SCI-823-0.00

PID No. 19415

S.R. 823 OVER MORRIS LANE BLUE RUN ROAD

STRUCTURE TYPE STUDY SUBMITTAL

Prepared for:
OHIO DEPARTMENT OF TRANSPORTATION
DISTRICT 9
650 EASTERN AVE.
CHILLICOTHE, OHIO 45601

MAY 19, 2006

Prepared by:
TranSystems

STRUCTURAL ENGINEERING
MAY 22 2006
WJK ☐ SM ☐ TJK ☐ JEM ☐
JAC ☐ RZ ☐ AW ☐ ☐
MT ☐ DAG ☐ JCR ☐ ☐
AD ☐ SS ☐ JS ☐ FILE ☐

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BRIDGE TYPE STUDY NARRATIVE

1. Introduction

TranSystems Corporation is providing engineering services to the Ohio Department of Transportation for the design of new left and right overpass structures that will carry the proposed S.R. 823 bypass over existing Morris Lane Blue Run Road (CR-54) and a relocated unnamed tributary to Candy Run. As requested by the Scope of Services, a Bridge Type Study report is to be submitted before any plan development. The purpose of this report is to investigate various span arrangements and superstructure and substructure types in order to determine the most appropriate and economical structure type that will meet the project requirements. An initial Bridge Type Study report dated 7/15/2005 was submitted to the Department and comments, dated 9/19/2005, were in turn received by TranSystems. However, since these dates, the entire project has experienced a change in profile – the original project profile presented in the Preferred Alternative Verification Report (PAVR) submitted July 2005 has been altered and the revised profile has been approved by the Department. The revised profile lowers the elevations of proposed S.R. 823 over Morris Lane Blue Run Road from the elevations specified in the July 2005 PAVR. This follow-up Bridge Type Study presents the results of these changes as well as alternative bridge types that are investigated in accordance with the 9/19/2005 ODOT comments. As a result, two (2) alternatives for construction of the proposed S.R. 823 Mainline over Morris Lane Blue Run Road are evaluated in this study and are designated as Alternatives 1 & 2. Each of these alternatives is evaluated with regard to estimated construction cost, projected maintenance costs, horizontal and vertical clearances, constructability and maintenance of traffic. Discussion of these alternatives is presented later in this report.

2. Design Criteria

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

3. Subsurface Conditions and Foundation Recommendation

DLZ Ohio, Inc. performed the subsurface exploration for the proposed bridge and prepared the Preliminary Bridge Foundation Recommendations which were presented in Section 3 and Appendix E of the original 7/15/2005 Structure Type Study report. Updated boring logs for the four test borings (TR-4, TR-5 and TR-6) and preliminary MSE wall evaluations – performed by DLZ Ohio, Inc. – accompany this modified/updated Structure Type Study Report. The preliminary evaluations reveal that MSE walls can be used at the rear and forward abutment locations. At the rear abutment, DLZ recommends the naturally occurring soils beneath the proposed MSE walls be overexcavated to the top of weathered rock (approx. 5.5') and replaced with compacted, granular fill or constructing the MSE wall in stages. Similarly, at the forward abutment, DLZ recommends 5.0' of undercut and replacement with engineered fill to achieve adequate factors of safety. DLZ recommends that 2:1 spill through slopes be used at the rear abutment and 3:1 spill through slopes be used at the forward abutment. Refer to the preliminary MSE wall evaluation report for more details and information.

4. Roadway

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

Both the left and right structures are similar and will consist of a 2 - 12'-0" travel lane with 6'-0" median shoulders and 12'-0" outside shoulders. Including a 1'-6" inside median parapet and a 1'-6" outside straight face deflector parapet yields a structure deck width of 45'-0" out-to-out. The distance from the centerline of construction of SR 823 to the near edge of both the left and right structures is constant at 3'-6". Horizontal and vertical sight distances, in accordance with the design standards, have been provided over the bridge for all alternatives considered.

ADT ? speed

Vertical and Horizontal Design – Since the proposed vertical alignment for all overpass structures on this project was dictated by the overall design of the new bypass profile, vertical clearance was not a critical design issue for each alternative proposed herein. For this report, more than 15'-0" of preferred vertical clearance could be provided for each structure's alternatives considered. In accordance with the ODOT L&D manual, Volume 1, for the twin structures at Morris Lane Blue Run Road, a minimum horizontal clear zone width of 23'-0" from edge of traveled way to face of obstruction is required. The traffic data is estimated because certified traffic data is not available for this route at this time.

Morris Lane Blue Run Road will remain on its existing grade and alignment.

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

Utilities - No utilities will be placed on the bridge. However, lighting and ITS conduits will be provided as necessary. An existing waterline and telephone line run parallel to Morris Lane Blue Run Rd. approximately 5' south of the south edge of pavement. There is an existing aerial electric line also on the south side of Morris Lane Blue Run Rd. that will need to be relocated. There are no other utilities known at this point in time.

Maintenance of Traffic - While the new bridges are under construction, traffic will be maintained on existing Morris Lane Blue Run Rd. It is anticipated that there will be limited closures during construction for beam setting.

5. Proposed Structure Configurations

Alignment & Profile: The proposed mainline alignment is tangent along entire length of both the left and right structures. The cross section has a crown at the profile grade line with a break at the median shoulder in accordance with the BDM. The proposed mainline profile grade line is located on the inside edge of pavement for both bridges and is in a 1600' sag vertical curve, PVI= 721+50, El. 759.94, G1 = -4.2% and G2 = 4.6%. The horizontal and vertical geometry for all alternatives considered are the same. Embankment slopes will be a maximum of 2:1 in order to minimize right-of-way impacts.

Structure Types: As per the Scope of Services, we investigated several bridge types and alternatives as part of this type study. Considering the preferred and minimum clearances required for Morris Lane Blue Run Road and the position of the relocated stream at the rear abutment, single span structures were selected as the most economical. The different alternatives discussed below present span arrangements at the preferred clearances. Three span spill through structures would be significantly longer due to the forward embankment slope of 3:1 and therefore were not considered as part of this study. Environmental concerns dictated that the channel to be relocated to pass under the bridge and not through a culvert.

why ? ?

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

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

BRIDGE TYPE ALTERNATIVE TABLE

Structure Type Alternative	1	2
Superstructure Type Description	Prestressed Concrete Girders 84" Modified AASHTO Type 4 beams	78"web, steel plate girders A709 Grade 50W
Proposed Beam Spacing	5 Spaces @ 7'-9"	4 Spaces @ 9'-6"
No. of Spans	1 (140.0')	1 (140.0')
Abutment Type	Semi-integral Type abutments on MSE wall supported embankments	Semi-integral Type abutments on MSE wall supported embankments
No. of Piers	0	0
Pier Type	None	None
Substructure Orientation	None	None
Approximate Bridge Limits	142.0'	142.0'
Approximate Structure Depth		
Slab	8.5"	8.75"
Haunch	2"	2"
Beam	84.0"	58.0"
Total	94.5" (7.875')	68.75" (5.729')

Alternatives Discussion:

Alternative 1

This alternative is comprised of a single span structure with span a length of 140'-0. The abutments are oriented perpendicular to the centerline of construction. Embankment slopes are supported by MSE walls approximately 50'-60' in height at both abutments. The forward MSE wall is placed 3' outside the existing clear zone to allow for future widening of the narrow existing lanes. ? The MSE wall at the rear abutment was set to avoid impacting the flow in the relocated channel.

The abutments will be semi-integral type supported on H-Piles. The details of the abutments will follow ODOT Standard Construction drawings. The piles shall be HP12x53 with a design capacity of 70-tons per pile. Piles at the forward abutment will be driven to refusal on bedrock and the rear piles in prebored holes. Piles will need to be sleeved through the MSE wall embankment zone in accordance with the MSE wall Special Provisions.

The preliminary design of this alternative consists of 6 - 84" AASHTO Type 4 Modified prestressed beams, spaced at 7'-9" with 3'-1 1/2" overhangs. The design loading applied was HS-25 with Alternate Military Loading and a future wearing surface of 60 psf. This analysis indicates that concrete strengths of 5000 psi at release and 7000 psi final are required. Ohio Prestressers Association recommended the 84" section with the 4' top flange be investigated and also indicated shipping feasibility was not of particular concern (see Appendix B). The details for the 84" section are the same as used on RIC-71-6.39 and are included in the preliminary plans. Both the left and right bridge width will be 42'-0" from toe to toe of parapets with an overall bridge deck width of 45'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 1/2".

The initial bridge construction cost for Alternative 1 is estimated to be $3,860,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $664,000, resulting in a total estimated ownership cost of $4,524,000 in year 2008 dollars.

Alternative 2

Alternative 2 is similar to Alternative 1 except that the superstructures consist of 5 - 78" web Grade 50W plate girders, spaced at 9'-6" with 3'-6" overhangs. The design loading applied was HS-25 (Case I fatigue) with Alternate Military Loading and a future wearing surface of 60 psf. Both the left and right bridge width will be 42'-0" from toe to toe of parapets with an overall bridge deck width of 45'-0". Deck thickness, including a 1" monolithic wearing surface, is 8 3/4".

The initial bridge construction cost for Alternative 2 is estimated to be $3,385,000 in year 2008 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,365,000, resulting in a total estimated ownership cost of $4,750,000 in year 2008 dollars.

Recommendations:

Based upon the above information and discussions, we recommend **Structure Type Alternative 1**, which consists of single span 84" Type 4 Modified prestressed beams with semi-integral abutments on MSE wall supported embankments for both the left and right structures. (See Appendix B for the Site Plan and Structure Details).

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

a. This Alternative appears to be economical when considering the construction costs.
b. Lowest life cycle costs.
c. Lowest total ownership costs.

APPENDIX A

Cost Comparison Summary

TranSystems

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S.R. 823 over Morris Lane-Blue Run Road L&R

STRUCTURE TYPE STUDY

By: PJP
Checked: JRC

Date: 5/15/2006
Date: 5/18/2006

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement		Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Structure Incidental Cost (16%)	Structure Contingency Cost (20%)	Total Alternative Const. Cost	Life Cycle Maintenance Cost	Total Relative Ownership Cost
	No. Spans	Lengths										
1	1	140'-0"	140.00	6 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (84")	$1,205,000	$1,568,000	$443,700	$643,300	$3,860,000	$664,000	$4,524,000
2	1	140'-0"	140.00	5 Steel Girders /per BRIDGE	78" Web Grade 50W	$960,000	$1,472,000	$389,100	$564,200	$3,385,000	$1,365,000	$4,750,000

NOTES:

1. Structure incidental cost allowance includes provision for structure excavation, porous backfill, sealing of concrete surfaces, bearings, and crushed aggregate slope protection costs.
2. Estimated construction cost does not include existing structure removal (if any), which should be quantified seperately, if required.

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STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - SUPERSTRUCTURE

By: PJP Date: 5/15/2006
Checked: JRC Date: 5/18/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Approach Roadway Cost	Framing Alternative	Proposed Girder Section	Prestressed Concrete Cost	Subtotal Superstructure Cost
1	1	140'-0"	140.00	142.00	458	$270,900	$115,000	$99,000	$0	6 Prestressed Concrete Girders /per BRIDGE	AASHTO Type 4 Modified (84")	$720,000	**$1,205,000**

COST SUPPORT CALCULATIONS

Deck Cross-Sectional Area:

Parapets:

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

Slab:

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

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

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

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

Based on parapet and slab percentages
of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete

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

Prestressed Concrete Girders
Unit Costs:

	Year 2005		Annual Escalation	Year 2008		No. Required	
AASHTO Type IV Beams							
Pier Diaphragms	$1,800	ea.	3.5%	$2,070	ea.	0	$0
Abutment Diaphragms	$1,200	ea.	3.5%	$1,380	ea.	0	$0
Intermediate Diaphragms	$905	ea.	3.5%	$1,040	ea.	30	$31,200
Modified Type 4 I-Beams (84")	$370	per ft.	3.5%	$410	ea.	1680	$688,800
							$720,000

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

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

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

Approach Roadway

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

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

	Cost Ratio	Year 2004	Annual Escalation	Year 2008
Strip Seal Expansion Joints	1.00	$250.00	3.5%	$318.07

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STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - SUBSTRUCTURE

By: PJP Date: 5/15/2006
Checked: JRC Date: 5/18/2006

SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Wall Cost	Additional Crane Cost	Subtotal Substructure Cost
1	1	140'-0"	5 Steel Girders /per BRIDGE	AASHTO Type 4 Modified (84")	$0	$0	$170,000	$27,900	$165,100	$1,130,200	$75,000	**$1,568,000**

COST SUPPORT CALCULATIONS

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

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

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

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

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment	306	$421.00	3.5%	$483.00	$147,800
Wingwalls	46	$421.00	3.5%	$483.00	$22,200

Note: 15% of abutment volume allowed for wingwalls.

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

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

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

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

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 1	20,400	$50.00	3.5%	$55.40

Pile Foundation Unit Cost ($/ft.): *HP 12X53 Piles, Furnished & Driven*

Number of Piles		Total Pile Length
72	SEE QUANTITY CALCULATIONS	4,900

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$20.15	3.5%	$23.10
Driven	$9.24	3.5%	$10.60
Total			$33.70

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

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

Shaft Foundation Unit Cost ($/ft.):

Unit Cost	Escalation	2008
$125.00	4.5%	$149.00

Cost of Shafts: $ -

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

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

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

Additional Crane Cost

$ 75,000

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S.R. 823 over Morris Lane-Blue Run Road L&R

STRUCTURE TYPE STUDY - PRESTRESSED CONCRETE GIRDER ALTERNATIVE 1 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 5/15/2006
Date: 5/18/2006

Pier Quantities

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

Pile Quantities

Location	Load/girder (Kips)	# Girders	Total Girder Load	Subst Wt (kips)	Pile Cap.(Kips)	No. Piles	Increase Factor	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Pile Length (Feet)
Rear Abut.	0	0	0	0	140	0	1	*18*	767.4	705.4	65.0	*1170*
Pier 1	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 2	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 3	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	0	0	0	140	0	1	*18*	765.4	698.5	70.0	*1260*
Total								**36**				**2430**
							Qty x 2 (L/R)	**72**				**4900**

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footi*	*Volume*	
Rear Abut	45	3	7.75	23.25	1046	3	1.5	4.50		203	6	3	18	1	810	2059
Fwd. Abut	45	3	7.75	23.25	1046	3	1.5	4.50		203	6	3	18	1	810	2059
Total (Cu.Ft.)					**2093**					**405**					**1620**	**4118**
Total (Cu.Yd.)					**78**					**15**					**60**	**153**
			Qty x 2 (L/R)		**156**					**30**					**120**	**306**

36" Drilled Shafts

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

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		60	90	5400	
RA Wing (L)		33	100	3300	
RA Wing (R)		33	100	3300	
Fwd Abut		47	90	4230	
FA Wing (L)		26	80	2080	
FA Wing (R)		26	80	2080	
Total (Sq.Ft.)				**20400**	

Superstructure P/S Concrete Quantities

Location	Type of girder	# Girders	Span Length	Total	Spacing Int. diaphragm	No. of Int in span	Number of Int Diap. 1 location	Total No. in Span
Span 1	MOD TYPE-4 84	12	140.0	1680	35.00	10	3	30
Span 2		0	0.0	0	0.00			0
Span 3		0	0.0	0	0.00			0
Span 4		0	0.0	0	0.00			0
Span 5		0	0.0	0	0.00			0
Span 6		0	0.0	0	0.00			0
Span 7		0	0.0	0	0.00			0
Span 8		0	0.0	0	0.00			0
Span 9		0	0.0	0	**Total**			**30**
Total	**MOD TYPE-4 84**	**12**		**1680**				

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STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - SUPERSTRUCTURE

By: PJP
Checked: JRC

Date: 5/15/2006
Date: 5/18/2006

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)	Deck Volume (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Approach Roadway Cost	Framing Alternative	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Subtotal Superstructure Cost
2	1	140'-0"	140.00	142.00	469	$276,900	$117,700	$99,000	$0	5 Steel Girders /per BRIDGE	78" Web Grade 50W	400400	$466,127	**$960,000**

COST SUPPORT CALCULATIONS

Deck Cross-Sectional Area:

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

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

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

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

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

Based on parapet and slab percentages
of total concrete area

Epoxy Coated Reinforcing Steel
Unit Cost ($/lb):
Assume 285 lbs of reinforcing steel per cubic yard of deck concrete

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

Structural Steel
Unit Costs ($/lb.):

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

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

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

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

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

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

Approach Roadway

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

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Morris Lane-Blue Run Road L&R

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - SUBSTRUCTURE

By: PJP — Date: 5/15/2006
Checked: JRC — Date: 5/18/2006

SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Wall Cost	Additional Crane Cost	Subtotal Substructure Cost
2	1	140'-0"	5 Steel Girders /per BRIDGE	78" Web Grade 50W	$0	$0	$166,600	$27,300	$148,300	$1,130,200	$0	**$1,472,000**

COST SUPPORT CALCULATIONS

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

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

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

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

Abutment QC/QA Concrete, Class QSC1 Cost:

Component	Volume (cu. yd.)	Year 2004	Annual Escalation	Year 2008	Total Cost
Abutment	300	$421.00	3.5%	$483.00	$144,900
Wingwalls	45	$421.00	3.5%	$483.00	$21,700

Note: 15% of abutment volume allowed for wingwalls.

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

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

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

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

	Total Area (sq. ft.)	Year 2005 Unit Cost	Annual Escalation	Year 2008
Alt. 2	20,400	$50.00	3.5%	$55.40

Pile Foundation Unit Cost ($/ft.): *HP 12X53 Piles, Furnished & Driven*

Number of Piles		Total Pile Length
64	SEE QUANTITY CALCULATIONS	4,400

Pile Foundation Unit Cost ($/ft.):

	Year 2004 Unit Cost	Annual Escalation	Year 2008
Furnished	$20.15	3.5%	$23.10
Driven	$9.24	3.5%	$10.60
Total			$33.70

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

	Number of Shafts		Total Shaft Length
Alt. 2	0	SEE QUANTITY CALCULATIONS	0

Shaft Foundation Unit Cost ($/ft.):

Unit Cost	Escalation	2008
$125.00	4.5%	$149.00

Cost of Shafts: $ -

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

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

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

Additional Crane Cost

$ -

SCI-823-0.00 - PORTSMOUTH BYPASS

S.R. 823 over Morris Lane-Blue Run Road L&R

STRUCTURE TYPE STUDY - STEEL PLATE GIRDER ALTERNATIVE 2 - QUANTITY CALCULATIONS

By: PJP
Checked: JRC

Date: 5/15/2006
Date: 5/18/2006

Pier Quantities

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

Abutment Quantities

Abut Location	Length (feet)	Backwall				Beam Seat					Footing					Total Volume
		Width	*Depth*	*Area*	*Volume*	*Width*	*Height*	*Area*		*Volume*	*Width*	*Depth*	*Area*	*# Footin*	*Volume*	
Rear Abut	45	3	7.5	22.50	1013	3	1.5	4.50		203	6	3	18	1	810	2025
Fwd. Abut	45	3	7.5	22.50	1013	3	1.5	4.50		203	6	3	18	1	810	2025
Total (Cu.Ft.)					**2025**					**405**					**1620**	**4050**
Total (Cu.Yd.)					**75**					**15**					**60**	**150**
Qty x 2 (L/R)					**150**					**30**					**120**	**300**

MSE Abutment Wall Quantities

Abut Location		Wall			
		Height	*Length*	*Area*	*Volume*
Rear Abut		60	90	5400	
RA Wing (L)		33	100	3300	
RA Wing (R)		33	100	3300	
Fwd Abut		47	90	4230	
FA Wing (L)		26	80	2080	
FA Wing (R)		26	80	2080	
Total (Sq.Ft.)				**20400**	

Pile Quantities

Location	Load/girder (Kips)	# Girders	Total Girder Load	Subst Wt (kips)	Pile Cap.(Kips	No. Piles	Increase Factor	Total Piles	Top Elev.	Bot Elev.	Pile Length	Total Pile Length (Feet)
Rear Abut.	0	0	0	0	140	0	1	*16*	769.3	705.4	65.0	*1040*
Pier 1	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 2	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 3	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 4	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 5	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 6	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Pier 7	0	0	0	0	140	0	1	*0*	0	0	0.0	*0*
Fwd. Abut.	0	0	0	0	140	0	1	*16*	767.2	698.5	70.0	*1120*
Total								**32**				**2160**
							Qty x 2 (L/R)	**64**				**4400**

36" Drilled Shafts

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

Superstructure Steel Quantities

Location	Wt.of girder (lb)/ft	# Girders	Span Length	Total Weight
Span 1	286	10	140	400400
Span 2	0	0	0	0
Span 3	0	0	0	0
Span 4	0	0	0	0
Span 5	0	0	0	0
Span 6	0	0	0	0
Span 7	0	0	0	0
Span 8	0	0	0	0
Total				400400

By: PJP
Checked: JRC

Date: 5/15/2006
Date: 5/18/2006

LIFE CYCLE MAINTENANCE COST

	Span Arrangement			Structural Steel Painting *			Superstructure Sealing			Approach Pavement Resurfacing		
Alt. No.	No. Spans	Lengths	Framing Alternative	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost	Cost Per Cycle	Number of Maintenance Cycles	Total Life Cycle Cost
1	1	140.00	6 Prestressed Concrete Girders /per BRIDGE	$0	0	$0	$44,600	2	$89,200	$0	10	$0
2	1	140.00	5 Steel Girders /per BRIDGE	$391,000	2	$782,000	$0	0	$0	$0	10	$0

	Span Arrangement			Bridge Deck Overlay (5)					Bridge Redecking (5)								
Alt. No.	No. Spans	Lengths	Framing Alternative	Deck Demo & Chipping	Deck Overlay	Deck Joint Gland (2)	Number of Maintenance Cycles	Total Life Cycle Cost	Deck Concrete Cost (3)	Deck Reinforcing Cost (3)	Deck Joint Cost (2)	Deck Removal Cost	Number of Maintenance Cycles	Total Life Cycle Cost	**Superstructure Life Cycle Maintenance Cost (1)**	**Total Initial Construction Cost**	**Total Relative Ownership Cost**
1	1	140	6 Prestressed Concrete Girders /per BRIDGE	$38,200	$46,300	n/a	1	$84,500	$270,900	$115,000	n/a	$104,300	1	$490,200	**$664,000**	**$3,860,000**	**$4,524,000**
2	1	140	5 Steel Girders /per BRIDGE	$38,200	$46,300	n/a	1	$84,500	$276,900	$117,700	n/a	$104,300	1	$498,900	**$1,365,000**	**$3,385,000**	**$4,750,000**

Structural Steel Painting:

Structural Steel Area:

	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (in.)	Nominal Exposed Girder Area (sq. ft.)	Secondary Member Allowance	Total Exposed Steel Area (sq. ft.)
Alt. 2	78	10	140.00	18.00	24,500	20%	29,400

Painting Cost per sq. ft.:

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

Superstructure Sealing:

PS Concrete I-Beam Area:

72" Modified AASHTO Type 4

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

84" Modified AASHTO Type 4

	H	V	Diag.	No.	Total
Bot. Flange	26			1	26.00
		8		2	16.00
Lower Fillets	9	9	12.73	2	25.46
Web		57		2	114.00
Upper Fillets	3	3	4.24	2	8.49
	17	2	17.12	2	34.23
Top Flange		5		2	10.00 in.
Total Exposed Perimeter					234.18

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1	12	140.00	32,785	10%	4,010

Sealing Cost per sq. yd.:

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

Bridge Redecking:

Bridge Deck Joint Cost per foot:

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

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

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2008	Deck Removal Cost
Alt. 1	12,600	$8.28	$104,300
Alt. 2	12,600	$8.28	$104,300

Bridge Deck Overlay (Item 848):

Bridge Deck MSC Overlay Cost per sq. yd.:

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

Bridge Deck MSC Overlay Cost per cu. yd.:

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

	Deck Area (3) (sq. ft.)	Deck Area (sq. yd.)	Hand Chipping (sq. yd.)	Variable Thickness Repair (cu. yd.)
Alt. 1	12,600	1,400	35	32
Alt. 2	12,600	1,400	35	32

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

Bridge Deck Joint Gland Replacement Cost per foot:

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

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

NOTES:

1. Life cycle maintenance costs assume a 75 -year structure life, and are expressed in present value (2008 construction year) dollars.
2. Bridges are assumed to have semi-integral abutments, therefore no strip seal deck joints will be required except for Alt. 3.
3. See Superstructure Cost sheet.
4. See Alternative Cost Summary sheet.
5. Assume bridge deck overlay at Year 25 and bridge deck replacement at Year 50.
Assume superstructures are painted or sealed on a 25-year recurrence interval.
Assume complete bridge replacement at Year 75.
6. Life cycle maintenance cost differences are assumed to be predominately a function of superstructure maintenance costs.
Consequently, substructure lifecycle maintenance costs are not included in this analysis.

Approach Pavement Resurfacing:

Resurface Perpetual Asphalt Pavement:
Resurfacing Units Costs:

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

	Year 2004	Annual Escalation	Year 2008
Asphalt Concrete Surface Course, per cu. yd.	$72.00	3.5%	$82.62

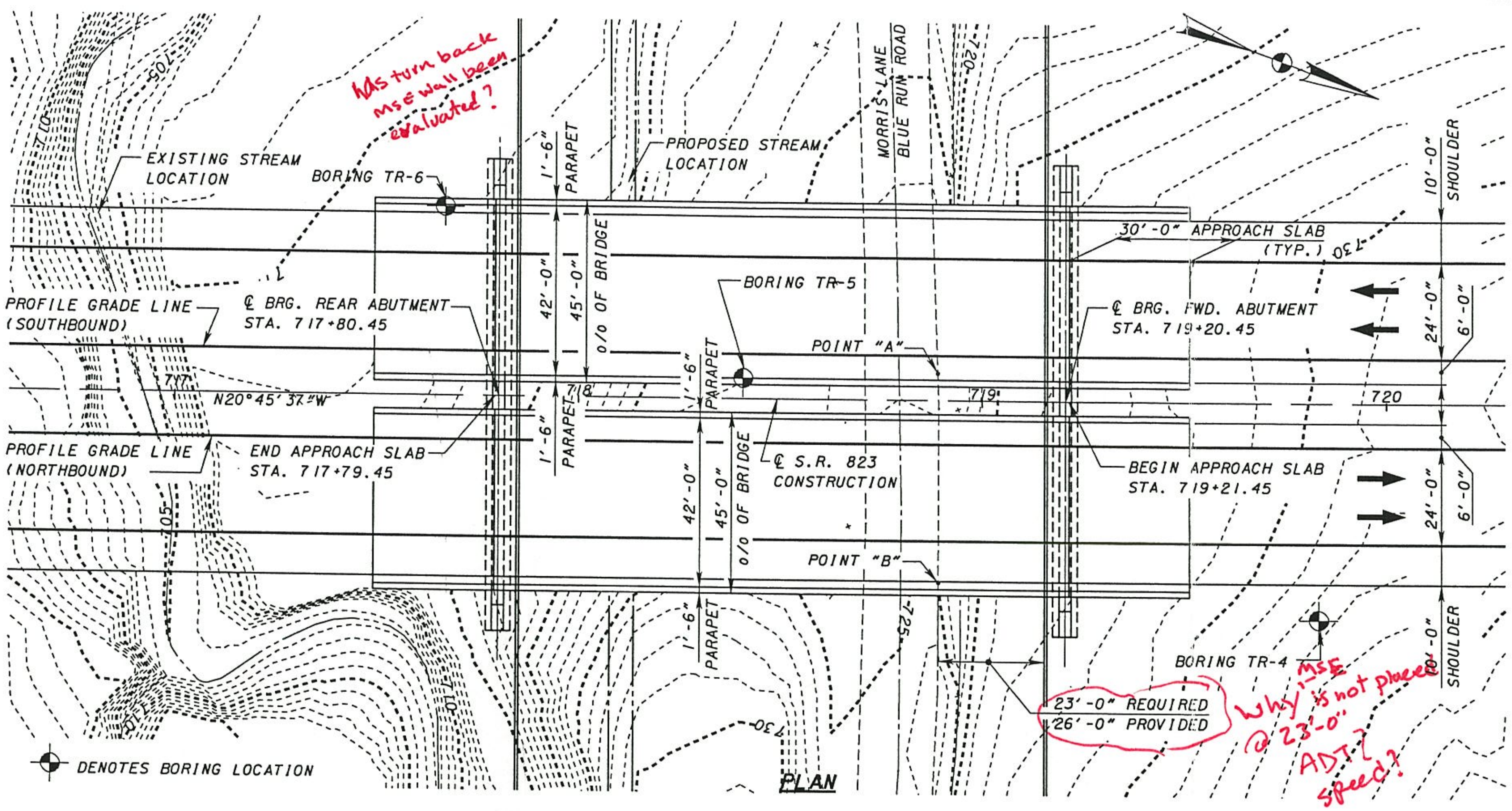
Asphalt Resurfacing Costs:

	Approach Roadway Length (ft.) (4)	Approach Roadway Width (ft.)	Resurfacing Area (sq. yd.)	Wearing Course Thickness (in.)	Wearing Course Volume (cu. yd.)
Alt. 1	0.0	80.0	0	1.50	0.0
Alt. 2	0.0	80.0	0	1.50	0.0

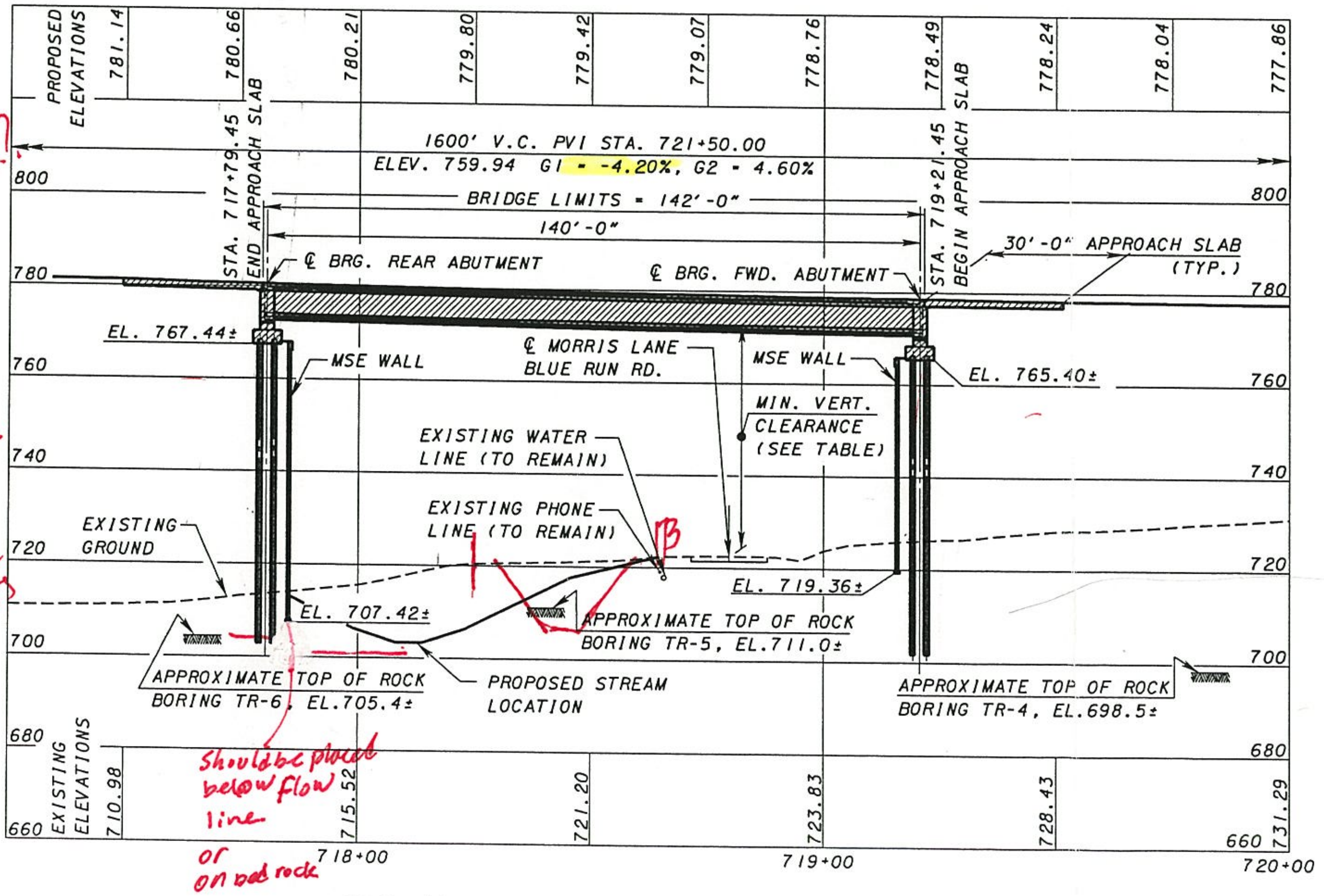
APPENDIX B

Preferred Alternative Site Plan and Details

TranSystems®



- Cost analysis for all possible structure types??
- Preauger Prebored holes with H-Piles.
- Ask about MSE Wall Costs



ELEVATION ALONG PROFILE GRADE S.R. 823

FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS

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

BORING LOCATIONS

BORING No.	STATION	OFFSET
TR-4	719+83.40	53.85' RT.
TR-5	718+40.69	5.03' LT.
TR-6	717+67.14	46.59' LT.

