER, SCUPPERS WILL BE PLACED ON BOTH LEFT AND RIGHT OUTSIDE SHOULDERS NEAR THE REAR ABUTMENT IN ORDER TO REDUCE THE AMOUNT OF WATER OVER THE EXPANSION JOINTS. THE CALCULATIONS FOR THESE SCUPPERS ARE SHOWN IN THE ATTACHED SPREADSHEET. ✓

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER)

BRIDGE OVER LITTLE SCIOTO RIVER

ARE SCUPPERS NEEDED ON MEDIAN SHOULDERS?

$$L = \frac{43560\,Q_1}{(c)(i_{10})(W_p)}$$ Location of first scupper

Q_1 = Total gutter flow, cfs

c = 0.9 (Run off coefficient)

i_{10} = 5.39 in/hr (Area D, 10yr for T_c = 10min)

W_p = Width of pavement contributing to gutter flow

$$Q_1 = \frac{0.56}{n}(S_x)^{5/3}(S_L)^{1/2}\,T^{8/3}$$

n = Mannings Roughness coefficient
= 0.015

S_x = Cross slope ft/ft

S_L = Longitudinal slope ft/ft

T = Design spread (allowable, shoulder width)

* Since the bridge is on a vertical curve the instantaneous longitudinal slope (S_L) varies and is therefor shown to be an average of 2% for calculation purposes. The vertical curve slope varies from 0.4% on the low end of the bridge to 5.0% ont the high end.

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER)

BRIDGE OVER LITTLE SCIOTO RIVER

- LEFT SIDE MEDIAN SHOULDER

$$Q = \frac{0.56}{0.015}(0.036)^{5/3}(0.02)^{\frac{1}{2}}(6)^{8/3}$$

$= 2.46$ cfs

$$\therefore L_o = \frac{(43560)(2.46)}{(0.9)(5.39)(34)}$$

$= 651'$ < Length of bridge (829.26')

- RIGHT SIDE MEDIAN SHOULDER

$$Q = \frac{0.56}{0.015}(0.04)^{5/3}(0.02)^{\frac{1}{2}}(4)^{8/3}$$

$= 1.00$ cfs

$$\therefore L_o = \frac{(43560)(1.00)}{(0.9)(5.39)(5.5)}$$

$= 1626'$ > length of bridge (955.02')

→ Double check w/ low side $S_L = 0.004$

$$Q = \frac{0.56}{0.015}(0.04)^{5/3}(0.004)^{\frac{1}{2}}(4)^{8/3}$$

$= 0.45$ cfs

$$\therefore L_o = \frac{(43560)(0.45)}{(0.9)(5.39)(5.5)} = 727' < \text{length of bridge } (955.02')$$

BOTH LEFT AND RIGHT MEDIAN SHOULDERS OF BRIDGE OVER LITTLE SCIOTO RIVER REQUIRE SCUPPERS SINCE THE L_o IS LESS THAN THE LENGTH OF THE BRIDGE.

L_o > LENGTH OF BRIDGE

ADDITIONAL SCUPPERS ARE ADDED NEAR THE REAR ABUTMENT IN ORDER TO REDUCE THE AMOUNT OF WATER OVER THE EXPANSION JOINTS. THE CALCULATIONS FOR THESE SCUPPERS ARE SHOWN IN THE ATTACHED SPREADSHEET. ✓

PHASE - 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO RIVER

SCUPPER @ STA 134+50 SR 823 MEDIAN, LT

STEP 1 CALCULATE DISCHARGE

L = STA 141+00 − STA 134+50 = 650'

141+00 is upstream inlet, minimal bypass

W = 34'

A = (650')(34) = 22100 sft = 0.51 Ac

C = 0.9

T_c = 10 min, i_{10} = 5.39 in/hr (Area D)

$Q_{10} = CiA = (0.9)(5.39)(0.51) = \underline{2.47}$ cfs

S_x = 0.036 ft/ft

S_L = 0.0232 ft/ft

STEP 2 CALCULATE DESIGN SPREAD

$$T = \left[\frac{(Q)(n)}{(0.56)(S_x)^{5/3}(S_L)^{\frac{1}{2}}}\right]^{3/8}$$

$$= \left[\frac{(2.47)(0.015)}{(0.56)(.036)^{5/3}(.0232)^{\frac{1}{2}}}\right]^{3/8}$$

= 5.84' ✓

PHASE - 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING

BRIDGE OVER LITTLE SCIOTO RIVER

STEP 3 SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW (reference HEC 21)

$$E = Q_i/Q = R_f E_o + R_s(1-E_o)$$

Q = Total discharge, cfs

Q_i = intercepted flow, cfs

E_o = Ratio of frontal flow to total flow

$$= \frac{Q_w}{Q} = 1-\left(1-\frac{W}{T}\right)^{2.67}$$

W = width of depressed gutter or grate, ft.

T = Design spread, ft.

Q_w = Flow in width W, ft.

R_f = Ratio of frontal flow intercepted to total frontal flow or frontal flow efficiency.

$$E = \frac{Q_i}{Q} = R_f E_o + \cancel{R_s(1-E_o)}$$ ← Ignore side flow because of short grate. ✓

$$= R_f E_o$$

$$= R_f\left[1-\left(1-\frac{W}{T}\right)^{2.67}\right]$$

$$E_o = 1-\left(1-\frac{W}{T}\right)^{2.67}$$

W = 18" = 1.5' width of grate

T = 5.84' (from step 2)

$$E_o = 1-\left(1-\frac{1.5}{5.84}\right)^{2.67}$$

$$= 0.55$$ ✓

PHASE-3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE

VELOCITY OF FLOW IN THE GUTTER = Q/A

$A = \frac{1}{2}(5.84)(d)$ $d = (.036)(5.84) = 0.21$

$= \frac{1}{2}(5.84)(0.18)$

$= 0.61$ sft ✓

$V = \frac{Q}{A} = \frac{2.47}{0.61} = 4.02$ ft/sec

LENGTH OF SCUPPER = 6"   WIDTH = 18"

FROM CHART 7 HEC-12 (same one in HEC-21)

$R_f = \pm 0.91$ (used parallel bars w/ $1\frac{1}{8}$" spacing)

$E = R_f E_o = (0.91)(0.55) = 0.5$

$Q_i = EQ = (0.5)(2.47) = 1.23$ cfs ✓

$Q_b = 2.47 - 1.23 = 1.24$ cfs ✓

SCUPPER @ STA 134+50

$Q = 2.47$ cfs

$Q_i = 1.23$ cfs

$Q_b = 1.24$ cfs

DESIGN SPREAD = 5.84'

PHASE - 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO

SCUPPER @ STA 132+80 SR823, MEDIAN, LT

STEP 1 CALCULATE DISCHARGE

L = STA 134+50 - STA 132+80
= 170'

W = 34'

A = (170)(34) = 5780 sft = 0.133 Ac ✓

C = 0.9

T_c = 10 min, i_{10} = 5.39 in/hr

$Q_{10} = CiA = (0.9)(5.39)(0.133) = \underline{0.65 \text{ cfs}}$ ✓

$Q_{Total} = Q_{10} + Q_{Bypass} = 0.76 + 1.24$ ✓
= 1.89 cfs ✓

STEP 2 CALCULATE DESIGN SPREAD AND VELOCITY IN THE GUTTER

$$T = \left[\frac{Qn}{(0.56)(S_x)^{5/3}(S_L)^{1/2}}\right]^{3/8}$$

$$= \left[\frac{(1.89)(0.015)}{(0.56)(0.036)^{5/3}(0.0141)^{1/2}}\right]^{3/8}$$

$= \underline{5.80'}$

$V = \frac{Q}{A}$ $A = \frac{1}{2}(5.8)(d)$ $d = (5.8)(0.036)$
$= \frac{1}{2}(5.8)(5.8)(0.036)$

$V = \frac{1.89}{0.60}$ $= 0.60$ sft

$\approx \underline{3.1 \text{ ft/sec}}$ ✓

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO

STEP 3 SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW

$$E = \frac{Q_i}{Q} = R_f E_o + \sout{R_s(1-E_o)}$$

$$E_o = \frac{Q_W}{Q} = 1-\left(1-\frac{W}{T}\right)^{2.67}$$

$$= 1-\left(1-\frac{1.5}{5.8}\right)^{2.67}$$

$$= 0.55$$

$R_f = \pm 1.00$ ✓ (chart 7 HEC-12, used 1-$\frac{1}{8}$" spacing)

$$E = R_f E_o = 0.55$$

Intercepted flow $Q_i = EQ$
$= (0.55)(1.89)$
$= 1.04$ cfs

Bypass flow $Q_b = 1.89 - 1.04$
$= 0.85$ cfs

SCUPPER @ STA 132+80
$Q = 1.89$ cfs
$Q_i = 1.04$ cfs
$Q_b = 0.85$ cfs
DESIGN SPREAD = 5.80'

PHASE 3, PORTSMOUTH BYPASS MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO RIVER

SCUPPER @ STA 131+80 SR 823 MEDIAN, LT

STEP 1 CALCULATE DISCHARGE

L = STA 132+80 - STA 131+80 = 100'