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

TRAFFIC DATA

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

NOTES:

1. ALL SHEETS WITH PLAN DIMENSIONS ARE HORIZONTAL.
2. EARTHWORK LIMITS ARE SHOWN 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.

TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"
PROPOSED	48.22' ±	45.26' ±
PREFERRED	15.0'	15.0'

FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 12x53 PILES AND HAVE A MAXIMUM CAPACITY OF 70 TONS PER PILE.

HYDRAULIC DATA

DRAINAGE AREA - 147.8 acres

Q_{50} - 294 cfs	Q_{100} - 353 cfs
V_{50} - 12.7 fps	V_{100} - 13.6 fps
EL_{50} - 709.53	EL_{100} - 709.74

PROPOSED STRUCTURE

TYPE: SINGLE SPAN 84" TYPE 4 (MOD.) PRESTRESSED CONCRETE I-BEAM WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS AND MSE WALLS.

SPANS: 140'-0" C/C BEARINGS

ROADWAY: 2 - 42'-0" T/T PARAPETS

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

SKEW: NONE
CROWN: NORMAL 0.016 FT/FT
ALIGNMENT: TANGENT
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (30'-0" LONG)
LATITUDE:
LONGITUDE:

DESIGN AGENCY
TranSystems
720 EAST PETE ROSE WAY, SUITE 360
CINCINNATI, OHIO, 45202

REVIEWED	DATE
JRC	5/18/06

STRUCTURE FILE NUMBER

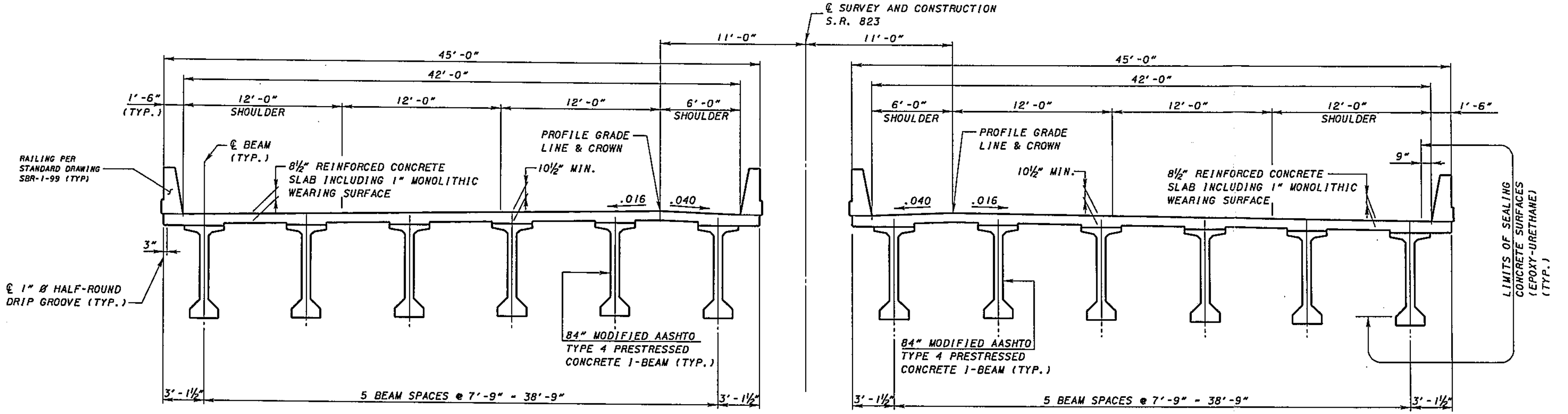
DESIGNED	DRAWN
PJP	CAS
CHECKED	REVISED

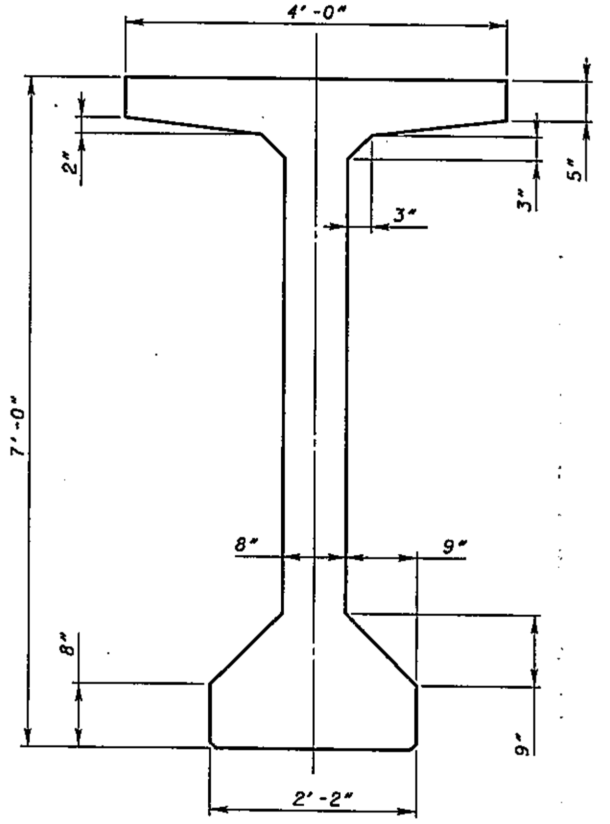
SCIOTO COUNTY
STA. 717+79.45
STA. 719+21.45

SITE PLAN - ALTERNATIVE 1 CR-54
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER MORRIS LANE BLUE RUN

SCI-823-0.00
PID19415

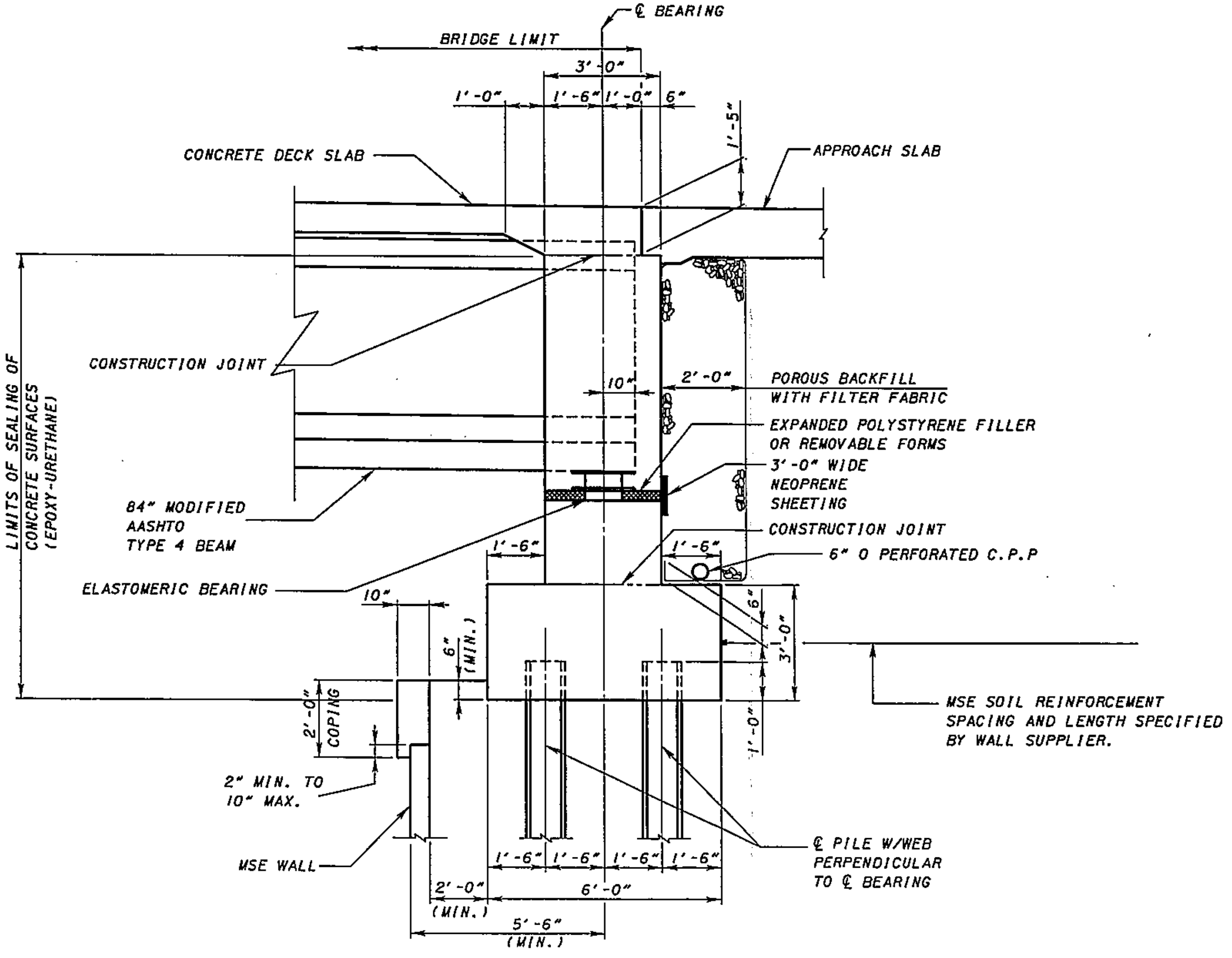
1/2





84" MODIFIED AASHTO TYPE 4 CONCRETE BEAM SECTION

SUPERSTRUCTURE DEPTH	
ITEM	84" MODIFIED AASHTO TYPE 4 BEAM
SLAB (INCLUDING WEARING SURFACE)	8.5"
HAUNCH (BOTTOM OF SLAB TO TOP OF FLANGE)	2"
GIRDER DEPTH	84"
TOP OF WEARING SURFACE TO BOTTOM OF GIRDER FLANGE (INCH)	94.5"
TOP OF WEARING SURFACE TO BOTTOM OF GIRDER FLANGE (FEET)	7.875'



TYPICAL ABUTMENT SECTION

DESIGN AGENCY
TranSystems
720 EAST PETE ROSE WAY, SUITE 360
CINCINNATI, OHIO, 45202

DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	JRC	5/18/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	

TYPICAL TRANSVERSE & ABUTMENT SECTIONS
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER MORRIS LANE BLUE RUN ROAD

SCI-823-0.00
PID19415

2 / 2

Ohio Prestressers Association
51 Mallard Point Hebron Ohio 43025-9688 Phone: 614-456-3012 Email: mekllc@columbus.rr.com

April 18, 2006

Patrick Plews, EI
TranSystems Corporation
720 E. Pete Rose Way
Suite 360
Cincinnati Ohio 45202

Re: Portsmouth Bypass, AASHTO Modified Type 4 I-beams 72"

Dear Patrick:

Thank you for the opportunity to provide input for your prestressed concrete bridge design.

Pursuant to Email correspondence, and review of the information you sent to Prestress Services Industries, LLC, and United Precast, Inc., on behalf of those member producers, I offer the following:

1. Producing 72" AASHTO Modified Type 4 Prestressed Concrete I-Beams is no problem for either member producer at lengths of 150'-0". see p. 4
2. Release strength of 6,000 psi and final strength of 8,000 psi is not a problem for either producer ~~and will not add additional cost to the beams~~.
3. It is highly recommended that a 4' top flange is used to add stability for shipping.
4. The producers do not anticipate any unusual problems shipping beams to the site. PSI scouted the route and can deliver, but only from the East side taking US23 to 728 East which becomes Lucasville/Minford Rd. They will continue east to CR 46/High Street (Minford) south to project area.
5. Budget pricing for your beams ranges from $258/lf to $300/lf furnished and erected. Budget pricing is developed from actual historical bridges sold by ODOT over the past 2 years.

Both Ohio Prestressers Association members are looking forward to competing on this project when it comes to sale. If you need any additional information, please call.

Sincerely,
Ohio Prestressers Association

Mary Ellen Kimberlin
Executive Director

APPENDIX C

Vertical Clearance Calculations

TranSystems

TranSystems

Made By MTN Date 05/17/06 Job No. P403030064
Checked By PJP Date 05/17/06 Sheet No.

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER BLUE RUN - MORRIS LANE **PID #** 19415

Alternative 1 - 6-84" Type 4 Modified Concrete I-Beams, Single Span **Point Location: A**

Adjstment for Cross Slope

Comment	Grade		Offset	
Profile grade line to critical pt.:	-0.04	x	4.375	-0.175

Total Adjustment = **-0.18**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	84	7
	94.5	7.88

Total Superstructure Depth (ft) = **7.88**

Vertical Clearance at Critical Point

Station @ Critical Point = **718+89.142**
Offset Location @ Critical Point = **6.625' LEFT**
Profile Grade Elevation at Critical Point = 778.89
Adjustment for Cross Slopes to Beam CL = -0.18
Top of Deck Elevation @ Critical Point = **778.72**

Total Superstructure Depth = -7.88
Bottom of Beam Elevation @ Critical Point = **770.84**

Approximate Top of Existing Ground @ Critical Point = **722.62**
Actual Vertical Clearance = ***48.22***
Preferred Vertical Clearance = *15.0*
Required Vertical Clearance = *14.5*

TranSystems

Made By MTN Date 05/17/06 Job No. P403030064
Checked By PJP Date 05/17/06 Sheet No.

VERTICAL CLEARANCE CALCULATIONS

Job Name SCI-823-0.00 **Structure**
Description S.R. 823 OVER BLUE RUN MORRIS LANE **PID #** 19415

Alternative 1 - 6-84" Type 4 Modified Concrete I-Beams, Single Span ***Point Location: B***

Adjstment for Cross Slope

Comment	Grade		Offset		
Shoulder:	-0.016	x	34.375	=	-0.55
				=	0.00
					0
			Total Adjustment	=	**-0.55**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.5	0.71
Haunch:	2	0.17
Girder or Beam Depth:	84	7
	94.5	7.88

Total Superstructure Depth (ft) = **7.88**

Vertical Clearance at Critical Point

Station @ Critical Point	=	**718+89.34**
Offset Location @ Critical Point	=	**45.375' RIGHT**
Profile Grade Elevation at Critical Point	=	778.89
Adjustment for Cross Slopes to Beam CL	=	-0.55
Top of Deck Elevation @ Critical Point	=	**778.34**
Total Superstructure Depth	=	-7.88
Bottom of Beam Elevation @ Critical Point	=	**770.46**
Approximate Top of Existing Ground @ Critical Point	=	**725.20**
Actual Vertical Clearance	=	***45.26***
Preferred Vertical Clearance	=	*15.0*
Required Vertical Clearance	=	*14.5*

TranSystems

Made By *MTN* **Date** *05/17/06* **Job No.** *P403030064*

Checked By *PJP* **Date** *05/17/06* **Sheet No.**

VERTICAL CLEARANCE CALCULATIONS

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

Description *S.R. 823 OVER BLUE RUN-MORRIS LANE* **PID #** *19415*

Alternative 2 - 5-78" Web Plate Girders, Single Span — ***Point Location:*** *A*

Adjstment for Cross Slope

Comment	Grade		Offset	
Profile grade line to critical pt.:	-0.04	x	4	-0.16
		Total Adjustment	=	**-0.16**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.75	0.73
Haunch:	2	0.17
Girder or Beam Depth:	80.5625	6.71
	91.3125	7.61

Total Superstructure Depth (ft) = **7.61**

Vertical Clearance at Critical Point

Station @ Critical Point = **718+89.129**

Offset Location @ Critical Point = **7.00' LEFT**

Profile Grade Elevation at Critical Point = 778.89

Adjustment for Cross Slopes to Beam CL = -0.16

Top of Deck Elevation @ Critical Point = **778.73**

Total Superstructure Depth = -7.61

Bottom of Beam Elevation @ Critical Point = **771.12**

Approximate Top of Existing Ground @ Critical Point = **722.61**

Actual Vertical Clearance = ***48.52***

Preferred Vertical Clearance = *15.0*

Required Vertical Clearance = *14.5*

TranSystems

Made By *MTN* **Date** *05/17/06* **Job No.** *P403030064*
Checked By ____ **Date** ____ **Sheet No.** ____

VERTICAL CLEARANCE CALCULATIONS

Job Name *SCI-823-0.00* **Structure** ____
Description *S.R. 823 OVER BLUE RUN-MORRIS LANE* **PID #** *19415*

Alternative 2 - 5-78" Web Plate Girders, Single Span ***Point Location: B***

Adjstment for Cross Slope

Comment	Grade		Offset		
Shoulder:	-0.016	x	34	=	-0.54
				=	0.00
					0
			Total Adjustment	=	**-0.54**

Superstructure Depth

Comment	Depth (in)	Depth (ft)
Deck Thickness:	8.75	0.73
Haunch:	2	0.17
Girder or Beam Depth:	80.5625	6.71
	91.3125	7.61

Total Superstructure Depth (ft) = **7.61**

Vertical Clearance at Critical Point

Station @ Critical Point = 718+89.34

Offset Location @ Critical Point = 45.00' RIGHT

Profile Grade Elevation at Critical Point = 778.89

Adjustment for Cross Slopes to Beam CL = -0.54

Top of Deck Elevation @ Critical Point = 778.35

Total Superstructure Depth = -7.61

Bottom of Beam Elevation @ Critical Point = 770.74

Approximate Top of Existing Ground @ Critical Point = 725.18

Actual Vertical Clearance = 45.56

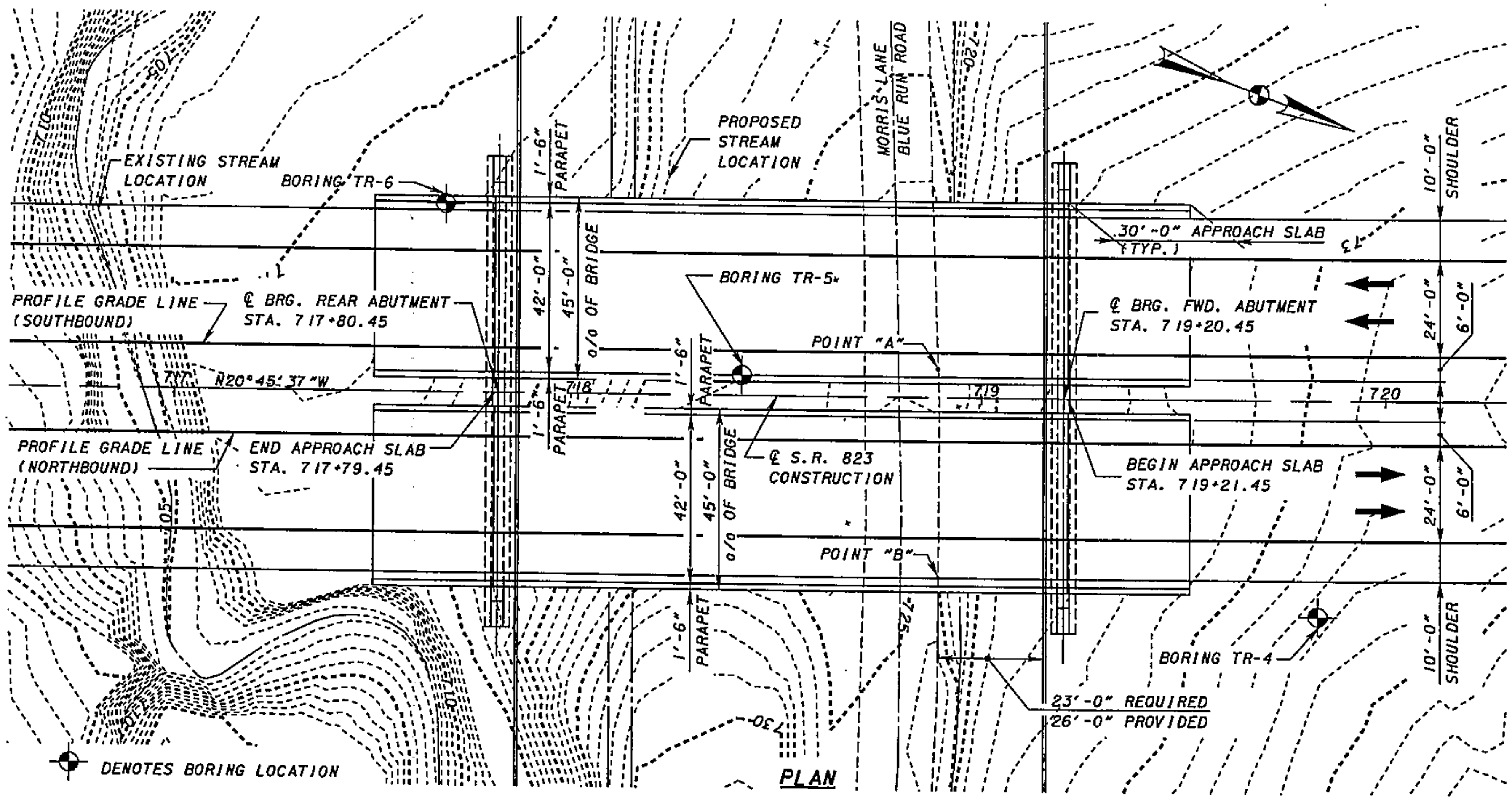
Preferred Vertical Clearance = 15.0

Required Vertical Clearance = 14.5

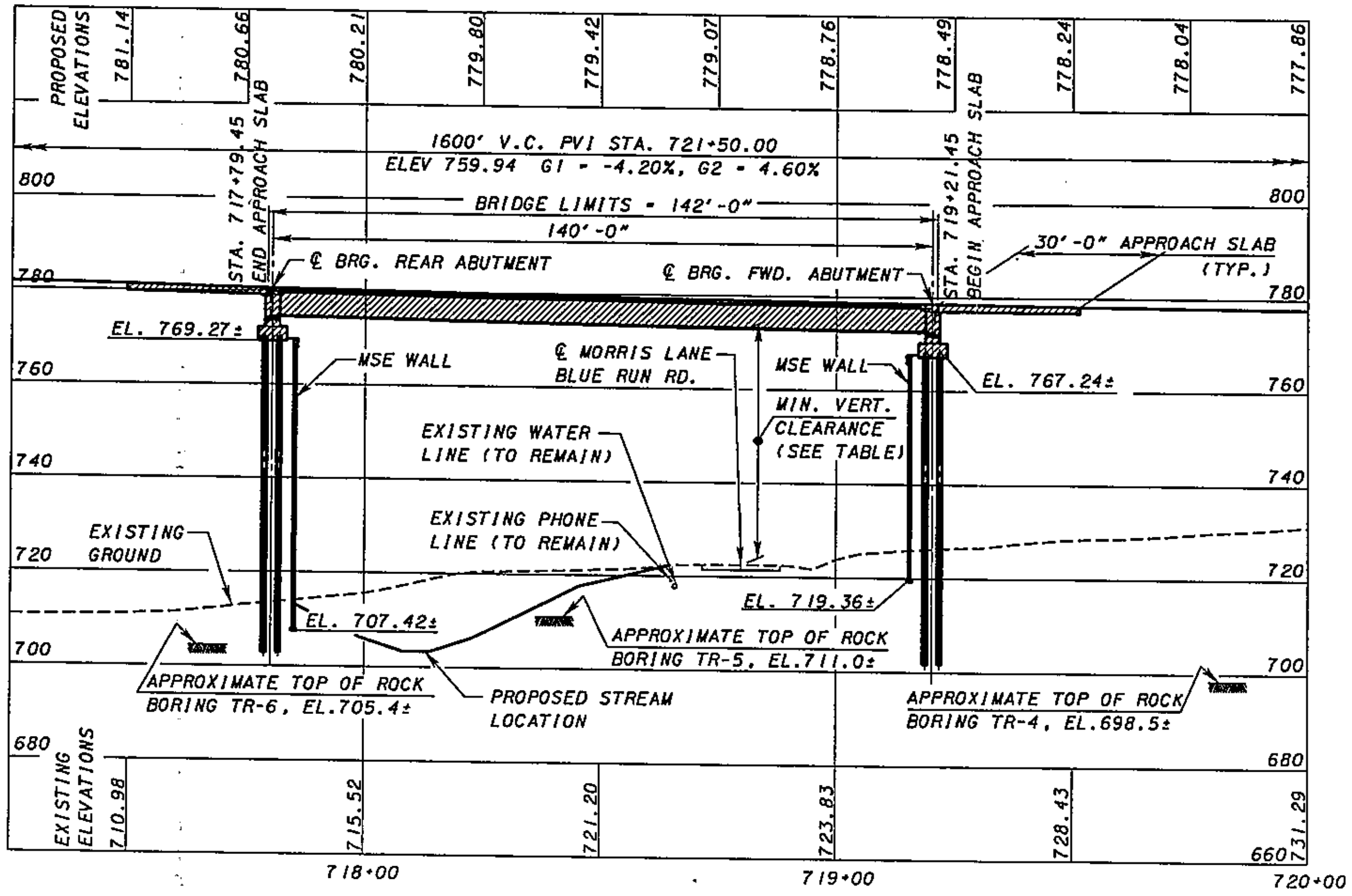
APPENDIX D

Preliminary Structure Site Plan

TranSystems



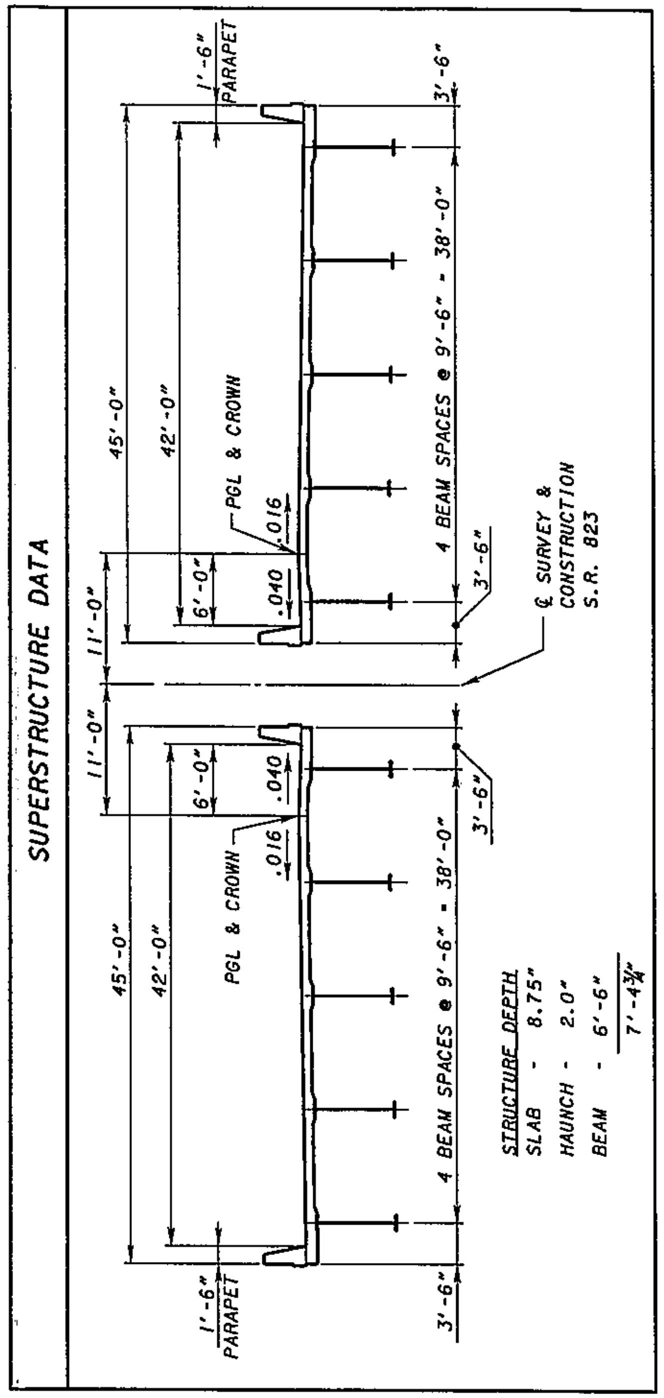
PLAN



ELEVATION ALONG PROFILE GRADE S.R. 823

TABLE OF VERTICAL CLEARANCES

LOCATION	"A"	"B"
PROPOSED	48.52' ±	45.56' ±
PREFERRED	15.0'	15.0'



PROPOSED STRUCTURE

TYPE: SINGLE SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY SEMI-INTEGRAL ABUTMENTS AND MSE WALL SUPPORTED EMBANKMENT.

SPANS: 140'-0" C/C BEARINGS

ROADWAY: 2 - 42'-0" T/T PARAPETS

LOADING: HS-25 & ALTERNATIVE MILITARY LOADING. FWS 60 PSF

SKEW: NONE
CROWN: NORMAL 0.016 FT/FT
ALIGNMENT: TANGENT
WEARING SURFACE: MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (30'-0" LONG)
LATITUDE:
LONGITUDE:

DESIGN AGENCY
TranSystems
720 EAST PETE ROSE WAY, SUITE 340
CINCINNATI, OHIO, 45202

DESIGNED	DRAWN	REVIEWED	DATE
MSL	CAS	JRC	5/18/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	

SCIOTO COUNTY
STA. 717+79.45
STA. 719+21.45

S I T E   P L A N - ALTERNATIVE 2

BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER MORRIS LANE BLUE RUN

SCI-823-0.00
PID19415

APPENDIX E

Preliminary Geotechnical Report
& Preliminary MSE Wall Evaluation

TranSystems®

DLZ

ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

May 5, 2006

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

Re: **Preliminary MSE Wall Evaluations**
823 over Morris Lane Blue Run Road
SCI-823-0.00 Portsmouth Bypass
DLZ Job No.: 0121-3070.03
Document # 0012

Dear Mr. Weeks:

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

It should be noted that the results of these evaluations are based upon the findings of three preliminary structural borings. After the bridge design is finalized, it may be necessary to drill additional borings in the area of the proposed MSE walls in accordance with ODOT's specifications for subsurface investigations in order to finalize the MSE wall evaluations. Boring logs for borings TR-4, TR-5, and TR-6 are attached.

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

old report

At the time this letter was prepared, it was understood that the plan location of the bridge structure for proposed 823 over Morris Lane Blue Run Road is similar to the configuration shown on the plan and profile drawings dated 07/12/05. See attached plan and profile drawing. It is understood that the planned structure is being modified as follows: The existing creek positioned at station 716+94 will be relocated to approximately station 718+56; MSE walls will be placed at approximately stations 718+38 and 719+22 to contain the abutments and hold back the roadway embankment for proposed 823. Furthermore, it is assumed that the maximum height of the MSE wall at station 718+38 (Rear Abutment) will be approximately 63 feet. Similarly the maximum height of the MSE wall station 719+22 (Forward Abutment) will be approximately 55 feet high.

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

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

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

Due to differences in the soil profiles at this location, the analyses of the MSE walls at the forward abutment and rear abutment were evaluated separately for stability. It should be noted, variations may be found in borings drilled for the final design that may change the results of these analyses.

MSE Wall Evaluation at Station 718+38 (Rear Abutment)

In the area of the proposed MSE wall in the rear abutment location, boring TR-5 generally encountered 3 inches of topsoil at the surface. Below the topsoil layer, primarily medium stiff to hard silt and clay (A-6a) was encountered to a depth of 5.5 feet below ground surface. Below 5.5 feet, highly weathered to decomposed brown and gray shale was encountered to a depth of approximately 10.0 feet below ground surface, at the top of competent bedrock. Underlying the soil, this boring encountered soft to medium hard, moderately to highly weathered shale to the bottom of the boring, at a depth of 23.0 feet.

The MSE wall at the rear abutment is assumed to have a maximum height of approximately 63 feet. The recommended minimum embedment depth for this wall is 6.4 feet.

Analyses for the MSE walls bearing on natural soils at this location yielded inadequate factors of safety for undrained bearing capacity and undrained sliding. Consequently, analyses were performed assuming native soils are undercut to the top of weathered bedrock and backfilled with compacted, granular fill. These analyses yielded adequate factors of safety for bearing capacity and stability. Global stability analyses performed also indicated adequate factors of safety. As a result, it is recommended that soils beneath the proposed MSE walls be undercut to the top of weathered bedrock (approximately 5.5 feet), and replaced with compacted granular fill. In areas where compacted granular fill is to be placed on bedrock, a level bench must be cut into the rock to place the fill for stability purposes. As an alternative to the formerly mentioned remedy, the MSE wall at the rear abutment could be built without the undercut using staged construction to maintain a drained condition. Stability analyses have determined that the MSE wall may be built in twenty-foot stages between settlement periods. Using staged construction, it is also recommended that pore water pressures and settlement be monitored during construction to ensure that a drained condition is maintained throughout the construction process.

For stability, preliminary calculations have shown that a minimum reinforcement length of 0.7(H+D) or 52 feet is required for stability.

It should be noted that the foundation leveling pad of the MSE wall at the rear abutment is in close proximity to a creek that will be realigned to approximately station 718+56, which will be running essentially parallel to Morris Lane Blue Run Road. The approximate elevation of bedrock under the MSE wall is 711 feet. If scour and erosion near the TOE of the MSE wall are a concern, then slope protection should be provided with riprap or other appropriate remedies.

Settlement calculations are not necessary for the MSE wall at the rear abutment. The MSE wall will either bear on or near bedrock resulting in negligible settlement.

MSE Wall Evaluation at Station 719+22 (Forward Abutment)

In the area of the proposed MSE wall in the forward abutment location, boring TR-4 generally encountered 3 inches of topsoil at the surface. Below the topsoil layer, primarily medium stiff to stiff silty clay (A-6b) was encountered to a depth of 5.5 feet below ground surface. Below 5.5 feet, medium dense to dense sandy silt (A-4a) was encountered to a depth of approximately 23.0 feet below ground surface. Below 23.0 feet, very stiff silty clay was encountered to a depth of 28.0 feet below ground surface. Below 28.0 feet, highly weathered to decomposed shale was encountered to a depth of

35.0 feet below ground surface, at the top of competent bedrock. Underlying the soil, this boring encountered soft to medium hard, moderately to highly weathered shale to the bottom of the boring, at a depth of 45.0 feet.

The MSE wall at the rear abutment is assumed to have a maximum height of approximately 55 feet. The recommended minimum embedment depth for this wall is 5.5 feet.

Initial analyses for the MSE walls bearing on natural soils at this location yielded inadequate factors of safety for undrained bearing capacity and undrained sliding. Analyses were then performed assuming a five-foot undercut, in addition to the minimum embedment, backfilled with compacted, granular fill. These analyses raised undrained bearing capacity and undrained sliding to acceptable levels. Consequently, it is recommended that an undercut of five feet be performed at this location to facilitate adequate undrained stability. As an alternative to the formerly mentioned remedy, the MSE wall at the forward abutment could be built without the undercut using staged construction to maintain a drained condition. The foundation soils are relatively thin (approximately 12 feet) and too dense to use wick drains to facilitate faster consolidation. Stability analyses have determined that the MSE wall may be built in twenty-foot stages between settlement periods. Using staged construction, it is also recommended that pore water pressures and settlement be monitored during construction to ensure that a drained condition is maintained throughout the construction process.

For stability, preliminary calculations have shown that a minimum reinforcement length of 0.9(H+D) or 55 feet is required for stability.

The total maximum settlement of the MSE wall volume at the forward abutment location was estimated to be approximately 7 inches at the centerline of the wall, assuming that the MSE wall is constructed using the minimum embedment as recommended. Differential settlement at this location was estimated to be less than 1.0%, and is not anticipated to be problematic at this location. MSE retaining walls are able to withstand relatively large amounts of differential settlement, typically up to 100 millimeters per 10 meters of wall length (1/100).

The preliminary analysis indicates that the MSE wall stability at this location is marginal. The final borings may indicate the presence of weaker foundation soils than those encountered in these preliminary borings. Therefore, a small change in soil properties could result in unsatisfactory stability results, thus rendering MSE walls unsuitable for this site.

MSE Wall Alternative

If it is determined that MSE walls will not be used to construct the embankments and contain the abutments, recommendations for spill-through slopes are as follows. Slopes at the rear abutment have been evaluated for stability. It is recommended that slopes of 2:1 or flatter be used to construct the embankments at the rear abutment. Similarly, slopes at the forward abutment have been evaluated for stability. It is recommended that slopes of 3:1 or flatter be used to construct the embankments at the forward abutment.

The following recommendations are taken from our report of Preliminary Structural Foundation Recommendations for SCI-823-0.00 over Morris Lane – Blue Run Road (C.R. 54) dated April 1, 2005. For more information please refer to the original report.

> Based on the subsurface materials encountered in the borings, spread footing foundations appear to be best suited for support of the proposed structure. Competent bedrock was encountered at shallow depths at the pier and rear (south) abutment locations. However, an additional 35 to 55 feet of fill will be placed at the abutment locations, resulting in an estimated depth to bedrock of 60 to 70 feet below the proposed grade at the abutments. Consequently, spread footings at the abutment locations will likely be founded in fill. Spread footings at the pier location will be founded on bedrock.
>
> Spread footings bearing in embankment fill may be designed for an allowable bearing capacity of 3000 psf. If spread footings are used to support the pier, the footings should be embedded into the bedrock. Top of bedrock elevations at the boring locations and allowable bearing capacity on rock are presented in the table below. The depth of the spread footing embedment will need to be designed based upon actual loading conditions.
>
> Driven H-piles could also be used at the forward (north) abutment. If driven H-piles are used at this location, it is recommended that they be driven to the top of bedrock. The full design capacity of the piles may be used for piles bearing on bedrock.
>
> Additionally, drilled shafts to rock or pre-bored H-piles into bedrock can also be used to support the structure. If high lateral or uplift loads are anticipated, drilled shafts or H-piles socketed into bedrock may be needed. The actual rock socket lengths will need to be designed based upon actual loading conditions.
>
> The following table summarizes the site conditions and bearing capacity recommendations for foundations on rock.

Foundation Recommendations

Boring Number	Structural Element	Existing Ground Surface Elevation* (ft)	Top of Rock Elevation* (ft)	Allowable Bearing Capacity
TR-4	Forward (North) Abutment	733.0	698.5	8 TSF
TR-5	Pier	721.0	711.0	10 TSF
TR-6	Rear (South) Abutment	710.4	705.4	12 TSF

*Elevations have been updated based upon as-drilled elevations.

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

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

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

Respectfully submitted,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

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

Encl: As noted

cc: file

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

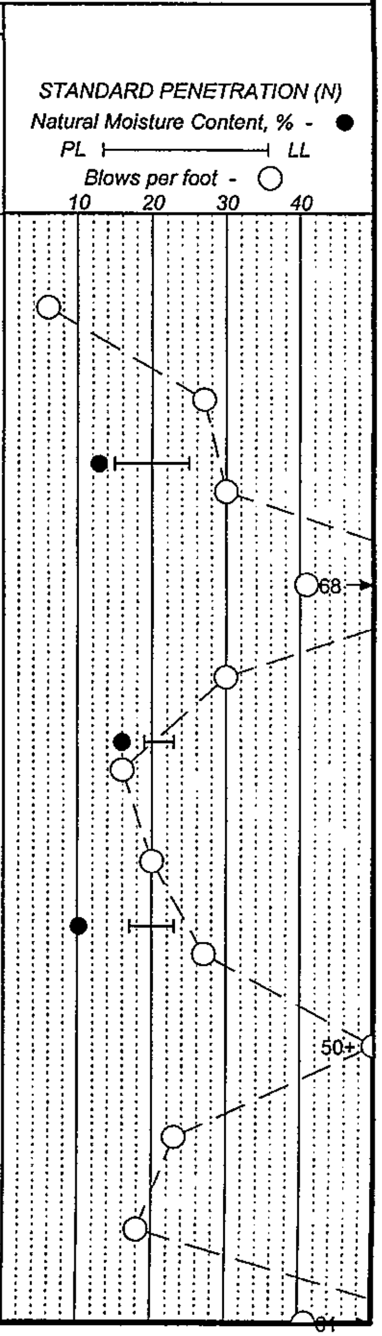
Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-4

Location: SCI-823-0.00 over CR 54 (Forward Abutment)
Date Drilled: 03/16/05

WATER OBSERVATIONS: Water seepage at: 2.5'
Water level at completion: 9.4' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0 0.3	733.0 732.7						Topsoil - 3"						
		1 2 4	18	1		0.75	Medium stiff brown SILTY CLAY (A-6b), trace fine sand; damp.						
3.0	730.0	4 10 17	18	2		1.5	Stiff brown and red SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp.						
5 5.5	727.5	7 13 17	18	3			Dense brown and red SANDY SILT (A-4a), little clay, trace to little gravel; damp.	10	6	–	21	48	15
10		9 35 33	18	4									
		7 13 17	17	5									
13.0 15	720.0	6 7 9	16	6			Medium dense brown and gray SILT (A-4b), little clay, little fine sand, trace coarse sand; damp.	0	5	–	18	60	17
17.0	716.0	12 12 8	18	7A 7B		0.75 4.5+	Hard brown SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; damp.						
18.0 20	715.0	7 12 15	8	8			Medium dense brown SANDY SILT (A-4a), little clay, trace gravel; damp.	4	21	–	23	36	16
		16 25 50/5	16	9			@ 21.5', possible decomposed boulder.						
23.0	710.0	5 11 12	18	10		2.75	Very stiff brown SILTY CLAY (A-6b), little fine to coarse sand; damp.						
25 25.5	707.5	8 9 9	18	11		3.25	Very stiff gray SILTY CLAY (A-6b), trace fine sand; damp.						
28.0 30	705.0	12 28 33	18	12			Severely weathered gray SHALE.						



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

LOG OF: Boring TR-4 | *Location:* SCI-823-0.00 over CR 54 (Forward Abutment) | *Date Drilled:* 03/16/05

WATER OBSERVATIONS: Water seepage at: 2.5'
Water level at completion: 9.4' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) Natural Moisture Content, % - ● PL ├──┤ LL Blows per foot - ○ 10 20 30 40
30	703.0						Severely weathered gray SHALE.							61
		16 37 50/4	16	13										
35.0	698.0						Soft to medium hard gray SHALE; thinly laminated to laminated, moderately to highly weathered, moderately fractured to broken, contains ferric bands. @ 35.8' to 36.1',37.3' to 37.6', decomposed zone. @ 37.6' to 38.0', high angle fracture.							50+
40		Core 120"	Rec 120"	RQD 63%	R-1		@ 39.6', high angle fracture. @ 42.3', thin clay seam.							
45.0	688.0						Bottom of Boring - 45.0'							
50														
55														
60														

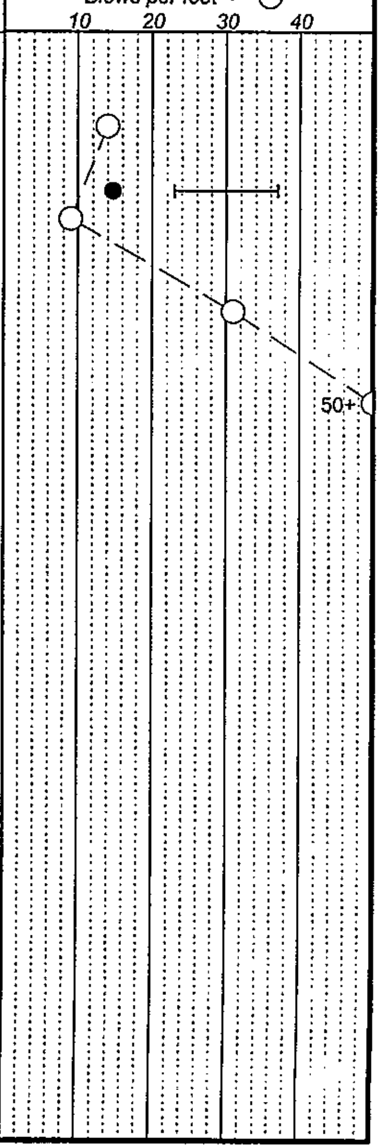
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-5
Location: SCI-823-0.00 over CR 54 (Pier)
Date Drilled: 3/15/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press /Core	Hand Penetrometer (tsf)	WATER OBSERVATIONS: Water seepage at: 2.5'-3.5' Water level at completion: None (prior to coring) 3.2' (includes drilling water) DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0 0.3	721.0 720.7						Topsoil - 3"						
		5 6 8	18	1		4.5+	Hard brown and gray SILT AND CLAY (A-6a), trace fine to coarse sand; damp.						
5		3 5 4	16	2		1.0	@ 3.5', Medium stiff	0	3	--	3	56	38
5.5	715.5	5 11 20	18	3			Severely weathered brown and gray SHALE.						
		20 33 50/1	10	4									
10.0	711.0	Core 36"	Rec 36"	RQD 89%	R-1		Soft brown and gray SHALE; highly weathered to decomposed, broken.						
12.4 15 20	708.6	Core 120"	Rec 120"	RQD 100%	R-2		Soft to medium hard gray SHALE; moderately to highly weathered, arenaceous, thinly laminated to laminated, slightly to moderately fractured. @ 19.8' to 19.9', decomposed.						
23.0 25 30	698.0						Bottom of Boring - 23.0'						

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



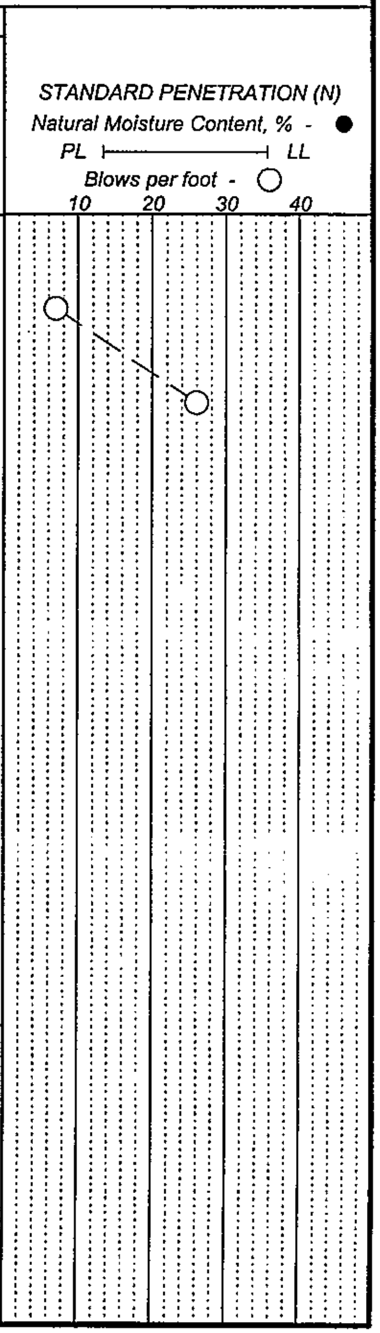
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-6
Location: SCI-823-0.00 over CR 54 (Rear Abutment)
Date Drilled: 03/15/05 to 03/16/05

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

Depth (ft)	*Elev. (ft)*	*Blows per 6"*	*Recovery (in)*	*Sample No.* Drive	*Sample No.* Press / Core	*Hand Penetro-meter (tsf)*	*DESCRIPTION*	*GRADATION* % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.2	710.4 710.2						Topsoil - 2"						
3.0	707.4	1 3 4	18	1			Loose brown SANDY SILT (A-4a), some gravel, trace clay; contains sandstone fragments; damp.						
5.0	705.4	4 8 18	16	2			Hard gray SILTY CLAY (A-6b), trace to little fine sand; dry to damp.						
9.0	701.4	Core 48"	Rec 48"	RQD 54%	R-1		Medium hard brownish gray SANDSTONE; very fine to fine grained, decomposed, slightly fractured.						
19.0	691.4	Core 120"	Rec 120"	RQD 83%	R-2		Medium hard gray SANDSTONE; very fine grained, moderately weathered, argillaceous, micaceous, laminated to thinly bedded, slightly to highly fractured. @ 9.2' to 9.4', 15.4' to 15.9', clay seams @ 11.9', high angle fracture. @ 12.5' to 12.7', decomposed zone.						
							Bottom of Boring - 19.0'						



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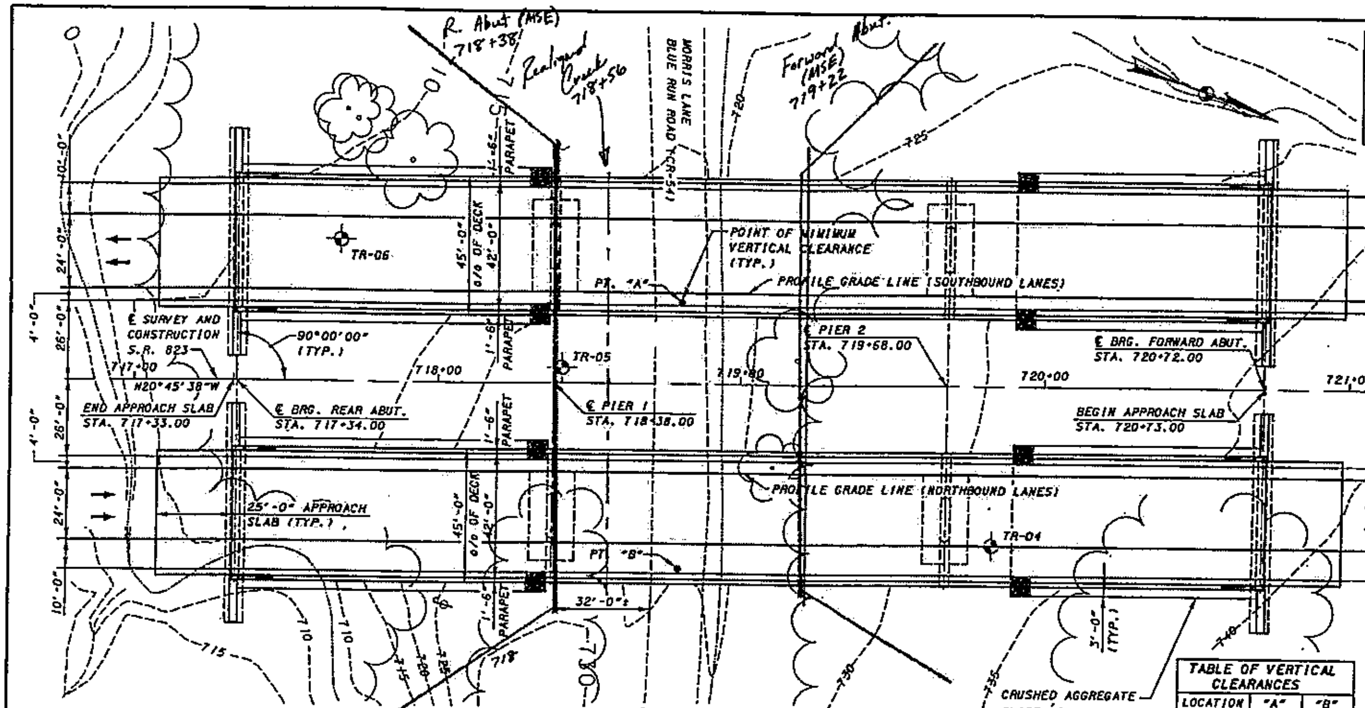
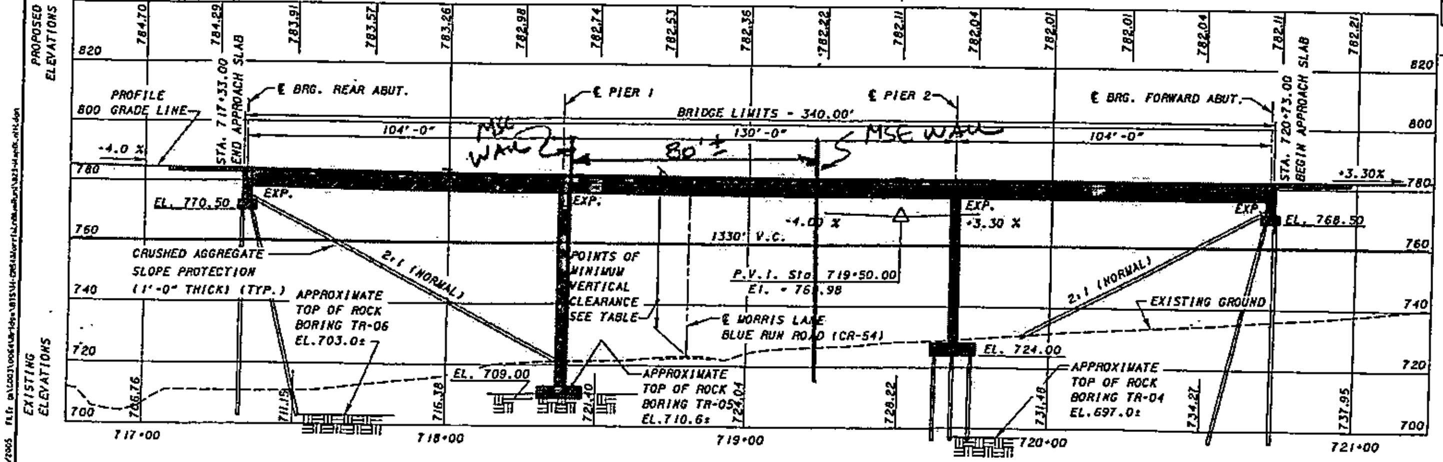
15
20
25
30



PLAN

TABLE OF VERTICAL CLEARANCES		
LOCATION	"A"	"B"
PROPOSED	51.7'±	54.6'±
REQUIRED	15.0'	15.0'

⌖ - DENOTES SOIL BORING LOCATION



ELEVATION ALONG PROFILE GRADE S.R. 823

FIRST GUARDRAIL POST OFF BRIDGE LOCATIONS		
LOCATION	STATION	SIDE
REAR ABUT.	x	RT.
REAR ABUT.	x	LT.
FWD. ABUT.	x	RT.
FWD. ABUT.	x	LT.

BORING LOCATIONS		
BORING No.	STATION	OFFSET
TR-04	719+83.40	53.85' RT.
TR-05	718+40.69	5.03' LT.
TR-06	717+67.14	46.59' LT.

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

TRAFFIC DATA

(SR 823)
CURRENT YEAR ADT (2010) = 19,800
CURRENT YEAR ADTT (2030) = 2,722
DESIGN YEAR ADT (2010) = 26,000
DESIGN YEAR ADTT (2030) = 3,640

PROPOSED STRUCTURE

TYPE: 3-SPAN CONTINUOUS STEEL PLATE GIRDER A709 GRADE 50W WITH COMPOSITE REINFORCED CONCRETE DECK SUPPORTED BY REINFORCED CONCRETE SUBSTRUCTURE UNITS
SPANS: 104'-0", 130'-0", 104'-0" c/c BEARINGS
ROADWAY: 2 - 42'-0" TOE TO TOE OF PARAPETS
LOADING: HS-25 (CASE I) AND ALTERNATE MILITARY LOADING; FWS - 60 PSF
SKEW: NONE
CROWN: NORMAL 0.016 FT./FT.
ALIGNMENT: TANGENT
WEARING SURFACE: 1" MONOLITHIC CONCRETE
APPROACH SLABS: AS-1-81 (25'-0" LONG)
LATITUDE:
LONGITUDE:
STRUCTURE FILE NO.:

NOTES:

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

FOUNDATION DATA:

ALL NEW PILES SHALL BE HP 12x53 PILES AND HAVE A MAXIMUM CAPACITY OF 70 TONS PER PILE.

UTILITIES:

UTILITIES DISPOSITION WILL BE ADDRESSED IN THE TS&L SUBMITTAL.