W = 34'

A = (100')(34') = 3400 sft = .078 Ac ✓

C = 0.9

T_c = 10 min , i_{10} = 5.39 in/hr

$Q_{10} = CiA = (.9)(5.39)(.078) = 0.38$ cfs

$Q_{TOTAL} = Q_{10} + Q_{BYPASS} = 0.38 + 0.85 = 1.23$ cfs ✓

STEP 2 CALCULATE DESIGN SPREAD AND VELOCITY IN GUTTER

$$T = \left[\frac{Q\,n}{(0.56)(S_x)^{5/3}(S_L)^{1/2}}\right]^{3/8}$$

$$= \left[\frac{(1.23)(0.015)}{(0.56)(.036)^{5/3}(0.088)^{1/2}}\right]^{3/8}$$

$= 5.39'$

$V = \frac{Q}{A}$ $A = \frac{1}{2}(5.39)(d)$ $d = (5.39)(.036)$

$= \frac{1}{2}(5.39)(5.39)(.036)$

$V = \frac{1.23}{0.52}$ $= 0.52$ sft

$= 2.35$ ft/sec ✓

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO RIVER

STEP 3 SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW

$E = \frac{Q_i}{Q} = R_f E_o + ~~R_s(1-E_o)~~$

$E_o = \frac{Q_w}{Q} = 1 - (1 - \frac{W}{T})^{2.67}$

$= 1 - (1 - \frac{1.5}{5.39})^{2.67}$

$= 0.58$

$R_f \doteq 1.0$ (chart 7, HEC-12, used 1-1/8" spacing)

$E = R_f E_o = 0.58$ ✓

Intercepted flow $Q_i = EQ$

$= (0.58)(1.23)$

$= 0.71$ cfs

Bypass flow $Q_b = 1.23 - 0.71$

$= 0.51$ cfs

SCUPPER @ STA 131+80
Q = 1.23 cfs
Q_i = 0.71 cfs
Q_b = 0.51 cfs
DESIGN SPREAD = 5.39'

PHASE 3, PORTSMOUTH BYPASS MEDIAN INLET (SCUPPER) SPACING

BRIDGE OVER LITTLE SCIOTO RIVER

SCUPPER @ STA 130+90 SR 823 MEDIAN, LT

STEP 1 CALCULATE DISCHARGE

L = STA ~~131~~ 131+80 - STA ~~131+80~~ 130+90 = 90'

W = 34'

A = (90)(34) = 3060 sft = 0.07 Ac

C = 0.9

T_c = 10 min, i_{10} = 5.39 in/hr

$Q_{10} = ciA = (.9)(5.39)(.07) = 0.34$ cfs

$Q_{TOTAL} = Q_{10} + Q_{BYPASS} = 0.34 + 0.51 = 0.85$ cfs

Note: see spreadsheet for final scupper spacing selected to reduce flow over bridge joints.

STEP 2 CALCULATE DESIGN SPREAD AND VELOCITY IN GUTTER

$$T = \left[\frac{Q\,n}{(0.56)(S_x)^{5/3}(S_L)^{1/2}}\right]^{3/8}$$

$$= \left[\frac{(0.85)(0.015)}{(.056)(.036)^{5/3}(.004)^{1/2}}\right]^{3/8}$$

$= 5.44'$

$V = \frac{Q}{A}$ $A = \frac{1}{2}(5.44)(d)$ $d = (5.44)(.036)$

$= \frac{1}{2}(5.44)(5.44)(.036)$

$= 0.53$ sft

$V = \frac{.85}{.53}$

$= 1.59$ ft/sec

Calculations for 1/8 US Grid

TranSystems

Made By: MDC	Date: 1/8/08	Job No: PID 77366
Checked By: PQP	Date: 2/19/08	Sheet No: 13

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING

STEP 3 SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW

$$E = \frac{Q_i}{Q} = R_f E_o + \sout{R_s(1 - E_o)}$$

$$E_o = \frac{Q_w}{Q} = 1 - \left(1 - \frac{W}{T}\right)^{2.67}$$

$$= 1 - \left(1 - \frac{1.5}{5.44}\right)^{2.67}$$

$$= 0.58$$

$R_f = \pm 1.0$

$E = R_f E_o = 0.58$

Intercepted flow $Q_i = EQ$

$= (0.58)(0.85)$

$= 0.49$ cfs

Bypass flow $Q_b = 0.85 - 0.49$

$= 0.36$ cfs

SCUPPER @ STA 130+90

$Q = 0.85$ cfs

$Q_i = 0.49$ cfs

$Q_b = 0.36$ cfs

DESIGN SPREAD = 5.44'