DESIGN AGENCY
TRANSYSTEMS CORPORATION

DESIGNED	DRAWN	REVIEWED	DATE
BTA	RCK	NFF	7/12/05
CHECKED	REVISED	STRUCTURE FILE NUMBER	
RER			

SCIOTO COUNTY
STA. 717+33.00
STA. 720+73.00

PRELIMINARY SITE PLAN - ALTERNATIVE 1
BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER MORRIS LANE BLUE RUN ROAD

SCI-823-0.00
PID 19415

1/2

Soil Parameters Used in MSE Wall Stability Analyses
Morris Lane Blue Run Road

Zone	Soil Type	Unit Weight (pcf)	Strength Parameters			
			Undrained		Drained	
			c	ϕ	c'	ϕ'
Reinforced Fill	Compacted Granular Fill	120	0	34	0	34
Retained Soil	Compacted Embankment Fill	120	0	30	0	30
Foundation Soil (Rear Abutment) (Borings TR-5)	Medium Stiff to hard Silt and Clay	125	1000	0	0	29
Foundation Soil (Rear Abutment)	Compacted Granular Fill	125	0	36	0	36
Foundation Soil (Forward Abutment) (Borings TR-4)	Medium Stiff to stiff Silt and Clay	125	2000	0	0	29
Foundation Soil (Forward Abutment)	Compacted Granular Fill	125	0	36	0	36

MSE Retaining Wall Parameters and Analyses Results
Morris Lane Blue Run Road (Rear Abutment)
Natural Soil Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{\circ}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 29°(0.67) = 0.37
Use (μ)(0.67) =0.35 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = **2,204 psf**
For MSE wall with minimum 52.5-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 11,735 psf
For MSE wall with minimum 52.5-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 1.5
Factor of Safety – Drained Condition = 2.0
Factor of Safety – Seismic Condition = 1.8
For MSE wall with 52.5-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 0 inches

Full Height of MSE Wall = 63.8 feet
Minimum Embedment Depth = 6.4 feet
Minimum Length of Reinforcement for External Stability = 52.5 feet

MSE Retaining Wall Parameters and Analyses Results
Morris Lane Blue Run Road (Rear Abutment)
Granular Fill Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{\circ}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 36°(0.67) = 0.49
Use (μ)(0.67) =0.55 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 29,892 psf
For MSE wall with minimum 52.5-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 29,892 psf
For MSE wall with minimum 52.5-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 1.5
Factor of Safety – Drained Condition = 2.0
Factor of Safety – Seismic Condition = 1.8
For MSE wall with 52.5-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 0 inches

Full Height of MSE Wall = 63.8 feet
Minimum Embedment Depth = 6.4 feet
Minimum Length of Reinforcement for External Stability = 52.5 feet

MSE Retaining Wall Parameters and Analyses Results
Morris Lane Blue Run Road (Forward Abutment)
Natural Soil Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{\circ}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 29°(0.67) = 0.37
Use (μ)(0.67) =0.35 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 4,239 psf
For MSE wall with minimum 55-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 12,550 psf
For MSE wall with minimum 55-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 1.5
Factor of Safety – Drained Condition = 1.7
Factor of Safety – Seismic Condition = 1.6
For MSE wall with 55-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 7 inches
Differential Settlement = .003 < 1/100

Full Height of MSE Wall = 55.5 feet
Minimum Embedment Depth = 5.5 feet
Minimum Length of Reinforcement for External Stability = 55 feet

MSE Retaining Wall Parameters and Analyses Results
Morris Lane Blue Run Road (Forward Abutment)
Granular Fill Foundation

Retained Soil (New Embankment)
Unit Weight = 120 pcf
Coefficient of Active Earth Pressure (K_a) = 0.33
(Based on $\Phi = 30^{\circ}$)

Sliding along base of MSE wall
Sliding Coefficient (μ)(0.67) = tan 36º(0.67) = 0.49
Use (μ)(0.67) =0.55 as a maximum value as per AASHTO, BDM,303.4.1.1

Allowable Bearing Capacity – Undrained Condition
q_{all} = 35,259 psf
For MSE wall with minimum 55-foot long reinforcing

Allowable Bearing Capacity – Drained Condition
q_{all} = 35,259 psf
For MSE wall with minimum 55-foot long reinforcing

Global Stability
Factor of Safety – Undrained Condition = 1.5
Factor of Safety – Drained Condition = 1.7
Factor of Safety – Seismic Condition = 1.6
For MSE wall with 55-foot long reinforcing

Estimated Settlement of MSE volume
Total settlement = 7 inches
Differential Settlement = .003 < 1/100

Full Height of MSE Wall = 55.5 feet
Minimum Embedment Depth = 5.5 feet
Minimum Length of Reinforcement for External Stability = 55 feet

DLZ

SUBJECT

Client TranSystems ODOT D-9

Project SCI 823-0.00 Portsmouth Bypass

Item MSE Wall Stability

01 - 823 over Morris Lane Blue Run Rd

Based on TR-5 Rear Abut.

JOB NUMBER 0121-3070.03

SHEET NO. OF

COMP. BY SJR DATE 05/03/06

CHECKED BY DATE

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=63.8'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

Wall Properties

$H+D$ = 70.2 feet

γ_{mse} = 120 pcf

L = 52.65 feet

L factor = 0.75 Length factor-range (0.7 - 1.0)

ϕ = 30 deg Friction Angle of Embankment Fill

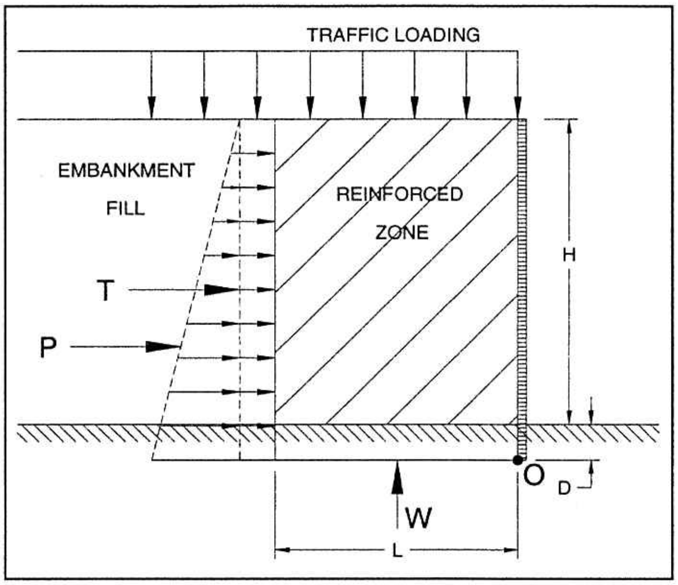
Foundational Soil Properties

c = 1000 psf Cohesion

ϕ' = 29 deg Friction angle

ω_T = 240 psf Traffic loading

RESISTANCE AGAINST SLIDING ALONG BASE



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

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

P_a = 103,135 lbs per foot of wall

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

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

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

P_r = 155,233 lbs per foot of wall

Use Undrained Value

$P_r = L(c)$ (Undrained)

P_r = 52,650 lbs per foot of wall

USE THIS VALUE

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

Calculated FS = **0.51**

Required FS = 1.50

Resistance Against Sliding is **No Good**

FS = 1.50 (Drained)

RESISTANCE AGAINST OVERTURNING

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

$\Sigma M_{resisting}$ = 11,675,759 lb-ft

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

$\Sigma M_{overturning}$ = 2,478,410 lb-ft

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

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturnin\ g}}$$

Calculated FS = **4.71**

Required FS = 2.00

Resistance Against Overturning is **OK**

DLZ

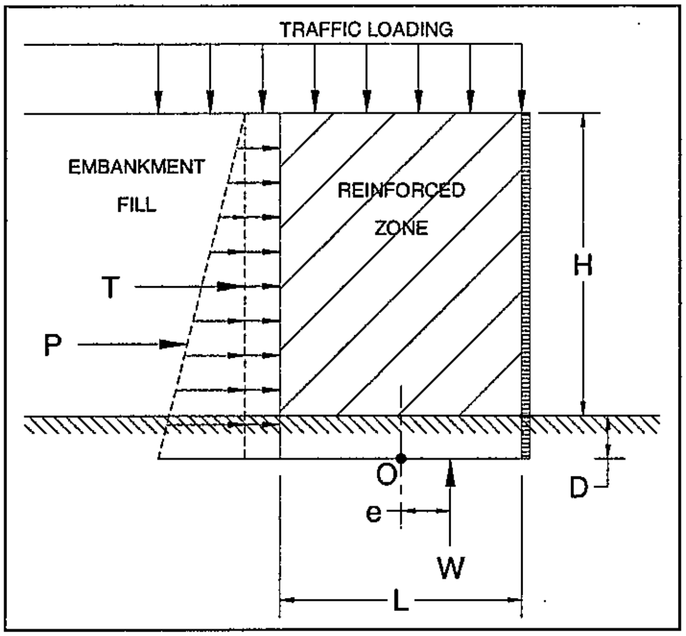
SUBJECT

Client TranSystems
Project SCI 823-0.00
Item Bearing Capacity
Based on Boring TR-5

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 5/3/06
CHECKED BY DATE

BEARING CAPACITY OF A MSE WALL

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



Effective Bearing Pressure

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

σ_v = 10,916 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 5,509 psf

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

q_{ALL} = 2,204 psf

Factor of Safety = **0.50** **No Good**

Ultimate drained bearing capacity, q_{ult}

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

q_{ULT} = 29,337 psf

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

q_{ALL} = 11,735 psf

Factor of Safety = **2.69** **OK**

Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	1000	psf	Cohesion	Foundation soil
ϕ	=	0	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	52.65	ft	Length of MSE reinforcement
L factor	=	0.75		Length factor-range (0.7 - 1.0)
D	=	6.4	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	70.2	ft	
H	=	63.8	ft	Height of wall
Ka	=	0.33		
⌈ Pa	=	23.4	ft	Moment arm
⌈ Wt	=	35.1	ft	Moment arm
B'	=	41.79	ft	
γ'	=	57.6	pcf	
W_t		12,636	lb/ft of wall	Weight from traffic
W_{mse}	=	443,524	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

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

Eccentricity of Resultant Force

e = 5.43 ft

Kern

e < L/6 = 8.78 ft

DLZ

SUBJECT			
Client	TranSystems ODOT D-9	JOB NUMBER	0121-3070.03
Project	SCI 823-0.00 Portsmouth Bypass	SHEET NO.	OF
Item	MSE Wall Stability	COMP. BY SJR	DATE 05/03/06
01 - 823 over Morris Lane Blue Run Rd		CHECKED BY	DATE
Based on TR-5	Granular Fill		

Rear Abutment

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=63.8'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

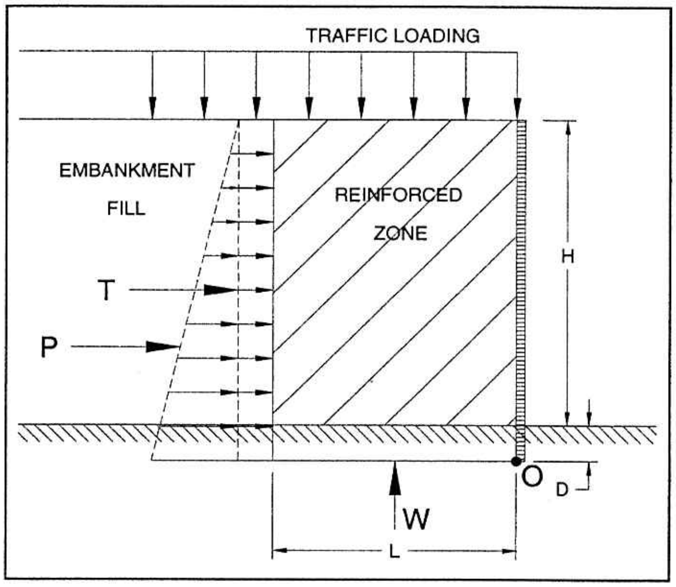
Wall Properties

$H+D$ = 70.2 feet
γ_{mse} = 120 pcf
L = 49.14 feet
L factor = 0.70
ϕ = 30 deg

Foundational Soil Properties

c = 0 psf Cohesion
ϕ' = 36 deg Friction angle
ω_T = 240 psf Traffic loading
Length factor-range (0.7 - 1.0)
Friction Angle of Embankment Fill

RESISTANCE AGAINST SLIDING ALONG BASE



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

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

P_a = 103,135 lbs per foot of wall

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

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

0.67μ Max. = 0.55 {AASHTO, Bridge Design Manual, 303.4.1.1}

P_r = 202,838 lbs per foot of wall

USE THIS VALUE

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

P_r = 0 lbs per foot of wall

Use Drained Value

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

Calculated FS = **1.97**   Required FS = 1.50

Resistance Against Sliding is **OK**

RESISTANCE AGAINST OVERTURNING

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

$\Sigma M_{resisting}$ = 10,170,883 lb-ft

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

$\Sigma M_{overturning}$ = 2,478,410 lb-ft

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

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturmin\ g}}$$

Calculated FS = **4.10**   Required FS = 2.00

Resistance Against Overturning is **OK**

DLZ

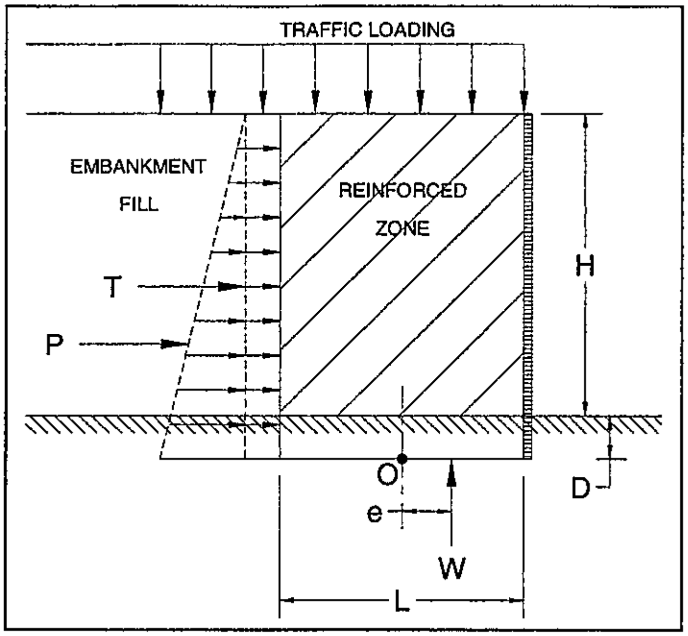
SUBJECT

Client TranSystems
Project SCI 823-0.00
Item Bearing Capacity
Based on Boring TR-5
Granular Fill

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 5/3/06
CHECKED BY DATE

BEARING CAPACITY OF A MSE WALL

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



Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	0	psf	Cohesion	Foundation soil
ϕ	=	36	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	36	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	49.14	ft	Length of MSE reinforcement
L factor	=	0.7		Length factor-range (0.7 - 1.0)
D	=	6.4	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	70.2	ft	
H	=	63.8	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	23.4	ft	Moment arm
Γ Wt	=	35.1	ft	Moment arm
B'	=	37.50	ft	
γ'	=	57.6	pcf	
W_t		11,794	lb/ft of wall	Weight from traffic
W_{mse}	=	413,955	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

Undrained		Drained	
N_c	50.59	N_c	50.59
N_q	37.75	N_q	37.75
N_γ	56.31	N_γ	56.31

Eccentricity of Resultant Force

e = 5.82 ft

Kern

e < L/6 = 8.19 ft

Effective Bearing Pressure

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

σ_v = 11,353 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 74,731 psf

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

q_{ALL} = 29,892 psf

Factor of Safety = **6.58** OK

Ultimate drained bearing capacity, q_{ult}

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

q_{ULT} = 74,731 psf

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

q_{ALL} = 29,892 psf

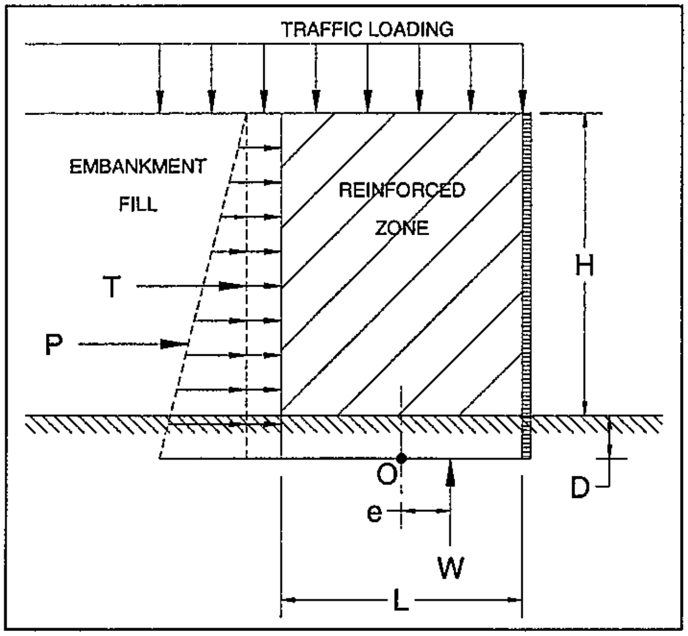
Factor of Safety = **6.58** OK

DLZ SUBJECT

Client	TranSystems	JOB NUMBER	0121-3070.03
Project	SCI 823-0.00	SHEET NO.	OF
Item	Bearing Capacity	COMP. BY	SJR DATE 5/3/06
Based on Boring TR-4	Forward Abut.	CHECKED BY	DATE

BEARING CAPACITY OF A MSE WALL

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



Effective Bearing Pressure

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

σ_v = 8,834 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 10,597 psf

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

q_{ALL} = 4,239 psf

Factor of Safety = **1.20** **No Good**

Ultimate drained bearing capacity, q_{ult}

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

q_{ULT} = 31,376 psf

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

q_{ALL} = 12,550 psf

Factor of Safety = **3.55** **OK**

Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	2000	psf	Cohesion	Foundation soil
ϕ	=	0	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	29	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	54.9	ft	Length of MSE reinforcement
L factor	=	0.9		Length factor-range (0.7 - 1.0)
D	=	5.5	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	61	ft	
H	=	55.5	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	20.333	ft	Moment arm
Γ Wt	=	30.5	ft	Moment arm
B'	=	46.98	ft	
γ'	=	57.6	pcf	
W_t		13,176	lb/ft of wall	Weight from traffic
W_{mse}	=	401,868	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

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

Eccentricity of Resultant Force

e = 3.96 ft

Kern

e < L/6 = 9.15 ft

DLZ

SUBJECT
Client TranSystems ODOT D-9
Project SCI 823-0.00 Portsmouth Bypass
Item MSE Wall Stability
01 - 823 over Morris Lane Blue Run Rd
Based on TR-4

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 05/03/06
CHECKED BY DATE

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=55.5'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

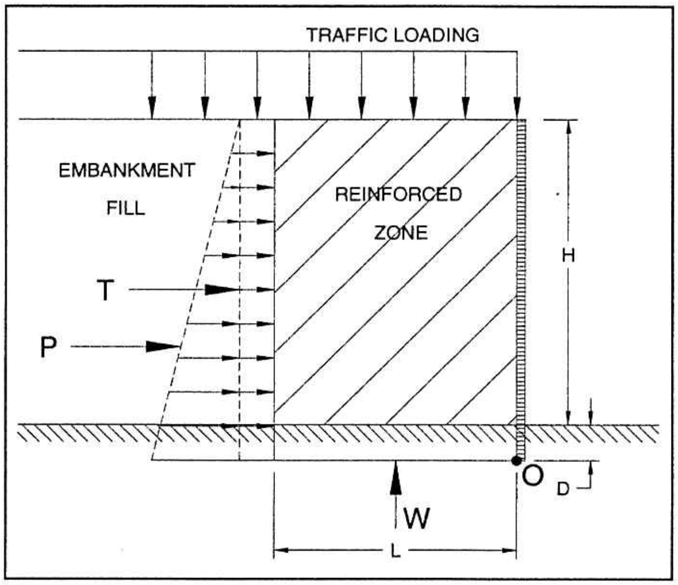
Wall Properties

H+D = 61 feet
γ_{mse} = 120 pcf
L = 54.9 feet
L factor = 0.90
ϕ = 30 deg

Foundational Soil Properties

c = 2000 psf Cohesion
ϕ' = 29 deg Friction angle
ω_T = 240 psf Traffic loading
Length factor-range (0.7 - 1.0)
Friction Angle of Embankment Fill

RESISTANCE AGAINST SLIDING ALONG BASE



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

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

P_a = 78,507 lbs per foot of wall

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

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

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

P_r = 140,654 lbs per foot of wall

Use Undrained Value

$P_r = L(c)$ (Undrained)

P_r = 109,800 lbs per foot of wall

USE THIS VALUE

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

Calculated FS = **1.40**

Required FS = 1.50

Resistance Against Sliding is **No Good**

RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).

* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 11,031,277 lb-ft

$\Sigma M_{overturning}$ = 1,645,426 lb-ft

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

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

$$FS = \frac{\Sigma M_{resisting}}{\Sigma M_{overturnin\ g}}$$

Calculated FS = **6.70**

Required FS = 2.00

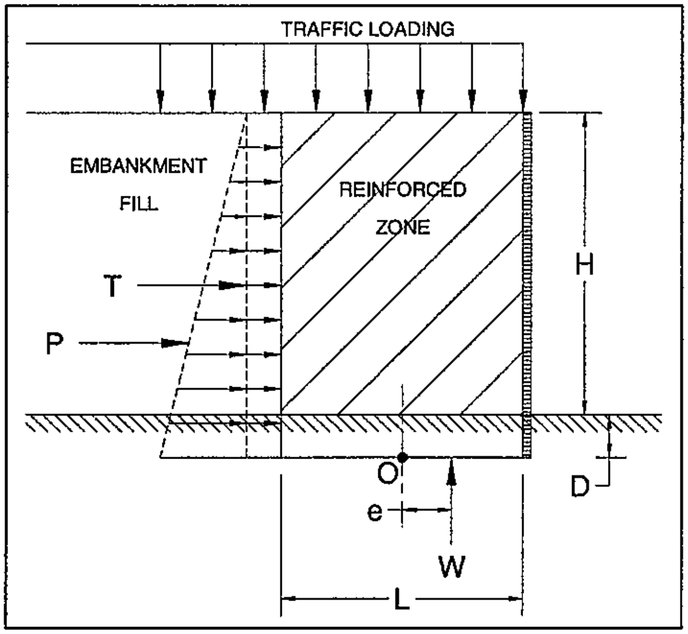
Resistance Against Overturning is **OK**

DLZ

SUBJECT			
Client	TranSystems	JOB NUMBER	0121-3070.03
Project	SCI 823-0.00	SHEET NO.	OF
Item	Bearing Capacity	COMP. BY	SJR DATE 5/3/06
Based on Boring TR-4	Forward Abut.	CHECKED BY	DATE
Granular Fill			

BEARING CAPACITY OF A MSE WALL

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



Effective Bearing Pressure

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

σ_v = 8,834 psf

Ultimate undrained bearing capacity, q_{ult}

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

q_{ULT} = 88,148 psf

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

q_{ALL} = 35,259 psf

Factor of Safety = **9.98** **OK**

Ultimate drained bearing capacity, q_{ult}

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

q_{ULT} = 88,148 psf

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

q_{ALL} = 35,259 psf

Factor of Safety = **9.98** **OK**

Soil Properties

γ_{EMB}	=	120	pcf	Unit weight	Embankment fill
ϕ'_{EMB}	=	30	deg.	Friction ang.	Embankment fill
γ_{FDN}	=	120	pcf	Unit weight	Foundation soil
c	=	0	psf	Cohesion	Foundation soil
ϕ	=	36	deg.	Friction ang.	Foundation soil
c'	=	0	psf	Cohesion	Foundation soil
ϕ'	=	36	deg.	Friction ang.	Foundation soil

Loads and Parameters

ω_t	=	240	psf	Traffic loading
L=B	=	54.9	ft	Length of MSE reinforcement
L factor	=	0.9		Length factor-range (0.7 - 1.0)
D	=	5.5	ft	Embedment depth
Dw	=	0	ft	Groundwater depth
H+D	=	61	ft	
H	=	55.5	ft	Height of wall
Ka	=	0.33		
Γ Pa	=	20.333	ft	Moment arm
Γ Wt	=	30.5	ft	Moment arm
B'	=	46.98	ft	
γ'	=	57.6	pcf	
W_t		13,176	lb/ft of wall	Weight from traffic
W_{mse}	=	401,868	lb/ft of wall	Weight from MSE wall

Bearing Capacity Factors for Equations

Undrained		Drained	
N_c	50.59	N_c	50.59
N_q	37.75	N_q	37.75
N_γ	56.31	N_γ	56.31

Eccentricity of Resultant Force

e = 3.96 ft

Kern

e < L/6 = 9.15 ft

DLZ

SUBJECT
Client TranSystems ODOT D-9
Project SCI 823-0.00 Portsmouth Bypass
Item MSE Wall Stability
01 - 823 over Morris Lane Blue Run Rd
Based on TR-4 Granular Fill

JOB NUMBER 0121-3070.03
SHEET NO. OF
COMP. BY SJR DATE 05/03/06
CHECKED BY DATE

STABILITY OF MSE WALL

Assumptions:

1 Estimated height of embankment; H=55.5'
2 It is assumed that the bridge is supported on piles
3 Ground water; Dw=0.0'
4 Traffic loading is neglacted in resisting forces
5

Wall Properties

$H+D$ = 61 feet
γ_{mse} = 120 pcf
L = 54.9 feet
L factor = 0.90
ϕ = 30 deg

Foundational Soil Properties

c	=	0	psf	Cohesion
ϕ'	=	36	deg	Friction angle
ω_T	=	240	psf	Traffic loading

Length factor-range (0.7 - 1.0)

Friction Angle of Embankment Fill

RESISTANCE AGAINST SLIDING ALONG BASE

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

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

P_a = 78,507 lbs per foot of wall

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

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

0.67μ Max. = 0.55 {AASHTO, Bridge Design Manual, 303.4.1.1}

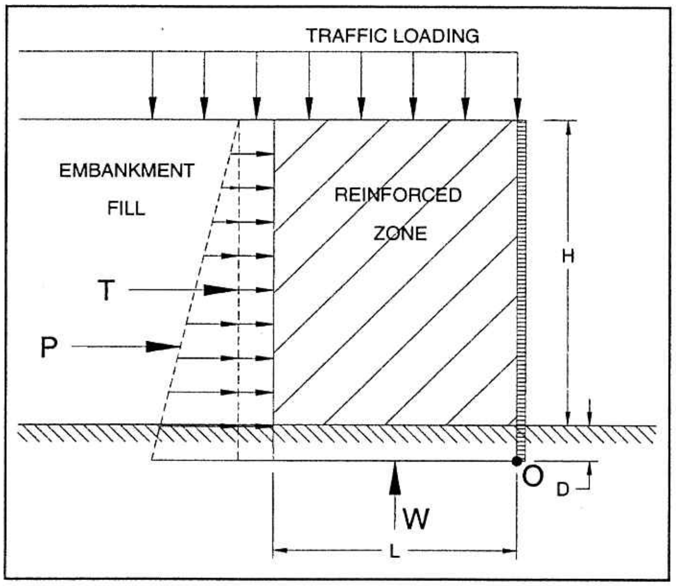
P_r = 196,915 lbs per foot of wall

USE THIS VALUE

$P_r = L(c)$ (Undrained)

P_r = 0 lbs per foot of wall

Use Drained Value



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

	Calculated	Required
	FS = **2.51**	FS = 1.50

Resistance Against Sliding is **OK**

RESISTANCE AGAINST OVERTURNING

* Summation of Moments about point "O" (base of wall).