Calculations for 1/8 US Grid

PHASE-3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO RIVER

SCUPPER @ STA 132+80 SR823 MEDIAN, RT

STEP 1 CALCULATE DISCHARGE

L = STA 141+00 - STA 132+80 = 820' ✓

W = 5.5' ✓

A = (820')(5.5') = 4510 sft = 0.104 Ac ✓

C = 0.9

T_c = 10 min, i_{10} = 5.39 in/hr (Area D)

$Q_{10} = CiA = (0.9)(5.39)(0.104) = 0.5$ cfs

$S_x = 0.04$ ft/ft

$S_L = 0.141$ ft/ft

STEP 2 CALCULATE DESIGN SPREAD & VELOCITY IN GUTTER

$$T = \left[\frac{Qn}{(0.56)(S_x)^{5/3}(S_L)^{1/2}}\right]^{3/8}$$

$$= \left[\frac{(0.5)(0.015)}{(0.56)(.04)^{5/3}(.141)^{1/2}}\right]^{3/8}$$

= 3.31' ✓

$V = Q/A$ $A = \frac{1}{2}(3.31)(d)$ $d = (3.31)(.04)$

$= \frac{1}{2}(3.31)(3.31)(.04)$

$V = \frac{0.5}{0.22}$ = 0.22 sft

= 2.3 ft/sec ✓

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING

BRIDGE OVER LITTLE SCIOTO RIVER

STEP 3 — SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW

$$E = \frac{Q_i}{Q} = R_f E_o + \sout{R_s(1 - E_o)}$$

$$E_o = \frac{Q_w}{Q} = 1 - \left(1 - \frac{W}{T}\right)^{2.67}$$

$$= 1 - \left(1 - \frac{1.5}{3.31}\right)^{2.67}$$

$$= 0.80 \checkmark$$

$R_f = \pm 1.00$ (chart 7 HEC-12, used 1-$\frac{1}{8}$" spacing)

$E = R_f E_o = 0.80$

Intercepted flow $Q_i = EQ$

$= (0.80)(0.50)$

$= 0.40$ cfs

Bypass flow $Q_b = 0.50 - 0.40$

$= 0.10$ cfs

SCUPPER @ STA 132+80
$Q = 0.50$ cfs
$Q_i = 0.40$ cfs
$Q_b = 0.10$ cfs
DESIGN SPREAD = 3.31'

PHASE 3, PORTSMOUTH BYPASS, MEDIAN INLET (SCUPPER) SPACING
BRIDGE OVER LITTLE SCIOTO

SCUPPER @ STA 130+90 SR 823 MEDIAN, RT

STEP 1 CALCULATE DISCHARGE

L = STA 132+80 − STA 130+90 = 190' ✓

W = 5.5'

A = (190)(5.5) = 1045 Sft = 0.024 Ac

C = 0.9

T_c = 10 min, i_{10} = 5.39 in/hr

$Q_{10} = CiA = (0.9)(5.39)(.024) = 0.12$ cfs

$Q_{total} = Q_{10} + Q_{bypass} = 0.12 + 0.1 = 0.22$ cfs

S_x = 0.04 ft/ft

S_L = 0.004 ft/ft

STEP 2 CALCULATE DESIGN SPREAD & VELOCITY IN GUTTER

$$T = \left[\frac{Qn}{(0.56)(S_x)^{5/3}(S_L)^{1/2}}\right]^{3/8}$$

$$= \left[\frac{(0.22)(0.015)}{(0.56)(.04)^{5/3}(.004)^{1/2}}\right]^{3/8}$$

= 3.05' ✓

$V = Q/A$ $A = \frac{1}{2}(3.05)(d)$ $d = (3.05)(.04)$

$= \frac{1}{2}(3.05)(3.05)(.04)$

$= \frac{0.22}{0.19}$ = 0.19 Sft

= 1.16 ft/sec ✓

PHASE 3, PORTSMOUTH BYPASS MEDIAN INLET (SCUPPER) SPACING

BRIDGE OVER LITTLE SCIOTO RIVER

STEP 3 SCUPPER EFFICIENCY, INTERCEPTED FLOW & BYPASS FLOW

$$E = \frac{Q_i}{Q} = R_f E_o + R_s(1 - E_o)$$

$$E_o = \frac{Q_w}{Q} = 1 - \left(1 - \frac{W}{T}\right)^{2.67}$$

$$= 1 - \left(1 - \frac{1.5}{3.05}\right)^{2.67}$$

$$= 0.84$$

$R_f = \pm 1.00$ (chart 7 HEC-12, used $1\frac{1}{8}$" spacing)