* Traffic loading is neglected in resisting forces

$\Sigma M_{resisting}$ = 11,031,277 lb-ft

$\Sigma M_{overturning}$ = 1,645,426 lb-ft

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

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

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

	Calculated	Required
	FS = **6.70**	FS = 2.00

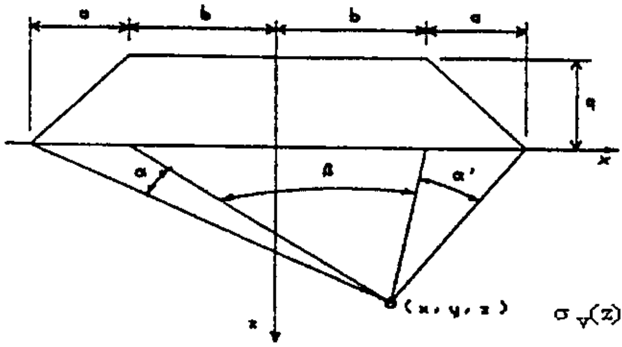
Resistance Against Overturning is **OK**

Client TranSystems / ODOT D-9
Project SCI-823 Portsmount Bypass
Item MSE wall Settlement
01-Morris Lane Blue Run Road

JOB NUMBER
SHEET NO. OF
COMP. BY SJR DATE 05/04/06
CHECKED BY DATE

SETTLEMENT ANALYSIS - EMBANKMENT

Embankment Informaiton:



Groundwater Table:	D=	5.0	ft				
Embankment Height:	H =	55.5	ft				
Fill Unit Weight:	γ_{emb} =	120	pcf		q =	6,660	psf
Width of Slope:	a =	111					
Top half-width of Emb:	b =	75					
Distance from CL:	x =	0					
Output Range:	z =	0	to	23	ft		

**See Data output Attached*

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

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

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

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

								Cohesionless Soils	Cohesive Soils		
No.	Bot. of Laye		Soil Type	γ_{soil} (pcf)	σ'_c (psf)	σ'_o (psf)	$\Delta\sigma z$ (psf)	σ'_f (psf)	C'	C_r	C_c	e_o
1	5.0	ft	Granular Fill	130	0	325	6,660	6,985	0.0	0.00	0.00	0.000
2	7.5	ft	Sandy Silt	125	4,000	728	6,660	7,388	0.0	0.01	0.13	0.360
3	17.5	ft	Sandy Silt	125	4,000	1,120	6,656	7,776	0.0	0.02	0.16	0.440
4	22.5	ft	Silty Clay	125	4,000	1,589	6,646	8,235	0.0	0.01	0.10	0.275
5	0.0			0	0							
6	0.0			0	0							
7	0.0			0	0							
8	0.0			0	0							
9	0.0			0	0							
10	0.0			0	0							

No.	Settlement:		Total Settlement
1	0.000	ft	
2	0.081	ft	0.602 ft
3	0.382	ft	
4	0.139	ft	
5			7.2 in
6			
7			
8			
9			
10			

Reference: Geotechnical Engineering Principles and Practices; Coduto, 1999

Overconsolidated Soils - Case I ($\sigma'_0<\sigma'_c$) Eqn:11.24

$$(\delta_c)_{ult} = \Sigma\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Overconsolidated Soils - Case II ($\sigma'_0<\sigma'_c<\sigma_f$) Eqn:11.25

$$(\delta_c)_{ult} = \Sigma\left[\frac{C_r}{1+e_0}H\log\left(\frac{\sigma'_c}{\sigma'_0}\right)+\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_c}\right)\right]$$

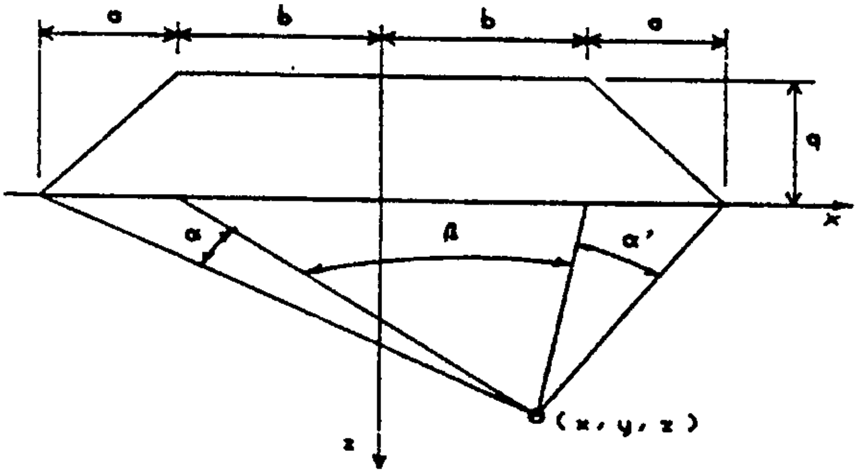
Normally Consolidated Soils ($\sigma'_0=\sigma'_c$) Eqn: 11.23

$$(\delta_c)_{ult} = \Sigma\frac{C_c}{1+e_0}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

Cohesionless Soils ($\sigma'_0=\sigma'_c$)

$$(\delta_c)_{ult} = \Sigma\frac{1}{C'}H\log\left(\frac{\sigma'_f}{\sigma'_0}\right)$$

INCREASE IN VERTICAL STRESS DUE TO EMBANKMENT LOADING



q = 6660 load

a = 111 width of slope

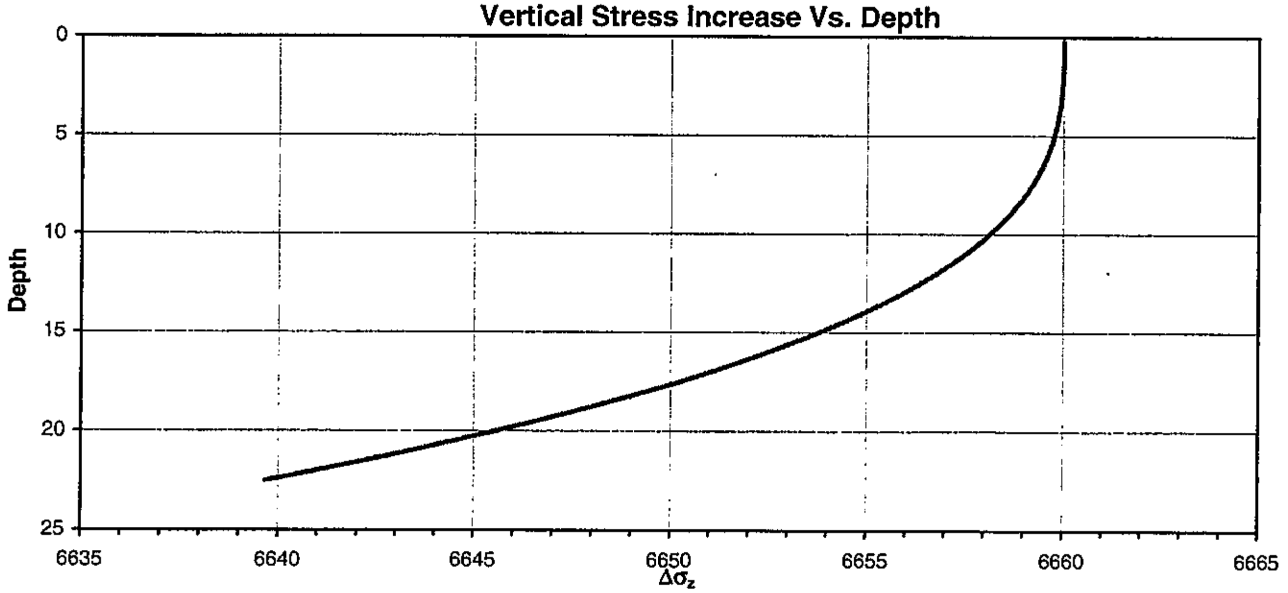
b = 75 top half-width of embankment

x = 0 distance from CL

z = 0 to 23 depth range

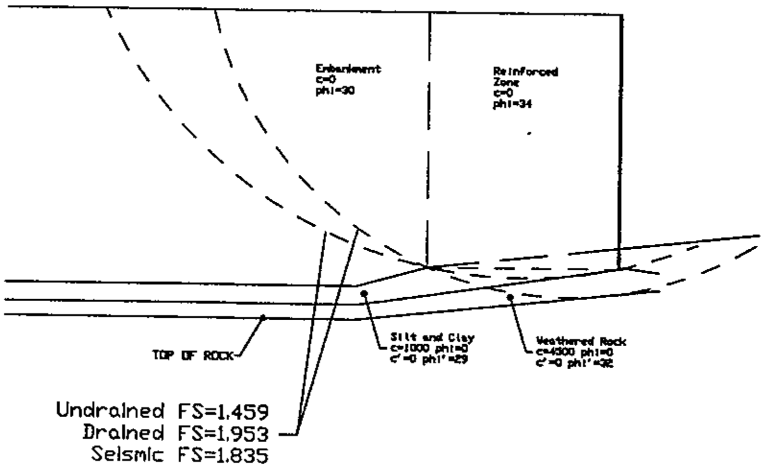
$$\sigma_v(z) := \left(\frac{q}{\pi\, a}\right)\left(a\cdot(\alpha(z)+\beta(z)+\alpha'(z))+b\cdot(\alpha(z)+\alpha'(z))+x\cdot(\alpha(z)-\alpha'(z))\right)$$

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

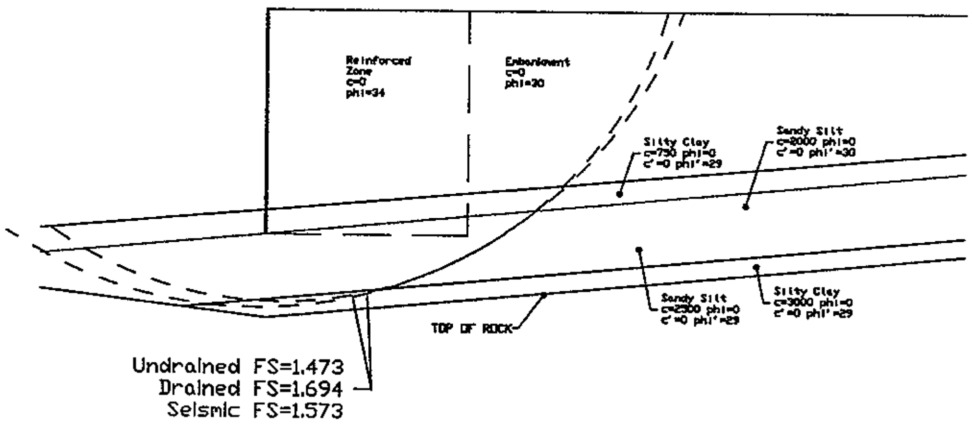


Reference: US Army Corps of Engineers EM 1110-1-1904 "Settlement Analysis", Table C-1

MSE Wall Stability
Morris Lane Blue Run Road
Forward Abutment Sta. 718+38
Based on TR-5
H=63.8' (full height)
Min. Embedment=6.4' or bedrock
Length=0.7(H+D)=52'



MSE Wall Stability
Morris Lane Blue Run Road
Forward Abutment Sta. 719+22
Based on TR-4
H=55.5' (full height)
Embedment=5.5'
Length=0.9(H+D)=54.9'



MORRIS LANE BLUE RUN ROAD
REAR ABUTMENT STA: 718+38
FORWARD ABUTMENT STA: 719+22

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

PROJECT NO. 0121-3070.03 | CALC: SJR | DATE 05-03-06

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DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

April 1, 2005

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

Re: **SCI-823-0.00 over Morris Lane – Blue Run Road (C.R. 54)**
Preliminary Structural Foundation Recommendations
Project SCI-823-0.00
DLZ Job No.: 0121-3070.03

Dear Mr. Parsons:

This letter reports the findings of the subsurface exploration and preliminary foundation recommendations for the proposed structure SCI-823-0.00 over Morris Lane – Blue Run Road (C.R. 54). It is anticipated that the proposed structure will be a two-span, elevated bridge. The existing grade at the proposed new bridge location is between approximate elevations 713 and 733 feet. It is anticipated that the SCI-823-0.00 mainline will be located in fill sections on either side of the proposed bridge. Approximately 55 feet and 35 feet of new fill are anticipated at the rear (south) and forward (north) abutments, respectively. It is anticipated that the center pier will be approximately 50 feet in height.

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

Field Exploration

A total of three borings, TR-4, TR-5, and TR-6, were drilled at the proposed structure on March 15 and 16, 2005. The borings were drilled to depths ranging from 19 to 45 feet. The borings were extended into bedrock, which was verified by rock coring. Boring logs and information concerning the drilling procedures are attached.

The boring locations were selected by TranSystems Corporation. Borings TR-4, TR-5, and TR-6 are located approximately at Stations 725+50, 724+00, and 723+00, respectively. Ground surface elevations at the boring locations and the boring locations were estimated from the established topographic mapping for the project and are presented on the attached Boring Logs.

Findings

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

Topsoil was encountered at the ground surface to depths of 2 to 3 inches. Boring TR-6 encountered a loose sandy silt (A-4a) beneath the topsoil to a depth of 3.0 feet. Beneath the sandy silt and the topsoil, medium stiff to hard silt and clay (A-6a) and silty clay (A-6b) soils were encountered to depths ranging from 5.0 to 5.5 feet. Below these depths, Borings TR-5 and TR-6 encountered bedrock. However, Boring TR-4 encountered a dense gravel with sand and silt (A-2-4) between depths of 5.5 and 13.0 feet which was overlying medium dense sandy silt (A-4a) and medium stiff silt (A-4b) to a depth of 17.0 feet. Thereafter, Boring TR-4 encountered one foot of hard silt and clay (A-6a) overlying five feet of medium dense sandy silt (A-4a) to a depth of 23.0 feet. As noted on the boring log, a possible boulder was encountered in the sandy silt layer at a depth of 21.5 feet. The remainder of the soil overburden in Boring TR-4 was very stiff silty clay (A-6b) to a depth of 28.0 feet, below which weathered bedrock was encountered.

Beneath the soil overburden, Borings TR-4 and TR-5 encountered very soft to soft highly weathered to decomposed shale bedrock at depths of 28.0 feet and 5.5 feet, respectively. Beneath the decomposed shale and below a depth of 5.0 feet in Boring TR-6, more competent bedrock was encountered and was confirmed by coring. Boring TR-6 first encountered a medium hard slightly weathered siltstone beneath the overburden. Beneath the siltstone and softer shales, all of the borings encountered and terminated in soft to hard shale bedrock. The shale encountered in Boring TR-4, however, was highly weathered and fractured. One hundred percent recovery of the core samples was obtained in all three borings and the RQD values ranged from 54% to 100%, with an average RQD of 78%.

Water seepage was detected at a depth of 2.5 feet in Boring TR-4 prior to coring operations. At the completion of drilling, water levels in the borings ranged from 9.4 to 9.5 feet. The final water levels include drilling water and likely are not representative of actual groundwater conditions. Groundwater levels may vary seasonably.

Conclusions and Recommendations

Based on the subsurface materials encountered in the borings, spread footing foundations appear to be best suited for support of the proposed structure. Competent bedrock was encountered at shallow depths at the pier and rear (south) abutment locations. However, an additional 35 to 55 feet of fill will be placed at the abutment locations, resulting in an estimated depth to bedrock of 60 to 70 feet below the proposed grade at the abutments. Consequently, spread footings at the abutment locations will likely be founded in fill. Spread footings at the pier location will be founded on bedrock.

Spread footings bearing in embankment fill may be designed for an allowable bearing capacity of 3000 psf. If spread footings are used to support the pier, the footings should be embedded into the bedrock. Top of bedrock elevations at the boring locations and allowable bearing capacity on rock are presented in the table below. The depth of the spread footing embedment will need to be designed based upon actual loading conditions.

Driven H-piles could also be used at the forward (north) abutment. If driven H-piles are used at this location, it is recommended that they be driven to the top of bedrock. The full design capacity of the piles may be used for piles bearing on bedrock.

Additionally, drilled shafts to rock or pre-bored H-piles into bedrock can also be used to support the structure. If high lateral or uplift loads are anticipated, drilled shafts or H-piles socketed into bedrock may be needed. The actual rock socket lengths will need to be designed based upon actual loading conditions.

The following table summarizes the site conditions and bearing capacity recommendations for foundations on rock.

Foundation Recommendations

Boring Number	Structural Element	Existing Ground Surface Elevation* (ft)	Top of Rock Elevation* (ft)	Allowable Bearing Capacity
TR-4	Forward (North) Abutment	733.0	697.0	8 TSF
TR-5	Pier	723.0	710.6	10 TSF
TR-6	Rear (South) Abutment	713.0	703.0	12 TSF

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

Closing

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

Sincerely,

DLZ OHIO, INC.

Edward R Hood

Edward R. Hood, P.E.
Geotechnical Engineer

Dorothy A. Adams

Dorothy A. Adams, P.E.
Senior Geotechnical Engineer

ERH/vlc
Attachments: General Information – Drilling Procedures and Logs of Borings
Legend – Boring Log Terminology
Site Plan
Boring Logs TR-4, TR-5, TR-6

cc: File

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GENERAL INFORMATION
DRILLING PROCEDURES AND LOGS OF BORINGS

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

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

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

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

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

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

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

LEGEND – BORING LOG TERMINOLOGY

Explanation of each column, progressing from left to right

1. Depth (in feet) – refers to distance below the ground surface.
2. Elevation (in feet) – is referenced to mean sea level, unless otherwise noted.
3. Standard Penetration (N) – the number of blows required to drive a 2-inch O.D., 1-3/8 inch I.D., split-barrel sampler, using a 140-pound hammer with a 30-inch free fall. The blows are recorded in 6-inch drive increments. Standard penetration resistance is determined from the total number of blows required for one foot of penetration by summing the second and third 6-inch increments of an 18-inch drive.

   50/n – indicates number of blows (50) to drive a split-barrel sampler a certain number of inches (n) other than the normal 6-inch increment.
4. The length of the sampler drive is indicated graphically by horizontal lines across the "Standard Penetration" and "Recovery" columns.
5. Sample recovery from each drive is indicated numerically in the column headed "Recovery".
6. The drive sample location is designated by the heavy vertical bar in the "Sample No., Drive" column.
7. The length of hydraulically pressed "Undisturbed" samples is indicated graphically by horizontal lines across the "Press" column.
8. Sample numbers are designated consecutively, increasing in depth.
9. Soil Description

   a. The following terms are used to describe the relative compactness and consistency of soils:

   Granular Soils – Compactness

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

   Cohesive Soils – Consistency

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

   b. Color – If a soil is a uniform color throughout, the term is single, modified by such adjective as light and dark. If the predominant color is shaded by a secondary color, the secondary color precedes the primary color. If two major and distinct colors are swirled throughout the soil, the colors are modified by the term "mottled".

   c. Texture is based on the Ohio Department of Transportation Classification System. Soil particle size definitions are as follows:

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

d. The main soil component is listed first. The minor components are listed in order of decreasing percentage of particle size.

e. Modifiers to main soil descriptions are indicated as a percentage by weight of particle sizes.

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

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

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

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

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

10. Rock Hardness and Rock Quality Designation

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

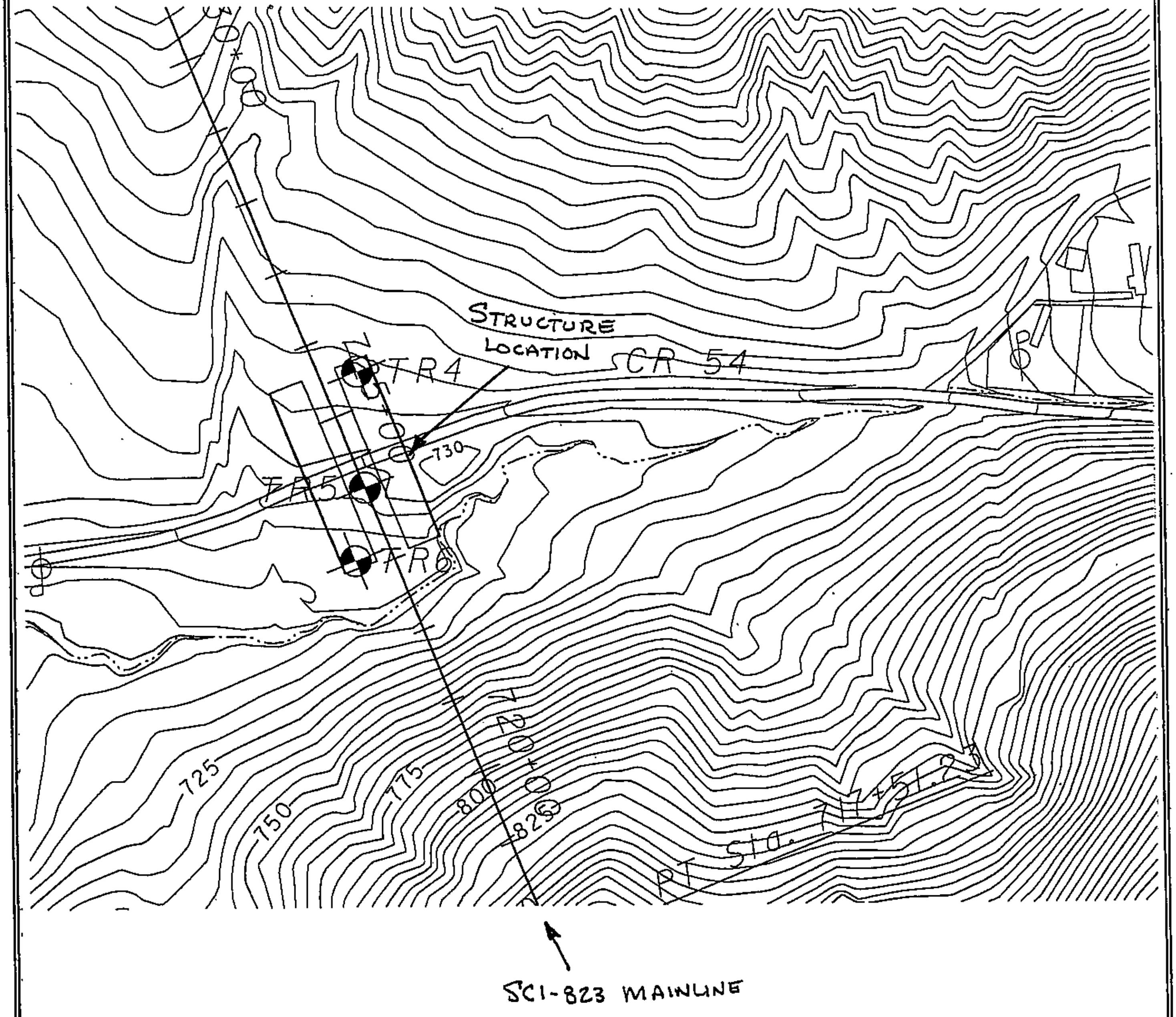
Term	Description
Very Soft	Permits denting by moderate pressure of the fingers. Resembles hard soil but has rock structure. (Crushes under pressure of fingers and/or thumb)
Soft	Resists denting by fingers, but can be abraded and pierced to shallow depth by a pencil point. (Crushes under pressure of pressed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

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

11. Gradation – when tests are performed, the percentage of each particle size is listed in the appropriate column (defined in Item 9c).

12. When a test is performed to determine the natural moisture content, liquid limit moisture content, or plastic limit moisture content, the moisture content is indicated graphically.

13. The standard penetration (N) value in blows per foot is indicated graphically.



Source: Topographic Mapping provided by TranSystems Corporation, Dated 2004

NORTH

DLZ
ENGINEERS * ARCHITECTS * SCIENTISTS

SITE PLAN

Morris Lane - Blue Run Road
SCI-823 over CR 54
SCI-823-0.00

FIGURE 1.

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

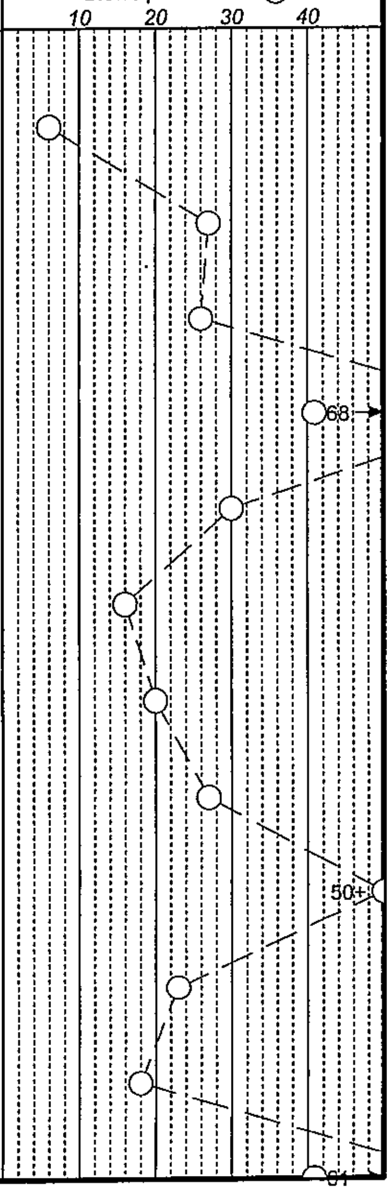
Client: TranSystems, Inc.
Project: SCI-823-0.00
Job No. 0121-3070.03

LOG OF: Boring TR-4
Location: SCI-823-0.00 over CR 54 (Forward Abutment)
Date Drilled: 03/16/05

WATER OBSERVATIONS: Water seepage at: 2.5'
Water level at completion: 9.4' (Including drill water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetro-meter (tsf)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	733.0												
0.3	732.7						Topsoil - 3"						
		1 2 4	18	1		0.75	Medium stiff brown SILTY CLAY (A-6b), trace fine sand; damp.						
3.0	730.0						Stiff brown and red SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; damp.						
		4 10 17	18	2		1.5							
5													
5.5	727.5						Dense brown and red GRAVEL WITH SAND AND SILT (A-2-4); damp.						
		7 13 13	18	3									
		9 35 33	18	4									
10													
		7 13 17	17	5									
13.0	720.0						Medium dense brown and gray SANDY SILT (A-4a); damp.						
		6 7 9	16	6									
15													
15.5	717.5						Medium stiff brown and gray SILT (A-4b); damp.						
		12 12 8	18	7A 7B		0.75 4.5+							
17.0	716.0						Hard brown SILT AND CLAY (A-6a), some fine to coarse sand, trace to little gravel; damp.						
18.0	715.0						Medium dense brown SANDY SILT (A-4a); damp.						
		7 12 15	8	8									
20													
		16 25 50/5	16	9			@ 21.5', possible decomposed boulder.						
23.0	710.0						Very stiff brown SILTY CLAY (A-6b), little fine to coarse sand; damp.						
		5 11 12	18	10		2.75							
25													
25.5	707.5						Very stiff gray SILTY CLAY (A-6b), trace fine sand; damp.						
		8 9 9	18	11		3.25							
28.0	705.0						Very soft gray SHALE; decomposed.						
		12 28 33	18	12		4.5+							
30													

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



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

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

LOG OF: Boring TR-4
Location: SCI-823-0.00 over CR 54 (Forward Abutment)
Date Drilled: 03/16/05

WATER OBSERVATIONS: Water seepage at: 2.5'
Water level at completion: 9.4' (including drill water)

Depth (ft)	*Elev. (ft)*	*Blows per 6"*	*Recovery (in)*	*Sample No. Drive*	*Sample No. Press / Core*	*Hand Penetro-meter (tsf)*	*DESCRIPTION*	*% Aggregate*	*% C. Sand*	*% M. Sand*	*% F. Sand*	*% Silt*	*% Clay*	*STANDARD PENETRATION (N)*
30	703.0						Very soft gray SHALE; decomposed.							61
		16 37 50/4	16	13		—								50+
35.0	698.0	Core 120"	Rec 120"	RQD 63%	R-1		Soft gray SHALE; moderately to highly weathered, broken with typical low angle clay coated fractures. @ 35.8'-36.1',37.3'-37.6', clay seam. @ 37.6'-38.0', high angle clean fracture. @ 39.6', 45° fracture. @ 42.3', thin clay seam							
45.0	688.0						Bottom of Boring - 45.0'							

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

Depth scale: 30, 35.0, 40, 45.0, 50, 55, 60

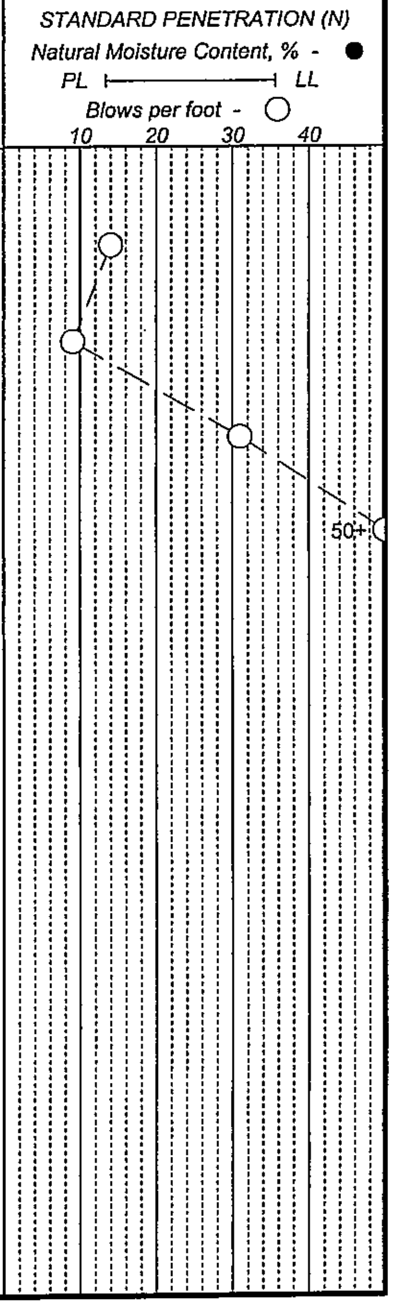
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-5 | *Location:* SCI-823-0.00 over CR 54 (Pier) | *Date Drilled:* 3/15/05

WATER OBSERVATIONS: Water seepage at: not recorded
Water level at completion: not recorded

Depth (ft)	*Elev. (ft)*	*Blows per 6"*	*Recovery (in)*	*Sample No.* *Drive*	*Sample No.* *Press / Core*	*Hand Penetro-meter (tsf)*	*DESCRIPTION*	*GRADATION* *% Aggregate*	*% C. Sand*	*% M. Sand*	*% F. Sand*	*% Silt*	*% Clay*
0	723.0												
0.3	722.7						Topsoil - 3"						
		5 6 8	18	1		4.5+	Hard brown and gray SILT AND CLAY (A-6a), trace fine sand; damp.						
3.0	720.0	3 5 4	16	2		0.75-1.25	Medium stiff to stiff brown SILT AND CLAY (A-6a), little fine to coarse sand, trace gravel; moist to wet.						
5 5.5	717.5	5 11 20	18	3		4.5+	Soft brown SHALE; highly weathered to decomposed.						
		20 33 50/1	10	4		4.5+	@ 8.5', brownish gray, contains rust staining.						
10.0	713.0	Core 36"	Rec 36"	RQD 89%	R-1		Soft brown and gray SHALE; highly weathered to decomposed, broken.						
12.4	710.6	Core 120"	Rec 120"	RQD 100%	R-2		Soft gray SHALE; moderately to highly weathered.						
15													
20													
23.0	700.0						Bottom of Boring - 23.0'						
25													
30													



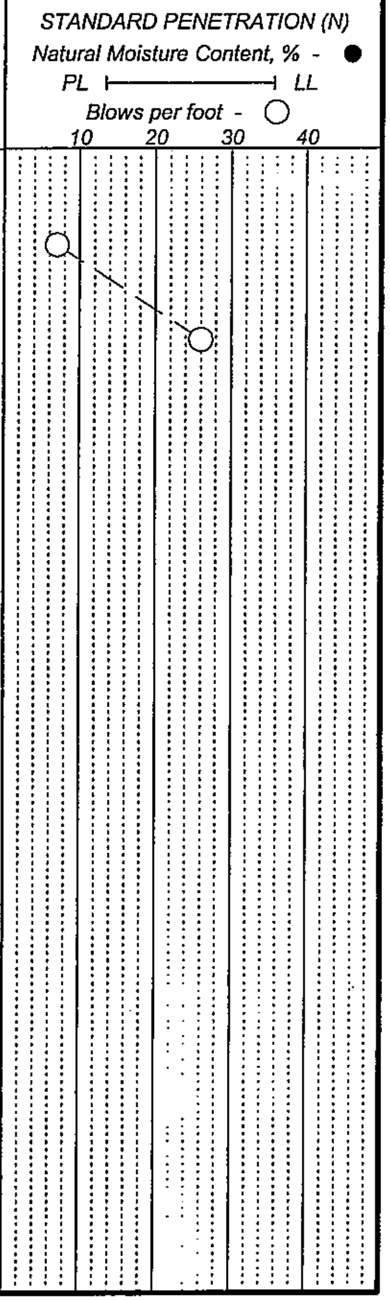
DLZ OHIO INC. * 6121 HUNTLEY ROAD, COLUMBUS, OHIO 43229 * (614)888-0040

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

LOG OF: Boring TR-6 | *Location:* SCI-823-0.00 over CR 54 (Rear Abutment) | *Date Drilled:* 03/15/05 to 03/16/05

WATER OBSERVATIONS: Water seepage at: none
Water level at completion: 9.5'

Depth (ft)	*Elev. (ft)* 713.0	*Blows per 6"*	*Recovery (in)*	*Sample No. Drive*	*Sample No. Press / Core*	*Hand Penetrometer (tsf)*	*DESCRIPTION*	*% Aggregate*	*% C. Sand*	*% M. Sand*	*% F. Sand*	*% Silt*	*% Clay*
0.2	712.8						Topsoil - 2"						
3.0	710.0	1 3 4	18	1			Loose brown SANDY SILT (A-4a), some gravel, trace clay; damp.						
5.0	708.0	4 8 18	16	2			Hard gray SILTY CLAY (A-6b); dry to damp.						
9.0	704.0	Core 48"	Rec 48"	RQD 54%	R-1		Medium hard brownish gray SILTSTONE; slightly weathered, slightly fractured.						
19.0	694.0	Core 120"	Rec 120"	RQD 83%	R-2		Hard gray SHALE; slightly ~~to~~ moderately weathered, arenaceous. @ 9.2'-9.4', 15.4'-15.9', clay seems @ 11.9', 45 degree fracture.						
							Bottom of Boring - 19.0'						



FILE: 0121-3070-03 [3/31/2005 4:49 PM]

APPENDIX F

Hydraulic Report

TranSystems

SCI-823-0.00

PID No. 19415

S.R. 823 OVER MORRIS LANE BLUE RUN ROAD

Hydraulic Report

TranSystems

Hydraulic Narrative

Project Description

TranSystems Corporation is providing engineering services to the Ohio Department of Transportation for the design of 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. As part of the project new left and right overpass structures will carry the proposed S.R. 823 bypass over both existing Morris Lane Blue Run Road and a relocated unnamed tributary of Candy Run. As requested by the Scope of Services, a hydraulic report is to be submitted before any plan development. The purpose of this report is to investigate the relocating the unnamed tributary of Candy Run to pass under the bridges. The bridge substructures will be placed outside the limits of the 500 year flow in the channel.