$E = R_f E_o = 0.84$ ✓

Intercepted Flow $Q_i = EQ$

$= (0.84)(0.22)$

$= 0.18$ cfs

Bypass flow $Q_b = 0.22 - 0.18$

$= 0.04$ cfs

SCUPPER @ STA 130+90
$Q = 0.22$ cfs
$Q_i = 0.18$ cfs
$Q_b = 0.04$ cfs
DESIGN SPREAD = 3.05'

SCI-823 over SR335 and Little Scioto River PID77366
DONE BY: MDC
CHECKED BY: PJP ✓ 2/19/08

SCI-823 over SR335 and Little Scioto River

STATION	SCUPPER	SX	SL	T AVAILABLE	Q GUTTER	WP	L0	Q=CIA	T	T AVAILABLE	D	A=(1/2)*T*D	V=(Q/A) FT/SEC	Rf FOR PARALLEL BARS WITH 1-1/8 SPACING), SEE CHART-7; HEC12	E0 = RfE0 + Rs(1-E0); E0 =(1-(1-(W/T))^2.67)	E=RF*E0	Qi = EQ	Qb = Q-Qi	REMARKS
LHS MEDIAN																			
134+50	1	0.036	0.0232	6	2.65	34	700.69	2.47	**5.84**	6	**0.21**	0.61	4.02	0.91	0.55	0.50	1.23	1.24	
132+80	2	0.036	0.0141	6	2.07	34	546.25	1.89	**5.80**	6	**0.21**	0.60	3.12	1.00	0.55	0.55	1.04	0.85	
131+80	3	0.036	0.0088	6	1.63	34	431.54	1.23	**5.39**	6	**0.19**	0.52	2.35	1.00	0.58	0.58	0.71	0.51	
131+00	4	0.036	0.0045	6	1.17	34	308.59	0.85	**5.32**	6	**0.19**	0.51	1.67	1.00	0.59	0.59	0.50	0.35	
130+95	5	0.036	0.0042	6	1.13	34	298.13	0.37	**3.95**	6	**0.14**	0.28	1.32	1.00	0.72	0.72	0.27	0.10	
130+90	6	0.036	0.004	6	1.10	34	290.95	0.12	**2.61**	6	**0.09**	0.12	0.98	1.00	0.90	0.90	0.11	**0.01**	
RHS MEDIAN																			
132+80	1	0.04	0.0141	4	0.84	5.5	1365.19	0.50	**3.31**	4	**0.13**	0.22	2.30	1.00	0.80	0.80	0.40	0.10	
130+90	2	0.04	0.004	4	0.45	5.5	727.13	0.22	**3.05**	4	**0.12**	0.19	1.16	1.00	0.84	0.84	0.18	**0.04**	
LHS OUTSIDE																			
131+00	1	0.04	0.0045	9.5	4.74	11	3871.95	1.07	**5.43**	9.5	**0.22**	0.59	1.81	1.00	0.58	0.58	0.62	0.45	
130+95	2	0.04	0.0042	9.5	4.58	11	3740.66	0.46	**4.03**	9.5	**0.16**	0.32	1.43	1.00	0.71	0.71	0.33	0.13	
130+90	3	0.04	0.004	9.5	4.47	11	3650.51	0.14	**2.63**	9.5	**0.11**	0.14	1.05	1.00	0.90	0.90	0.13	**0.02**	
RHS OUTSIDE																			
131+15	1	0.036	0.0053	12	8.05	39.5	1830.41	4.33	**9.51**	12	**0.34**	1.63	2.66	1.00	0.37	0.37	1.59	2.74	
131+10	2	0.036	0.0048	12	7.66	39.5	1741.93	2.76	**8.19**	12	**0.29**	1.21	2.29	1.00	0.42	0.42	1.15	1.61	
131+05	3	0.036	0.0048	12	7.66	39.5	1741.93	1.63	**6.72**	12	**0.24**	0.81	2.01	1.00	0.49	0.49	0.80	0.83	
131+00	4	0.036	0.0045	12	7.42	39.5	1686.62	0.86	**5.34**	12	**0.19**	0.51	1.67	1.00	0.59	0.59	0.50	0.36	
130+95	5	0.036	0.0042	12	7.17	39.5	1629.43	0.38	**3.99**	12	**0.14**	0.29	1.33	1.00	0.72	0.72	0.27	0.11	
130+90	6	0.036	0.004	12	6.99	39.5	1590.16	0.13	**2.71**	12	**0.10**	0.13	1.00	1.00	0.88	0.88	0.12	**0.02**	