Design Criteria

The design year storm was selected as the 50 year as per the Ohio Department of Transportation (ODOT) criteria. As a check of the conditions of the 100 year storm was to be modeled. The ODOT Office of Structural Engineering (OSE) requested a 500 year storm was to be modeled for the Mechanically Stabilized Earth (MSE) wall alternative. The 500 year runoff is not contained in the within the modeling parameters of the USGS Water Resources Investigation Report 89-4126. Common practice is to calculate the flow 500year flow (Q_{500}) by multiplying 1.3 times the 100 year flow (Q_{100}). This is as suggested in the ODOT Bridge Design Manual section 203.3. The relocated channel was designed to maintain similar bank full widths (2 year storm) as the existing channel. The channel does not exhibit two stage morphology therefore it was not considered in the design of the channel.

Channel Hydraulics

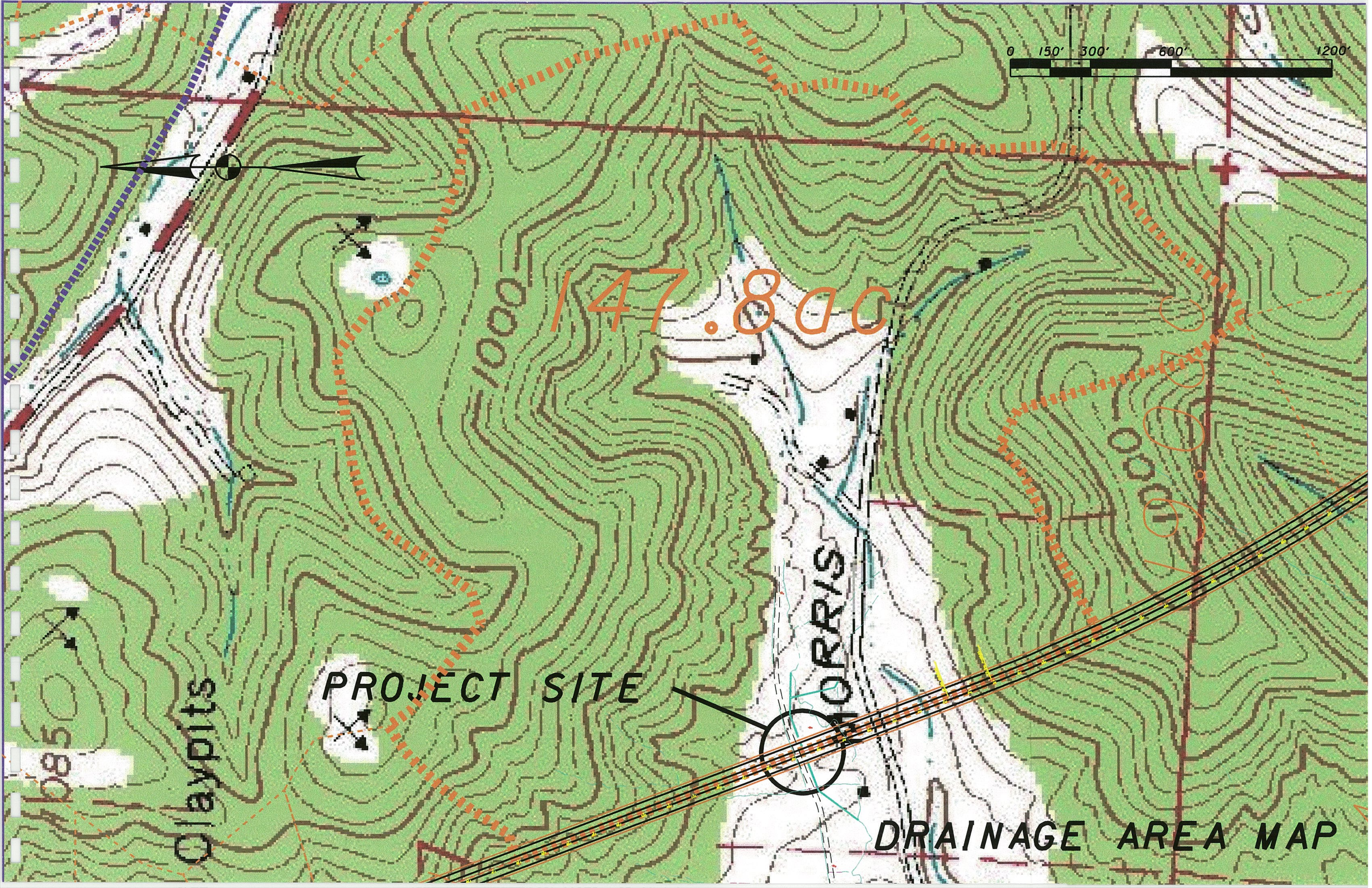
Channel hydraulics were calculated using HEC-RAS ver. 3.1.3. The main channel is considered clean and winding with some pools of cobble and gravel bottom. The banks have light brush as a minimally maintained roadside ditch. This study of existing conditions used manning numbers of 0.040 for the channel and 0.060 for the overbank. HEC-RAS output information for the models is included in the following sections. The initial HEC-RAS modeling runs using subcritical flow regime produced froude numbers near 1. Consequently, the modeling runs were changed to use the mixed flow option, for the flow regime, and not limited to the parabolic method of critical depth computation. The model of existing conditions indicates a bankfull width of 10' based upon the analysis of the 2 year flow. A break in the existing stream profile causes a hydraulic jump near the structure.

The proposed channel section of a 6' flat bottom with 3:1 side slopes was selected to match the bankfull width and other properties of the existing channel at representative sections upstream and downstream of the relocation. The proposed channel relocation is approximately 130' shorter than the existing channel requiring careful attention to downstream impacts. The profile of the channel was designed to make up the difference in the upstream segments of the relocation and match the existing slope in the downstream segment. The hydraulic jump that occurred in the existing conditions is moved downstream of the bridge approximately 80' by introducing a 40' segment of channel at 1.5%. This channel design matches the existing channel hydraulics at the location of the section where the relocated channel meets the existing channel. The proposed channel will be protected with Type 3 Tied Concrete Block Mat as verified by ODOT hydraulic section. The bridge is included in the model although it does not have any impact on the analysis.

Flood Hazard Evaluation

The proposed relocation has no effect on the water surface elevations or velocities in the upstream or downstream segments from the relocated channel.

DRAINAGE AREA



DRAINAGE AREA MAP

RUNOFF CALCULATION

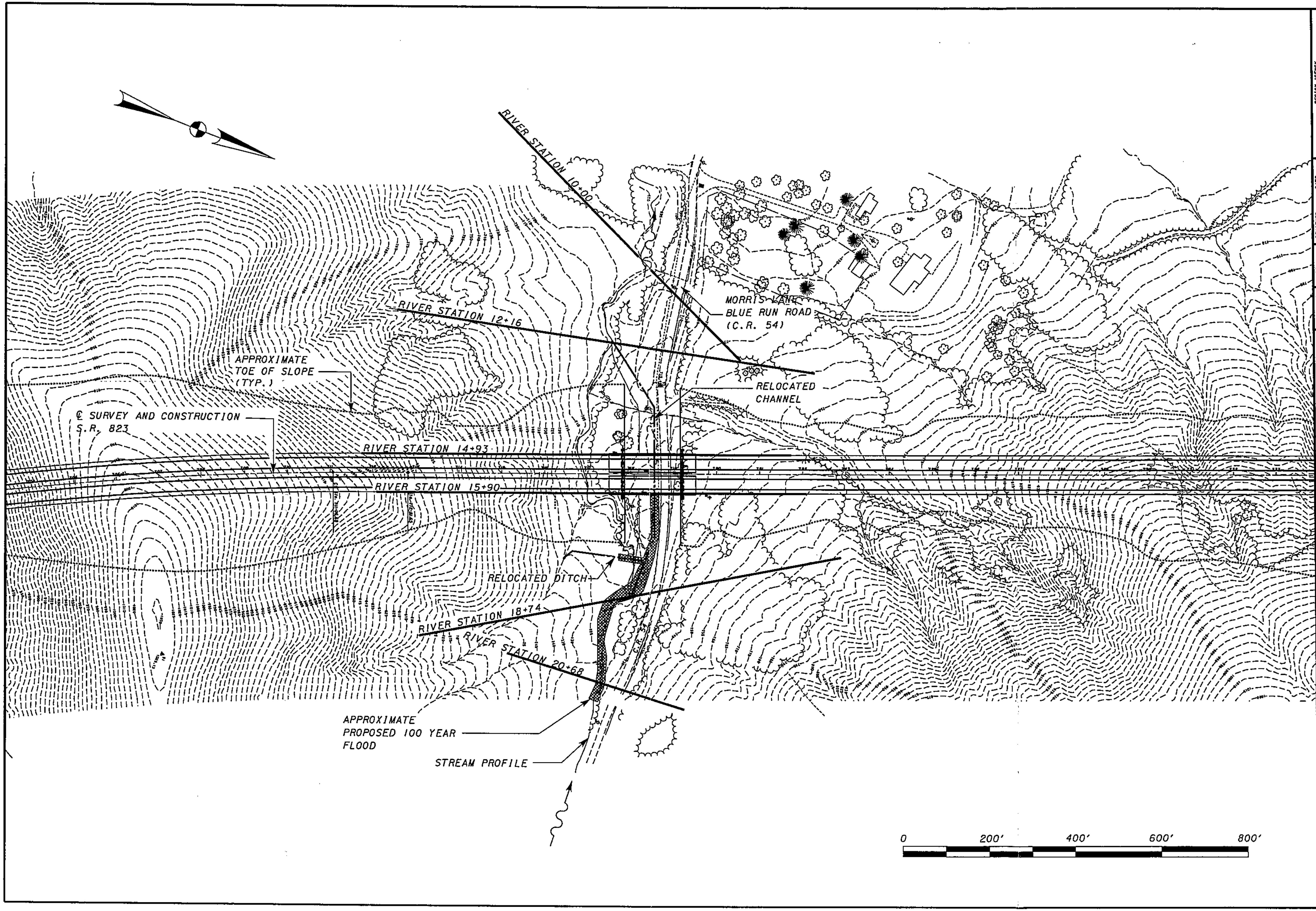
TECHNIQUES FOR ESTIMATING FLOOD-PEAK DISCHARGES OF RURAL, UNREGULATED STREAMS IN OHIO AREA A

U.S. GEOLOGICAL SURVEY Water Resources Investigations Report 89-4126

Values	Units	Definitions
6435778.70	SQ. FT.	
0.231	SQ. MI.	**CONTDA =** Contributing Drainage Area
0.00	SQ. FT.	
0.00	%	**STORAGE =** Storage Area
2827.00	FT.	**TOTAL CHANNEL LENGTH**
282.70	FT.	L_{10} = 10% of the Distance along channel
717	FT.	$Elev_{10}$ = Elevation at point L_{10}
2402.95	FT.	L_{85} = 85% of the Distance along channel
987	FT.	$Elev_{85}$ = Elevation at point L_{85}
2120.25	FT.	**Length =** $L_{85} - L_{10}$
672.37	FT./MI.	**SLOPE** = $(Elev_{10}-Elev_{85})$/Length
	CFS	$Q_{\#}$ = Flood-Peak Discharge # = Frequency of Storm

Q_2	**54.63**	CFS	$= 56.1(CONTDA)^{0.782}(SLOPE)^{0.172}(STORAGE+1)^{-0.297}$
Q_5	**115.39**	CFS	$= 84.5(CONTDA)^{0.769}(SLOPE)^{0.221}(STORAGE+1)^{-0.322}$
Q_{10}	**166.17**	CFS	$= 104(CONTDA)^{0.764}(SLOPE)^{0.244}(STORAGE+1)^{-0.335}$
Q_{25}	**236.16**	CFS	$= 129(CONTDA)^{0.760}(SLOPE)^{0.264}(STORAGE+1)^{-0.347}$
Q_{50}	**294.26**	CFS	$= 148(CONTDA)^{0.757}(SLOPE)^{0.276}(STORAGE+1)^{-0.355}$
Q_{100}	**352.59**	CFS	$= 167(CONTDA)^{0.756}(SLOPE)^{0.285}(STORAGE+1)^{-0.363}$
Q_{500}	458.367	CFS	=1.3*Q100 (Ref. ODOT BDM 203.3)

SUPPLEMENTAL SITE PLAN



SUPPLEMENTARY SITE PLAN

BRIDGE NO. SCI-823-XXXX
S.R. 823 OVER MORRIS LANE BLUE RUN ROAD

SCIOTO COUNTY
STA. 704+00
STA. 733+00

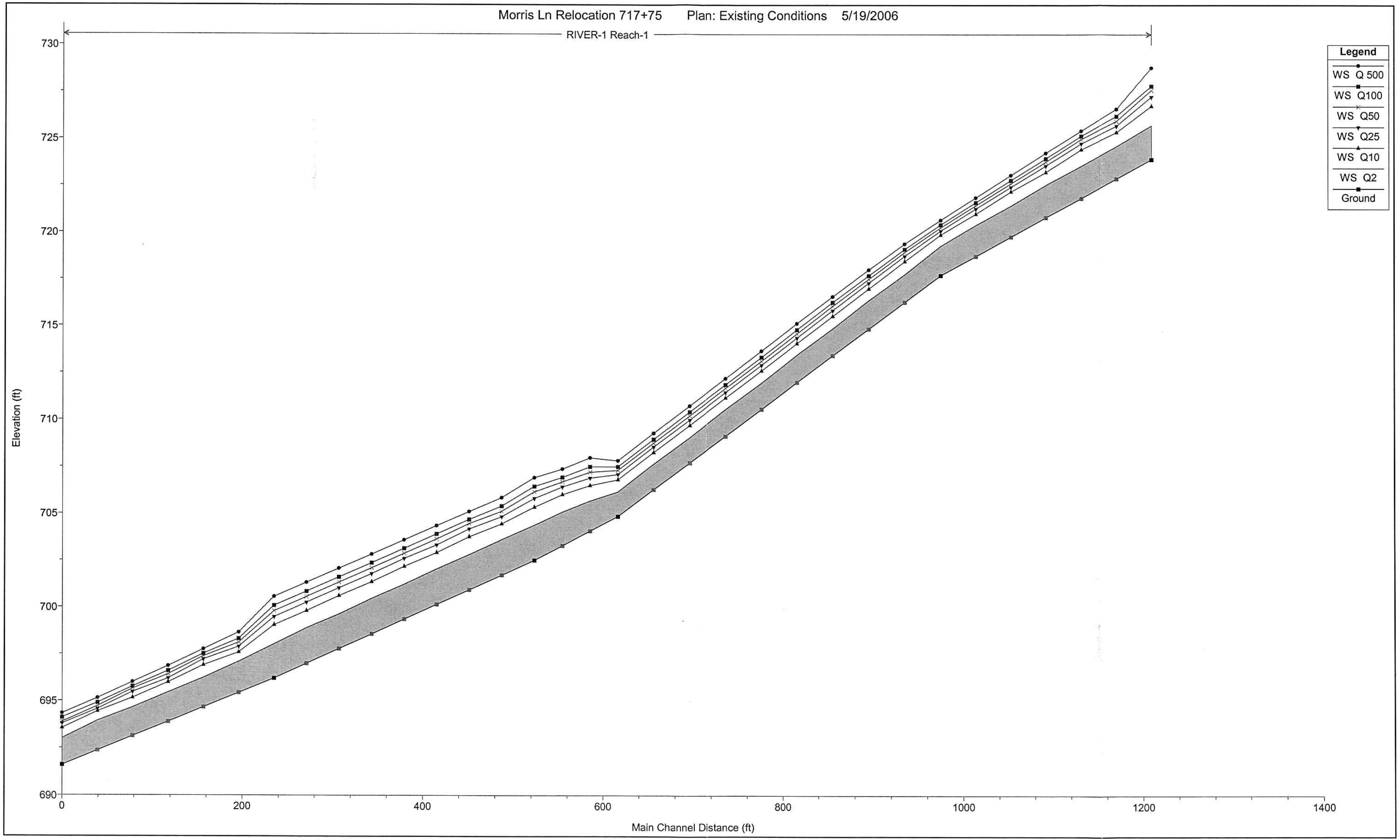
DESIGNED	DRAWN	REVIEWED	DATE
PJP	CAS	HJS	04/16/06
CHECKED	REVISED	STRUCTURE FILE NUMBER	

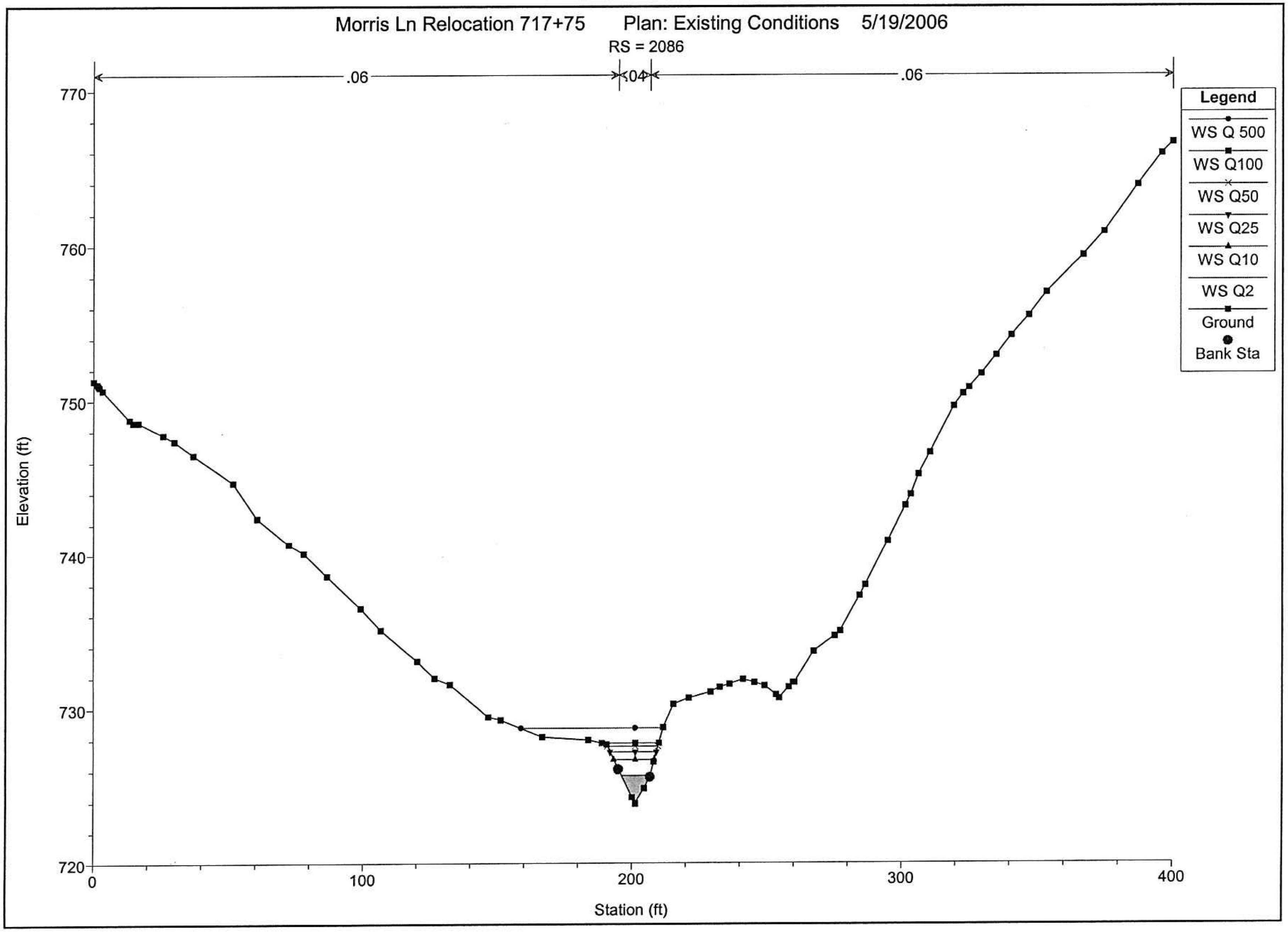
DESIGN AGENCY
TranSystems
700 EAST PETE ROSE WAY, SUITE 360, CINCINNATI, OHIO, 45202

SCI-823-0.00
PID19415

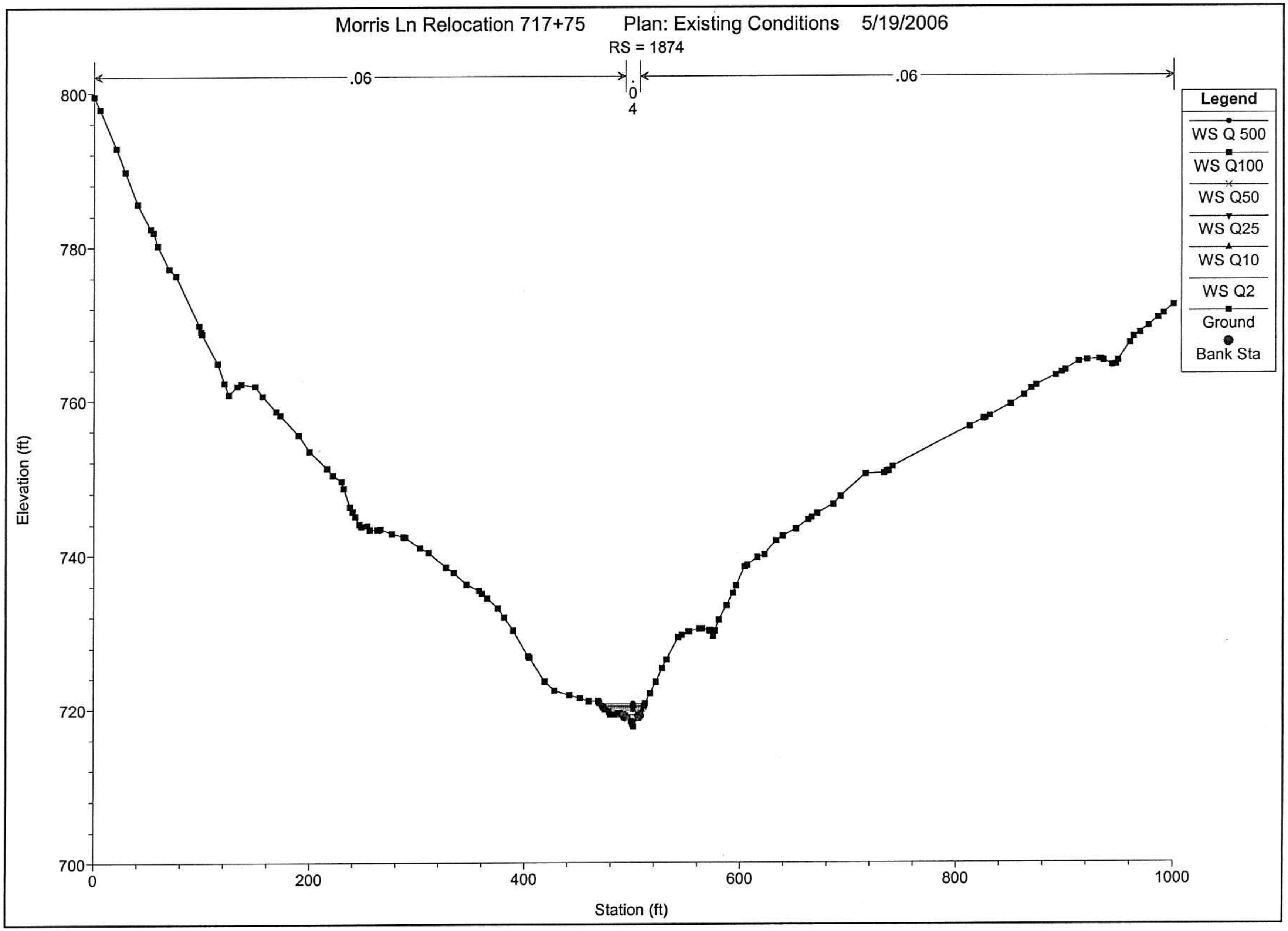
1/1

EXISTING CROSS SECTION PLOTS


Morris Ln Relocation 717+75 Plan: Existing Conditions 5/19/2006
RIVER-1 Reach-1
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Elevation (ft)
730
725
720
715
710
705
700
695
690
0
200
400
600
800
1000
1200
1400
Main Channel Distance (ft)


Morris Ln Relocation 717+75 Plan: Existing Conditions 5/19/2006

RS = 2086



Morris Ln Relocation 717+75 Plan: Existing Conditions 5/19/2006

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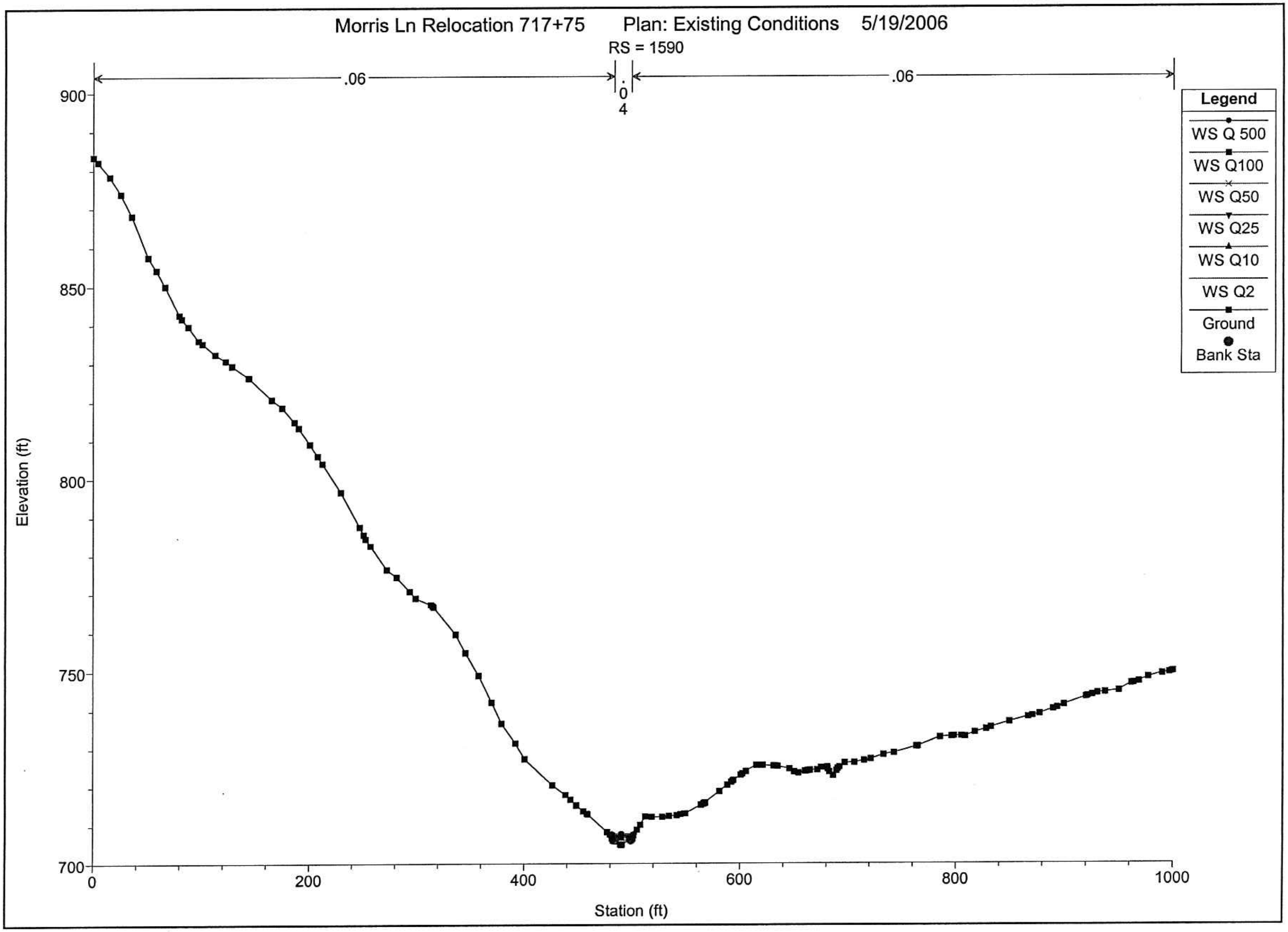
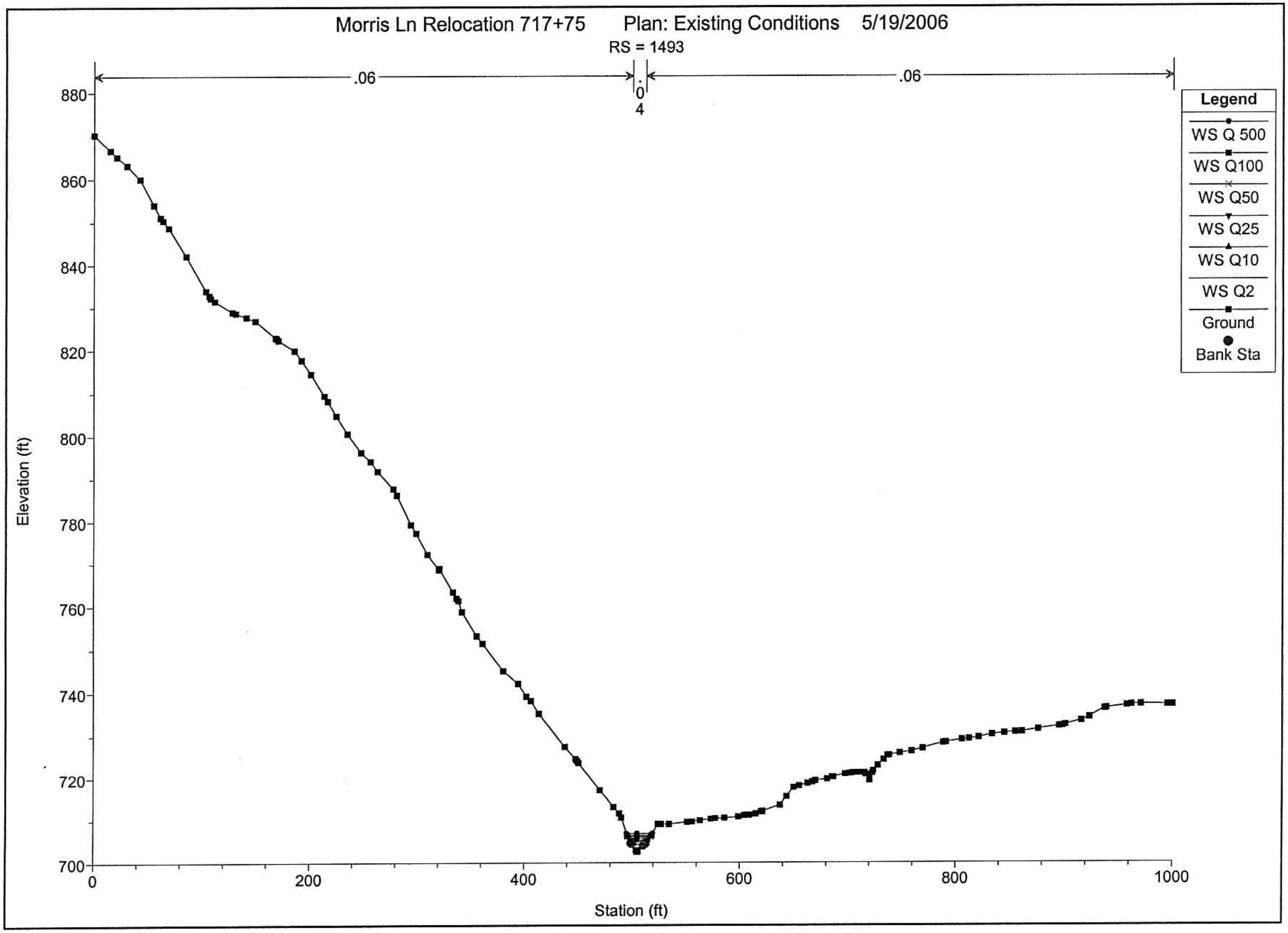
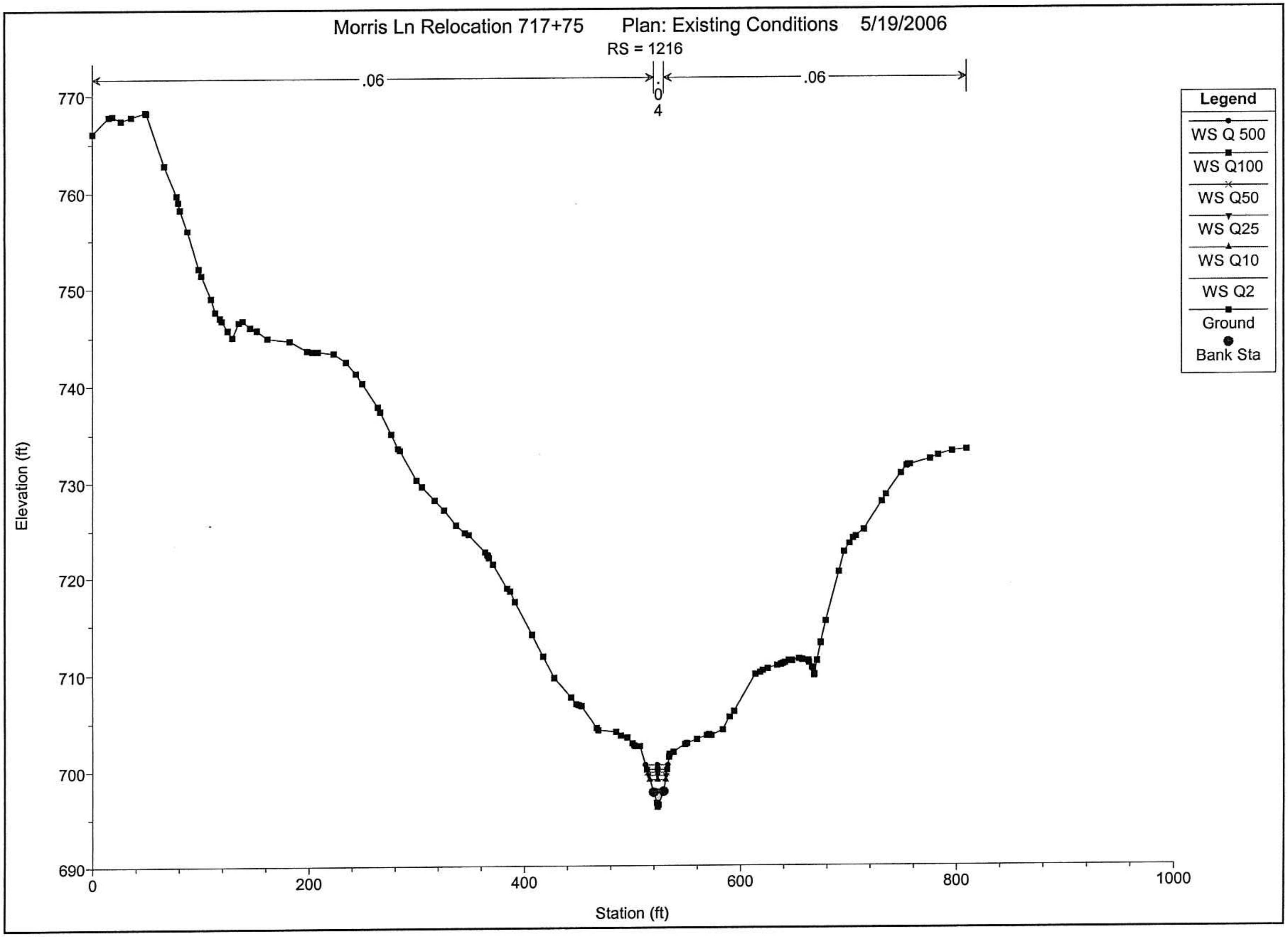


Morris Ln Relocation 717+75 Plan: Existing Conditions 5/19/2006

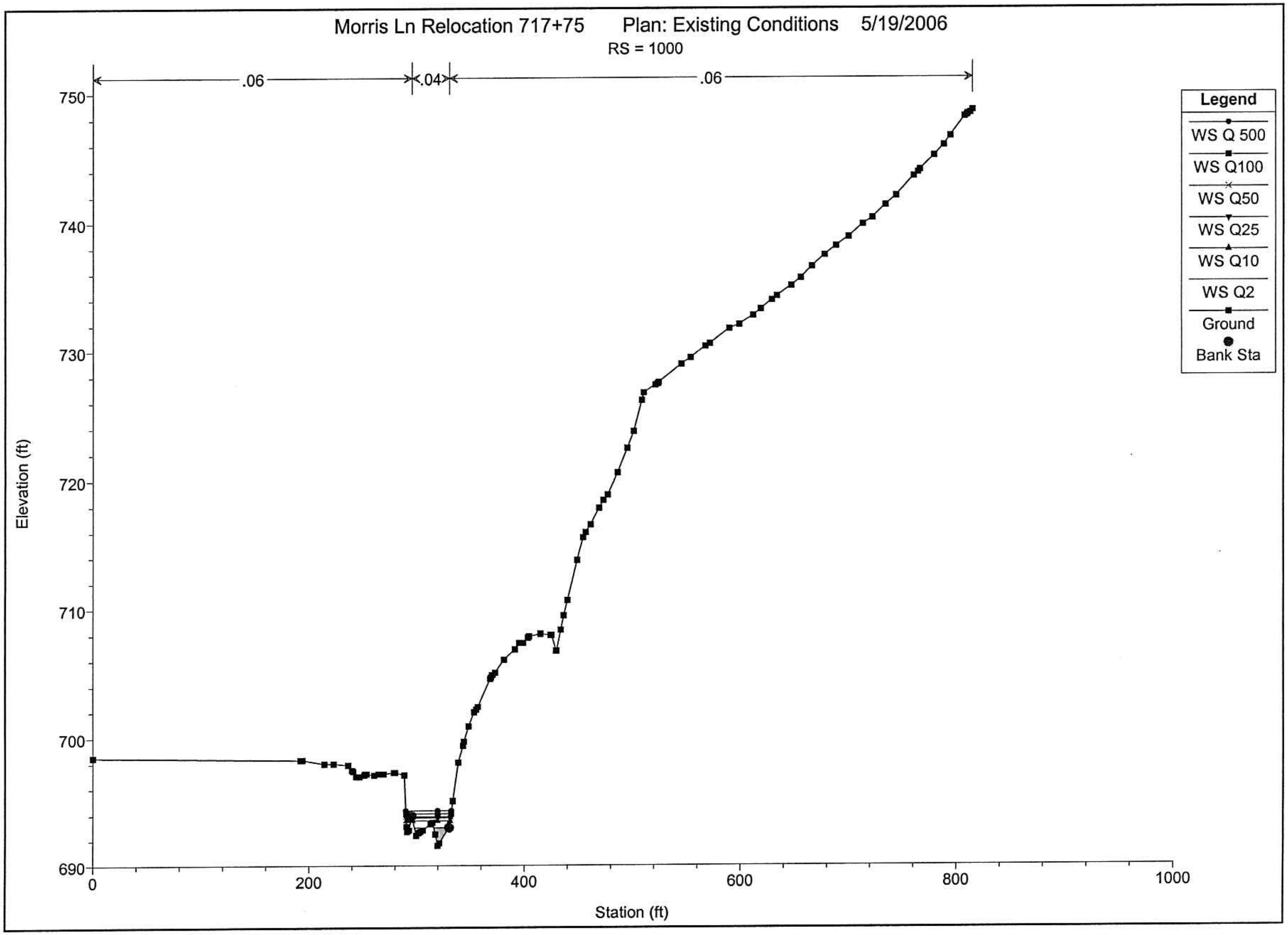
RS = 1590


Morris Ln Relocation 717+75
Plan: Existing Conditions
5/19/2006
RS = 1493
.06
.04
.06
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Bank Sta
Elevation (ft)
880
860
840
820
800
780
760
740
720
700
Station (ft)
0
200
400
600
800
1000

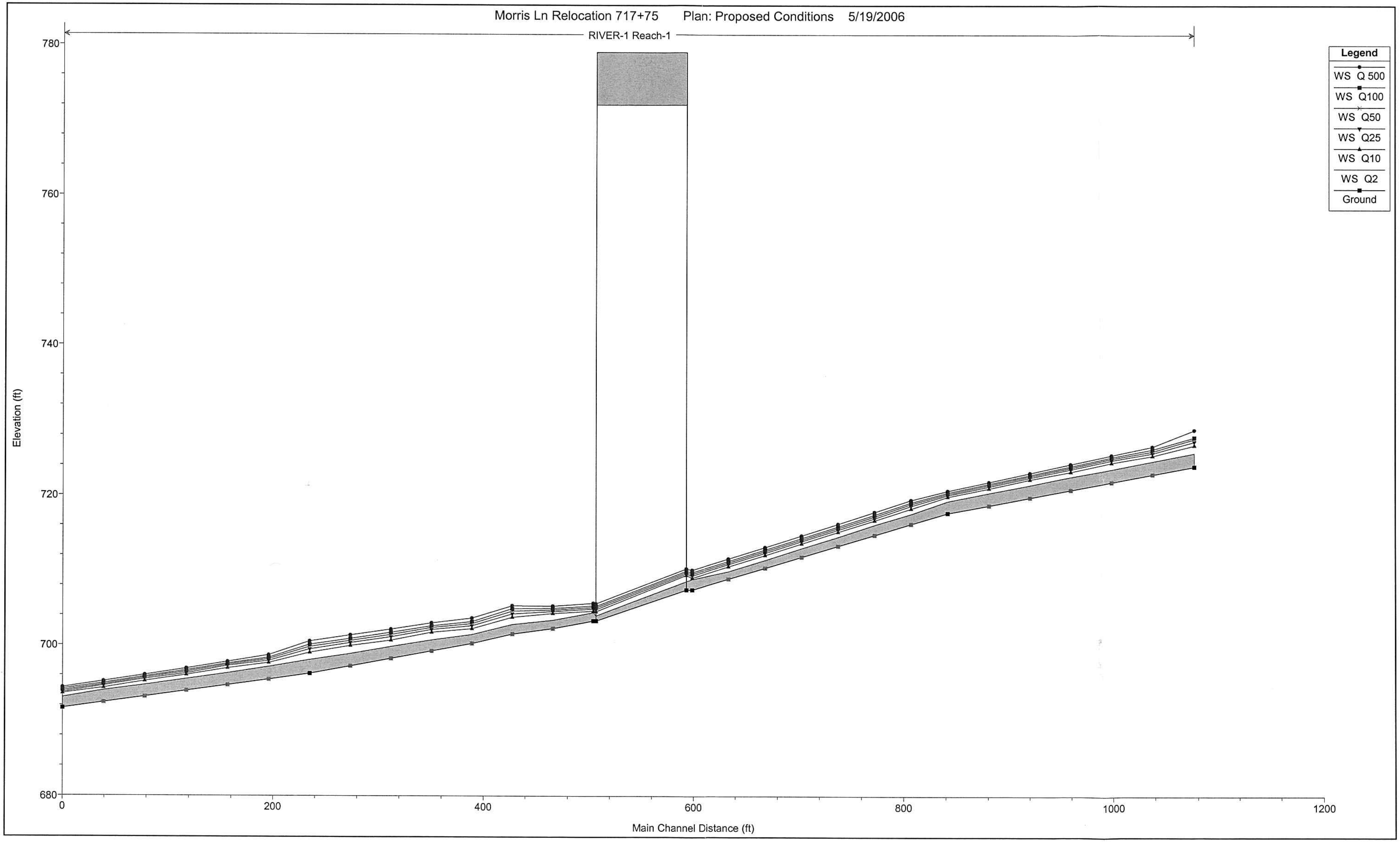


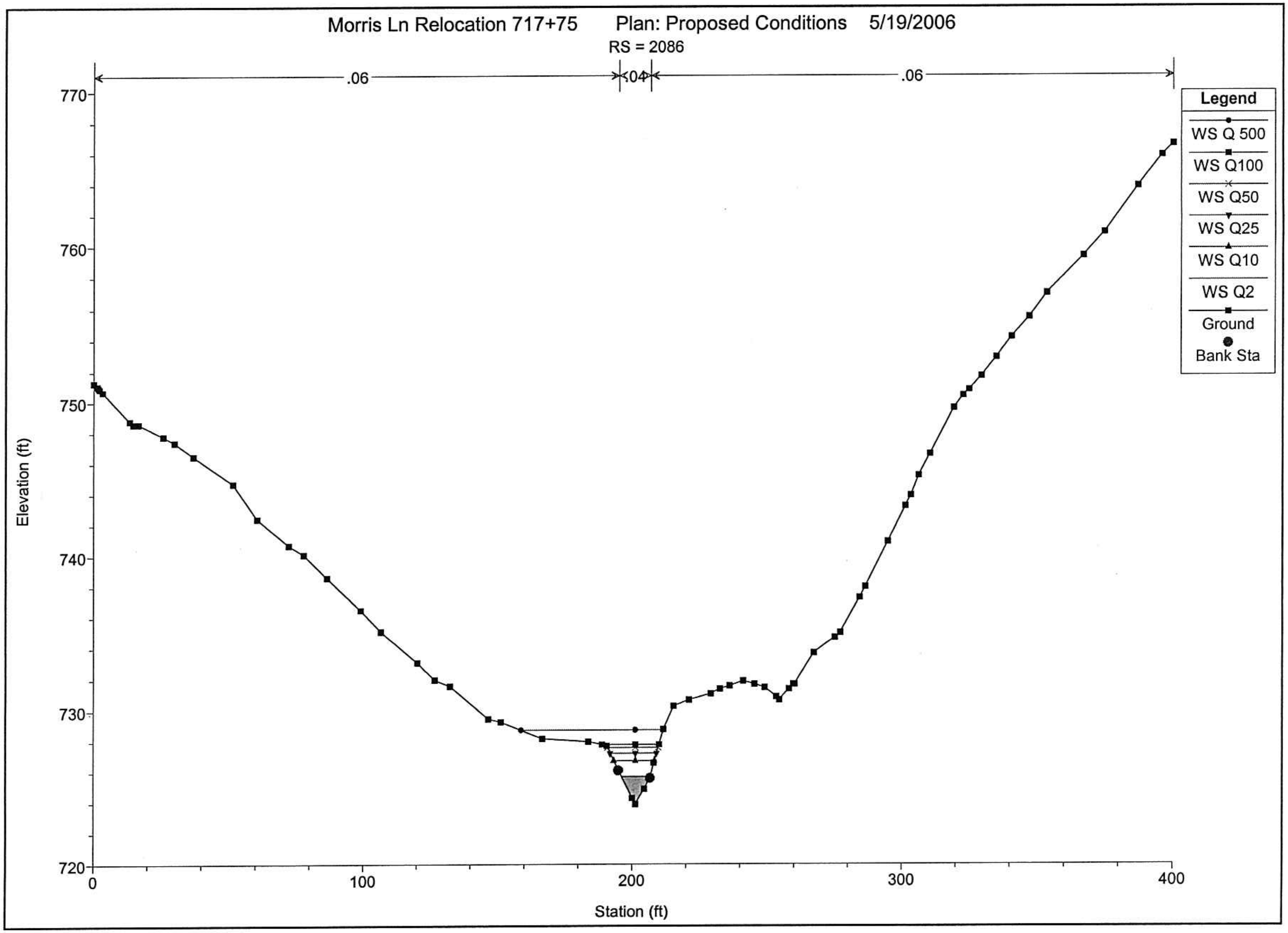
Morris Ln Relocation 717+75 Plan: Existing Conditions 5/19/2006

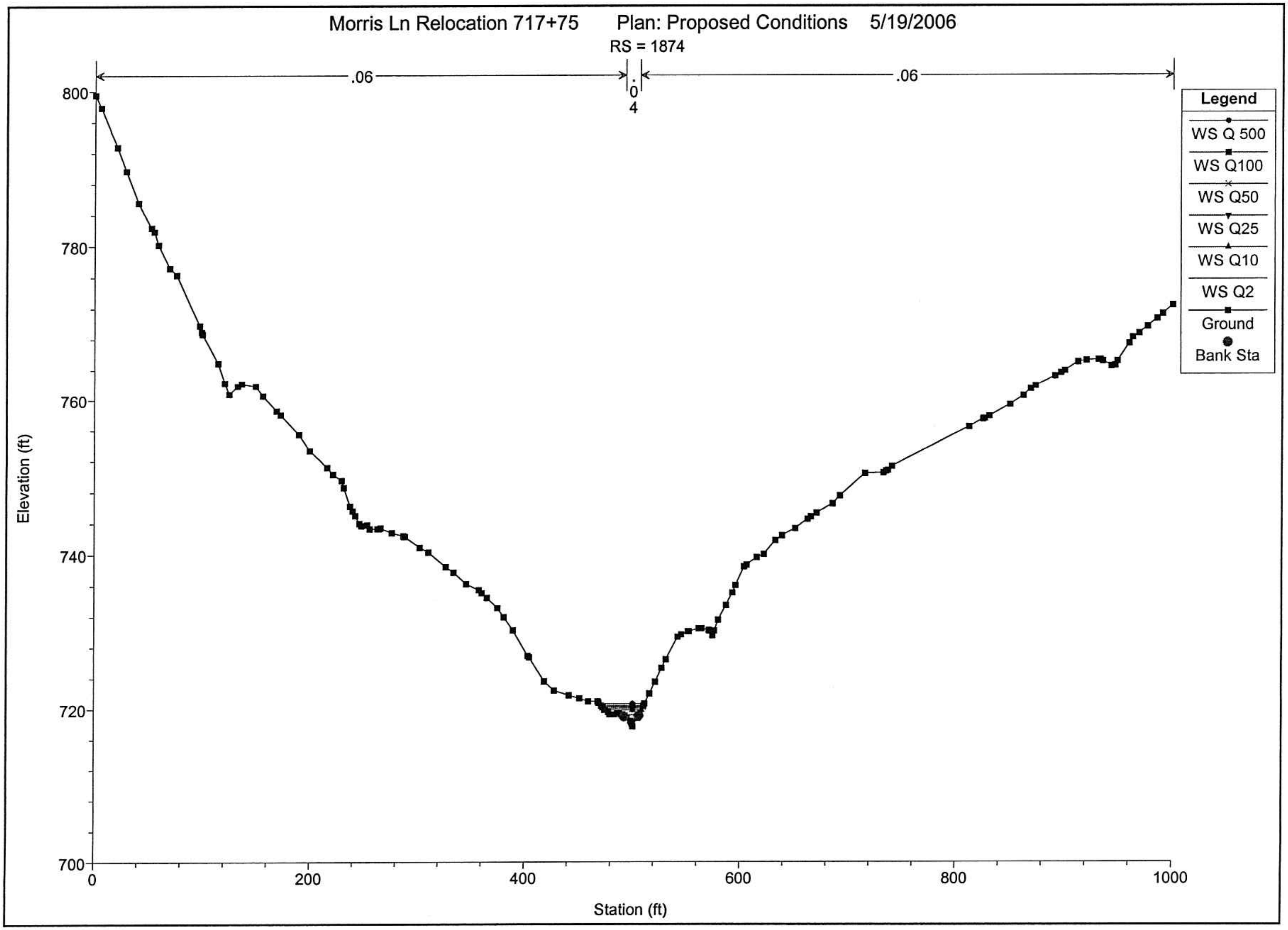
RS = 1216

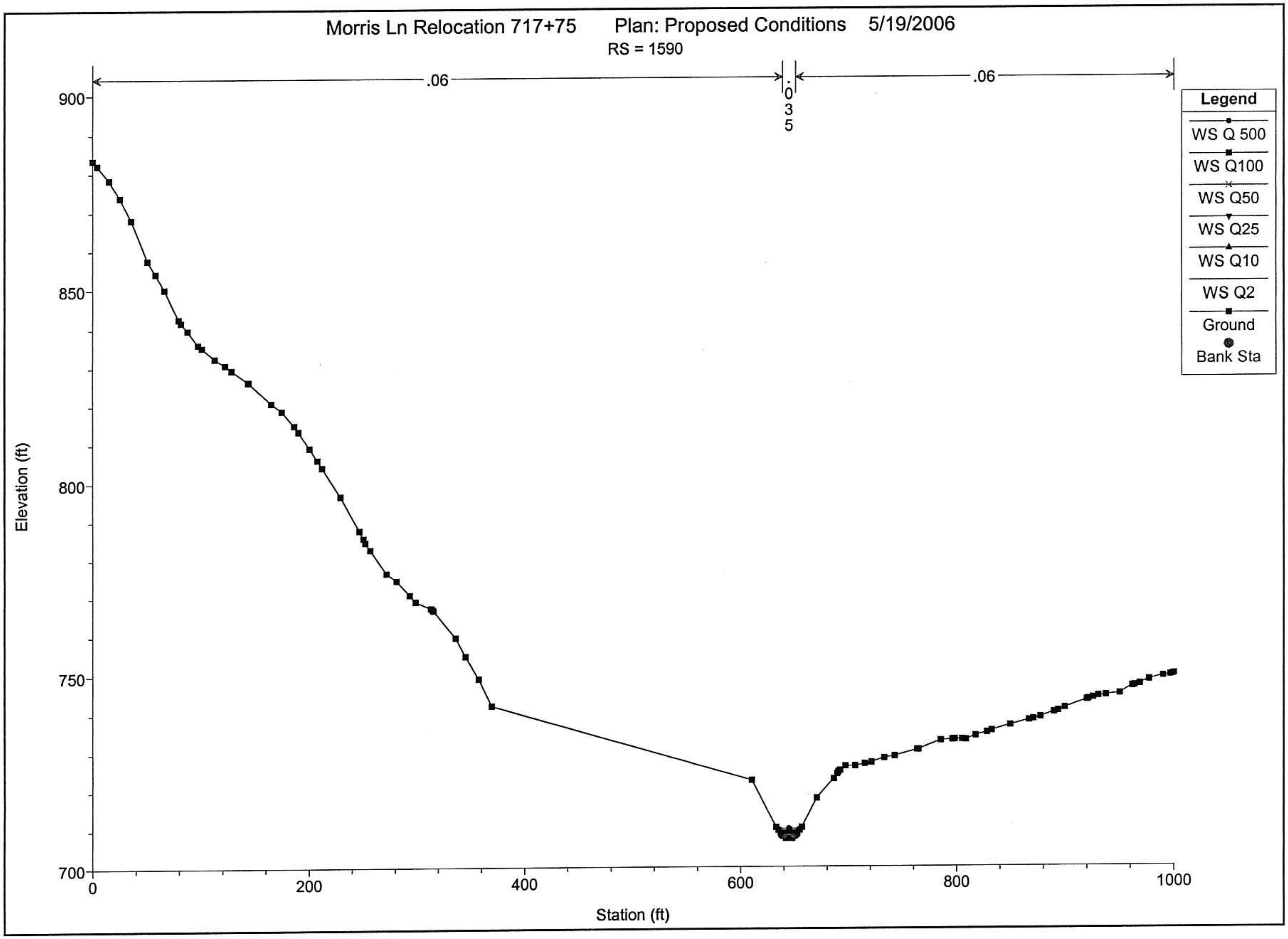

Morris Ln Relocation 717+75
Plan: Existing Conditions
5/19/2006
RS = 1000
.06
.04
.06
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Bank Sta
Elevation (ft)
750
740
730
720
710
700
690
Station (ft)
0
200
400
600
800
1000

PROPOSED CROSS SECTION PLOTS


Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006
RIVER-1 Reach-1
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Elevation (ft)
780
760
740
720
700
680
0
200
400
600
800
1000
1200
Main Channel Distance (ft)


Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006
RS = 2086
.06
.04
.06
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Bank Sta
Elevation (ft)
770
760
750
740
730
720
0
100
200
300
400
Station (ft)


Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006
RS = 1874
.06
.0
4
.06
Legend
WS Q 500
WS Q100
WS Q50
WS Q25
WS Q10
WS Q2
Ground
Bank Sta
Elevation (ft)
800
780
760
740
720
700
0
200
400
600
800
1000
Station (ft)



Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006

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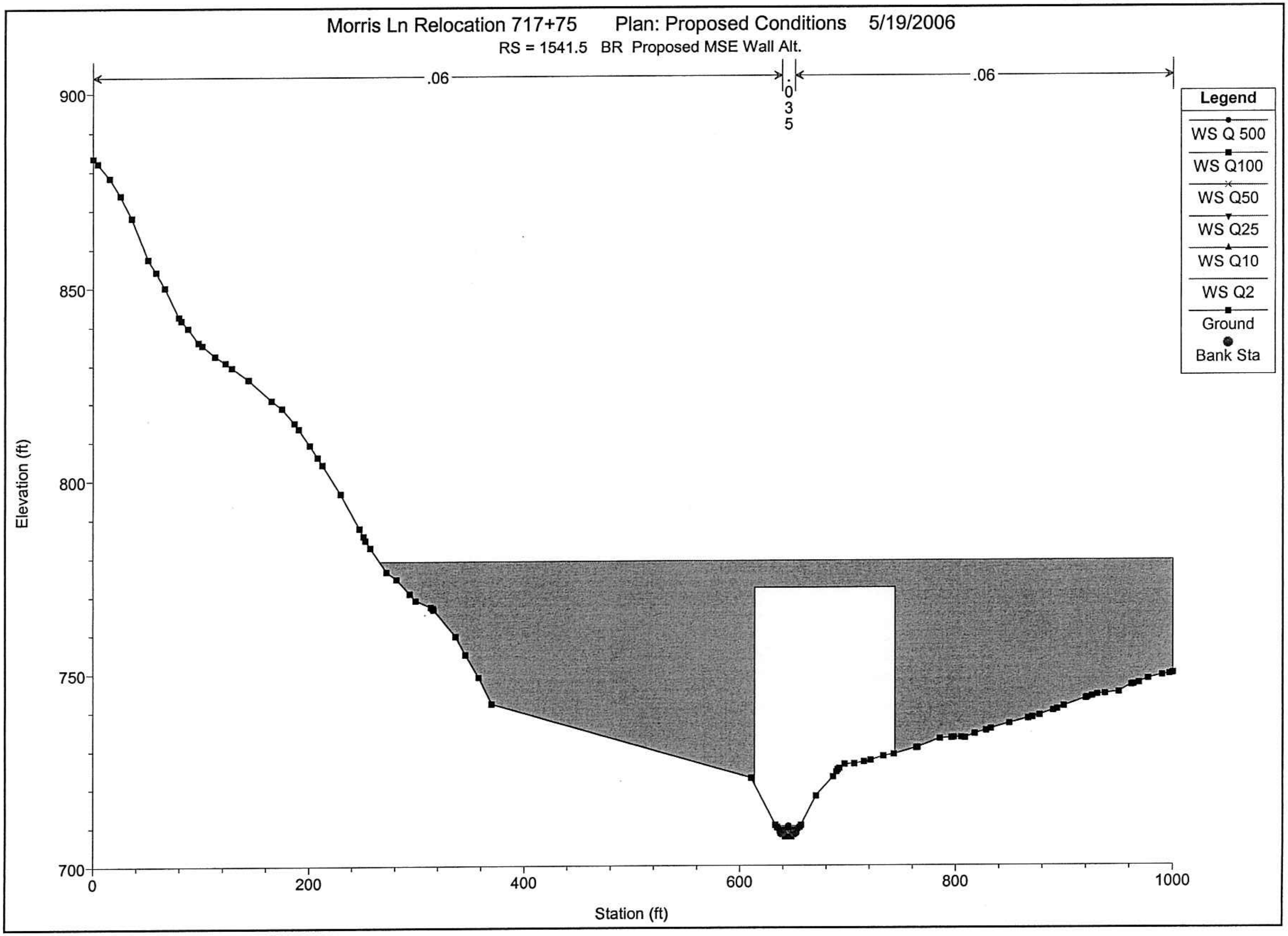
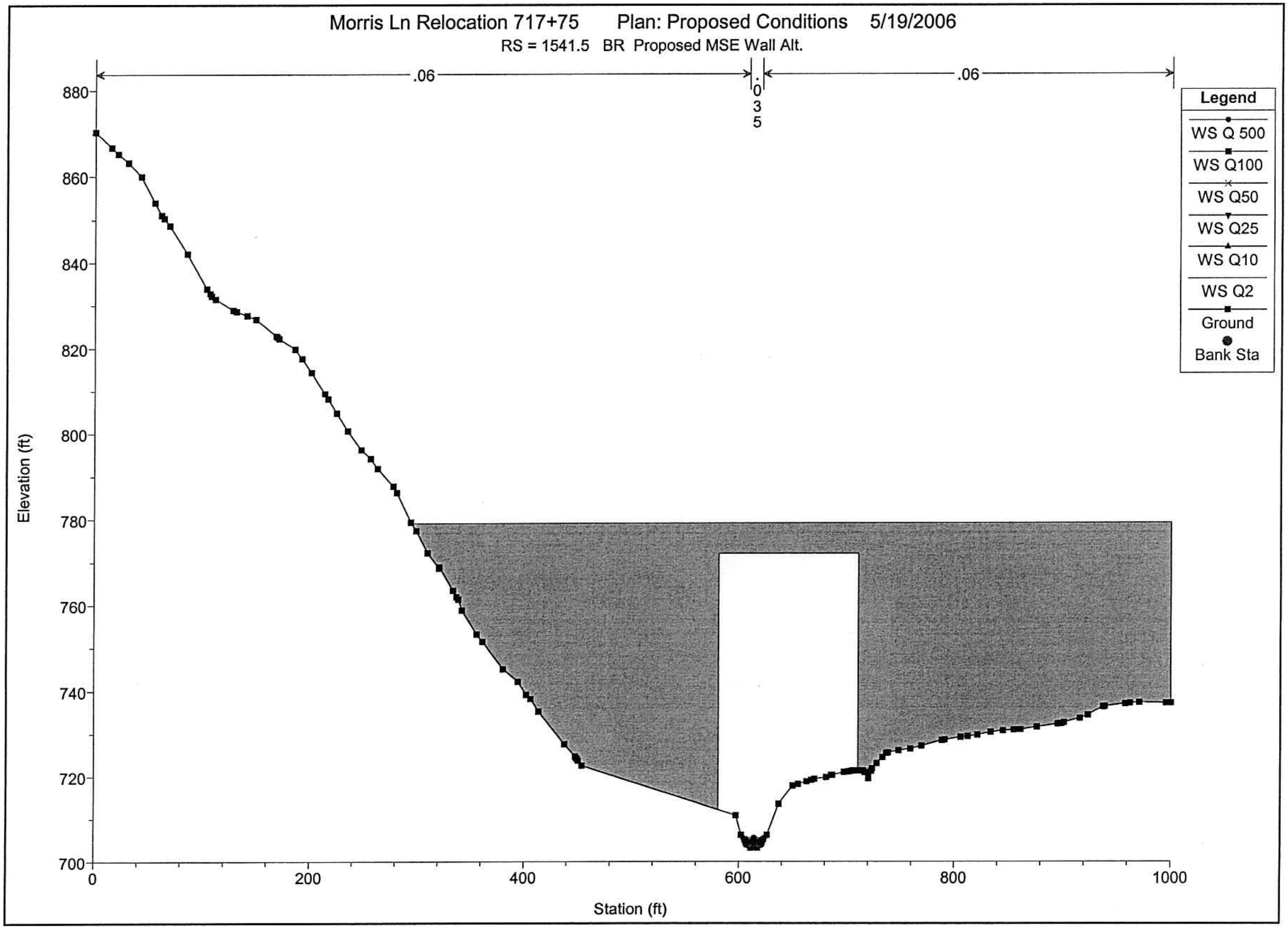


Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006

RS = 1541.5 BR Proposed MSE Wall Alt.

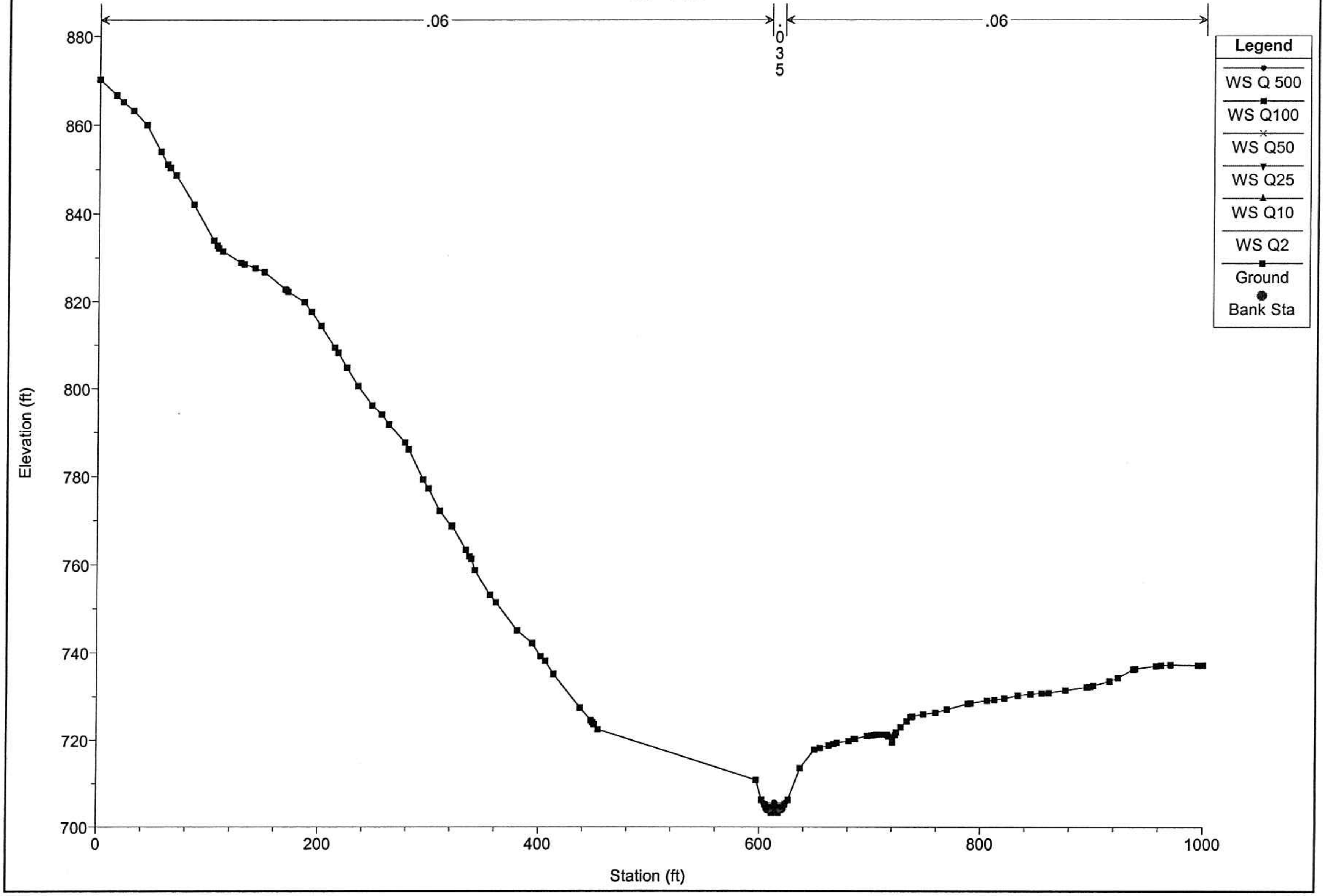


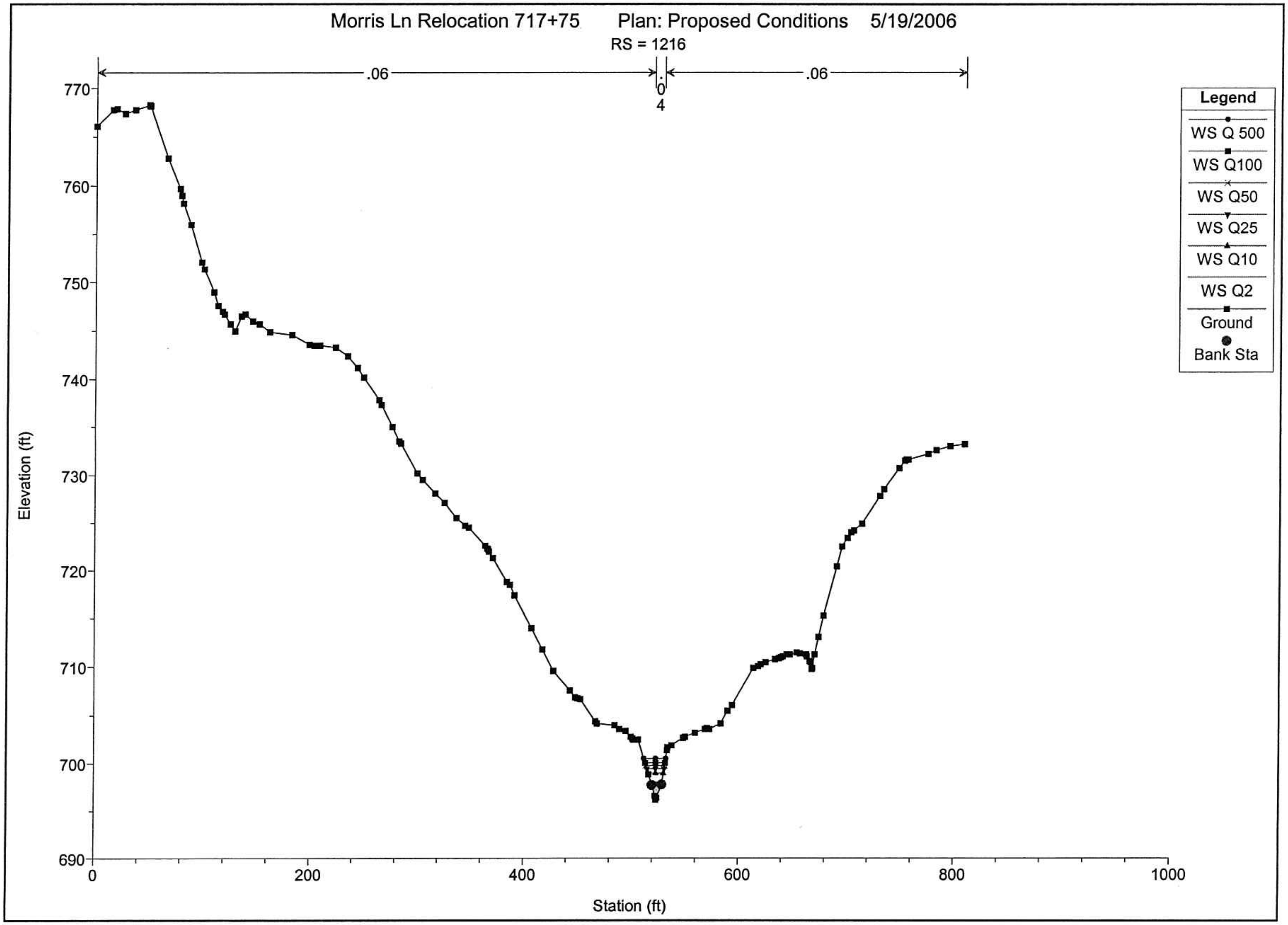
Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006

RS = 1541.5 BR Proposed MSE Wall Alt.

Morris Ln Relocation 717+75   Plan: Proposed Conditions   5/19/2006

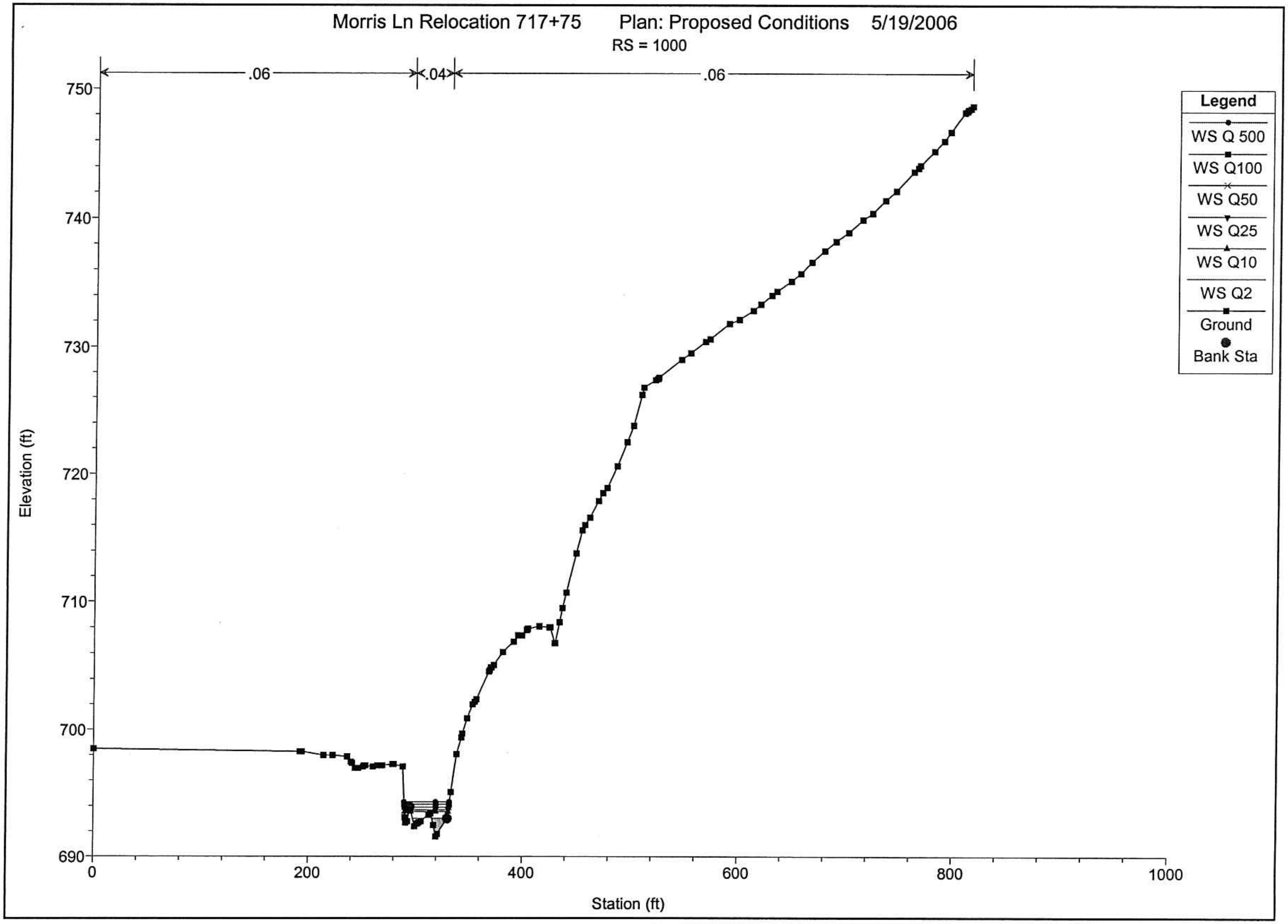
RS = 1493





Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006

RS = 1216



Morris Ln Relocation 717+75 Plan: Proposed Conditions 5/19/2006

RS = 1000

CHANNEL PHOTOGRAPHS

TranSystems

Looking West at Morris Lane at Bridge Location

Looking at Stream To Be Relocated at Bridge Location

Looking at Area Under Embankment Fill Between Morris Lane and The Existing Channel
(Back Station)

Looking at Area Under Embankment Fill Including Stream (Ahead Station)

HYDRAULIC CALCULATIONS

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2086	Q2	54.63	723.90	725.70	725.70	726.17	0.025274	5.46	10.00	10.80	0.99
Reach-1	2086	Q10	166.17	723.90	726.73	726.73	727.59	0.018923	7.46	23.31	15.02	0.96
Reach-1	2086	Q25	236.16	723.90	727.22	727.22	728.25	0.016873	8.24	31.20	17.14	0.95
Reach-1	2086	Q50	294.26	723.90	727.58	727.58	728.72	0.015788	8.76	37.63	18.69	0.94
Reach-1	2086	Q100	352.59	723.90	727.80	727.80	729.17	0.017267	9.65	41.88	21.08	0.99
Reach-1	2086	Q 500	458.40	723.90	728.77	728.77	729.69	0.008880	8.37	81.05	52.77	0.75
Reach-1	2050.66*	Q2	54.63	722.87	724.60	724.63	725.10	0.029653	5.68	9.62	11.10	1.07
Reach-1	2050.66*	Q10	166.17	722.87	725.34	725.66	726.57	0.035185	8.95	19.22	14.93	1.28
Reach-1	2050.66*	Q25	236.16	722.87	725.68	726.13	727.27	0.034884	10.22	24.71	16.78	1.32
Reach-1	2050.66*	Q50	294.26	722.87	725.94	726.44	727.77	0.034308	11.04	29.24	18.40	1.33
Reach-1	2050.66*	Q100	352.59	722.87	726.20	726.79	728.20	0.032602	11.62	34.22	20.04	1.33
Reach-1	2050.66*	Q 500	458.40	722.87	726.58	727.58	728.95	0.032323	12.77	42.74	25.54	1.35
Reach-1	2015.33*	Q2	54.63	721.83	723.55	723.58	724.03	0.029093	5.55	9.86	11.79	1.06
Reach-1	2015.33*	Q10	166.17	721.83	724.43	724.57	725.37	0.023667	7.85	22.69	17.51	1.07
Reach-1	2015.33*	Q25	236.16	721.83	724.75	725.05	726.01	0.025676	9.19	28.75	20.52	1.15
Reach-1	2015.33*	Q50	294.26	721.83	724.98	725.41	726.48	0.026960	10.12	33.73	23.88	1.20
Reach-1	2015.33*	Q100	352.59	721.83	725.15	725.50	726.93	0.029222	11.07	38.03	26.23	1.26
Reach-1	2015.33*	Q 500	458.40	721.83	725.43	726.37	727.64	0.032316	12.52	45.75	29.59	1.35
Reach-1	1980.*	Q2	54.63	720.80	722.53	722.53	722.95	0.025479	5.17	10.59	12.92	0.99
Reach-1	1980.*	Q10	166.17	720.80	723.21	723.50	724.30	0.031111	8.46	21.16	18.46	1.21
Reach-1	1980.*	Q25	236.16	720.80	723.56	723.98	724.91	0.030280	9.56	28.47	24.99	1.23
Reach-1	1980.*	Q50	294.26	720.80	723.76	724.26	725.34	0.031368	10.44	33.84	27.24	1.28
Reach-1	1980.*	Q100	352.59	720.80	723.94	724.47	725.73	0.032481	11.23	39.00	29.74	1.32
Reach-1	1980.*	Q 500	458.40	720.80	724.24	725.06	726.31	0.033114	12.33	48.39	32.85	1.36
Reach-1	1944.66*	Q2	54.63	719.77	721.43	721.46	721.87	0.029773	5.37	10.21	13.55	1.06
Reach-1	1944.66*	Q10	166.17	719.77	722.18	722.43	723.13	0.026784	7.97	23.94	26.41	1.13
Reach-1	1944.66*	Q25	236.16	719.77	722.43	722.81	723.69	0.030624	9.39	30.64	29.13	1.24
Reach-1	1944.66*	Q50	294.26	719.77	722.62	723.07	724.07	0.031514	10.21	36.56	31.66	1.28
Reach-1	1944.66*	Q100	352.59	719.77	722.79	723.37	724.41	0.032453	10.93	41.98	33.18	1.31
Reach-1	1944.66*	Q 500	458.40	719.77	723.06	723.78	724.96	0.033804	12.07	51.25	35.91	1.37
Reach-1	1909.33*	Q2	54.63	718.73	720.39	720.39	720.79	0.025225	5.07	10.93	14.86	0.99
Reach-1	1909.33*	Q10	166.17	718.73	720.99	721.30	721.98	0.032115	8.26	24.25	29.30	1.22
Reach-1	1909.33*	Q25	236.16	718.73	721.27	721.62	722.44	0.031583	9.22	32.95	33.19	1.25

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1909.33*	Q50	294.26	718.73	721.44	721.85	722.78	0.032909	10.04	38.75	34.69	1.29
Reach-1	1909.33*	Q100	352.59	718.73	721.61	722.06	723.07	0.033037	10.65	44.71	36.28	1.32
Reach-1	1909.33*	Q 500	458.40	718.73	721.86	722.51	723.57	0.034172	11.72	54.28	38.78	1.36
Reach-1	1874	Q2	54.63	717.70	719.28	719.36	719.71	0.030343	5.31	10.49	15.54	1.07
Reach-1	1874	Q10	166.17	717.70	719.87	720.11	720.71	0.030574	7.84	27.47	34.10	1.18
Reach-1	1874	Q25	236.16	717.70	720.09	720.40	721.14	0.033137	9.01	35.15	36.14	1.26
Reach-1	1874	Q50	294.26	717.70	720.27	720.60	721.44	0.033278	9.68	41.55	37.70	1.29
Reach-1	1874	Q100	352.59	717.70	720.41	720.80	721.72	0.033984	10.34	47.31	39.13	1.32
Reach-1	1874	Q 500	458.40	717.70	720.67	720.98	722.17	0.034334	11.29	57.47	41.55	1.36
Reach-1	1842.44*	Q2	54.63	716.27	717.75	717.87	718.28	0.043047	5.86	9.37	14.56	1.25
Reach-1	1842.44*	Q10	166.17	716.27	718.45	718.74	719.43	0.032903	8.22	24.14	30.33	1.23
Reach-1	1842.44*	Q25	236.16	716.27	718.74	719.08	719.86	0.030873	9.04	33.29	33.33	1.23
Reach-1	1842.44*	Q50	294.26	716.27	718.94	719.29	720.18	0.030201	9.64	40.24	35.89	1.24
Reach-1	1842.44*	Q100	352.59	716.27	719.11	719.49	720.46	0.030132	10.21	46.48	37.31	1.26
Reach-1	1842.44*	Q 500	458.40	716.27	719.39	719.83	720.91	0.029669	11.05	57.36	39.72	1.28
Reach-1	1810.88*	Q2	54.63	714.84	716.36	716.41	716.80	0.031483	5.30	10.37	14.89	1.09
Reach-1	1810.88*	Q10	166.17	714.84	716.99	717.35	718.07	0.035473	8.46	21.45	21.77	1.28
Reach-1	1810.88*	Q25	236.16	714.84	717.30	717.68	718.58	0.032985	9.38	30.11	30.63	1.28
Reach-1	1810.88*	Q50	294.26	714.84	717.51	717.94	718.92	0.032277	10.02	36.53	32.17	1.29
Reach-1	1810.88*	Q100	352.59	714.84	717.69	718.17	719.22	0.031600	10.56	42.73	33.98	1.29
Reach-1	1810.88*	Q 500	458.40	714.84	718.00	718.51	719.70	0.030391	11.37	53.77	37.38	1.30
Reach-1	1779.33*	Q2	54.63	713.42	714.85	714.95	715.36	0.041430	5.71	9.58	14.59	1.23
Reach-1	1779.33*	Q10	166.17	713.42	715.52	715.81	716.63	0.036855	8.53	20.70	20.05	1.30
Reach-1	1779.33*	Q25	236.16	713.42	715.83	716.29	717.21	0.035398	9.62	27.50	24.49	1.32
Reach-1	1779.33*	Q50	294.26	713.42	716.06	716.55	717.60	0.033642	10.24	33.81	28.93	1.32
Reach-1	1779.33*	Q100	352.59	713.42	716.26	716.77	717.93	0.032692	10.80	39.89	31.70	1.32
Reach-1	1779.33*	Q 500	458.40	713.42	716.57	717.17	718.45	0.031939	11.69	49.90	33.91	1.33
Reach-1	1747.77*	Q2	54.63	711.99	713.46	713.50	713.89	0.032370	5.26	10.40	14.94	1.10
Reach-1	1747.77*	Q10	166.17	711.99	714.07	714.37	715.17	0.036515	8.46	20.53	18.65	1.29
Reach-1	1747.77*	Q25	236.16	711.99	714.37	714.80	715.78	0.036636	9.68	26.51	21.80	1.34
Reach-1	1747.77*	Q50	294.26	711.99	714.59	715.10	716.21	0.036057	10.46	31.59	24.51	1.36
Reach-1	1747.77*	Q100	352.59	711.99	714.80	715.38	716.58	0.034630	11.03	37.18	27.75	1.36
Reach-1	1747.77*	Q 500	458.40	711.99	715.13	715.75	717.14	0.033013	11.90	47.08	31.61	1.36

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1716.22*	Q2	54.63	710.56	711.96	712.05	712.45	0.040453	5.60	9.75	14.78	1.21
Reach-1	1716.22*	Q10	166.17	710.56	712.61	712.90	713.70	0.036955	8.43	20.38	17.70	1.30
Reach-1	1716.22*	Q25	236.16	710.56	712.91	713.32	714.33	0.036644	9.64	26.12	20.76	1.34
Reach-1	1716.22*	Q50	294.26	710.56	713.13	713.64	714.77	0.036351	10.45	30.83	22.63	1.36
Reach-1	1716.22*	Q100	352.59	710.56	713.33	713.91	715.17	0.036050	11.15	35.51	24.64	1.38
Reach-1	1716.22*	Q 500	458.40	710.56	713.66	714.36	715.79	0.034586	12.10	44.49	28.47	1.39
Reach-1	1684.66*	Q2	54.63	709.13	710.55	710.60	710.98	0.033010	5.22	10.47	15.16	1.11
Reach-1	1684.66*	Q10	166.17	709.13	711.16	711.41	712.24	0.036610	8.35	20.47	17.67	1.29
Reach-1	1684.66*	Q25	236.16	709.13	711.46	711.86	712.87	0.036871	9.60	25.86	19.60	1.34
Reach-1	1684.66*	Q50	294.26	709.13	711.67	712.16	713.32	0.036770	10.44	30.33	21.69	1.37
Reach-1	1684.66*	Q100	352.59	709.13	711.87	712.44	713.73	0.036406	11.14	34.81	23.26	1.39
Reach-1	1684.66*	Q 500	458.40	709.13	712.20	712.88	714.38	0.035530	12.18	42.97	26.21	1.40
Reach-1	1653.11*	Q2	54.63	707.71	709.06	709.14	709.54	0.039105	5.55	9.85	14.77	1.20
Reach-1	1653.11*	Q10	166.17	707.71	709.71	709.97	710.77	0.036831	8.31	20.46	17.64	1.29
Reach-1	1653.11*	Q25	236.16	707.71	709.99	710.39	711.40	0.037335	9.58	25.68	18.73	1.35
Reach-1	1653.11*	Q50	294.26	707.71	710.21	710.69	711.86	0.036943	10.40	30.00	20.76	1.37
Reach-1	1653.11*	Q100	352.59	707.71	710.42	710.98	712.28	0.036463	11.10	34.37	22.39	1.39
Reach-1	1653.11*	Q 500	458.40	707.71	710.74	711.44	712.95	0.036170	12.21	41.94	24.85	1.42
Reach-1	1621.55*	Q2	54.63	706.28	707.65	707.71	708.08	0.034064	5.28	10.36	15.09	1.12
Reach-1	1621.55*	Q10	166.17	706.28	708.26	708.51	709.31	0.036557	8.24	20.58	17.71	1.29
Reach-1	1621.55*	Q25	236.16	706.28	708.56	708.90	709.92	0.036344	9.44	25.94	18.74	1.33
Reach-1	1621.55*	Q50	294.26	706.28	708.76	709.23	710.39	0.036804	10.32	29.93	19.71	1.37
Reach-1	1621.55*	Q100	352.59	706.28	708.96	709.51	710.82	0.036810	11.07	33.98	21.61	1.39
Reach-1	1621.55*	Q 500	458.40	706.28	709.28	709.97	711.51	0.036352	12.18	41.37	23.91	1.42
Reach-1	1590	Q2	54.63	704.85	706.16	706.26	706.64	0.038343	5.52	9.90	14.74	1.19
Reach-1	1590	Q10	166.17	704.85	706.81	707.05	707.85	0.036984	8.21	20.58	17.76	1.29
Reach-1	1590	Q25	236.16	704.85	707.09	707.44	708.46	0.037327	9.45	25.76	18.71	1.34
Reach-1	1590	Q50	294.26	704.85	707.31	707.77	708.92	0.037036	10.27	29.87	19.42	1.37
Reach-1	1590	Q100	352.59	704.85	707.50	708.05	709.35	0.037001	11.02	33.76	20.62	1.39
Reach-1	1590	Q 500	458.40	704.85	707.82	708.51	710.06	0.036888	12.18	40.78	23.14	1.43
Reach-1	1557.66*	Q2	54.63	704.07	705.67	705.61	706.00	0.020841	4.61	11.84	14.48	0.90
Reach-1	1557.66*	Q10	166.17	704.07	706.50	706.46	707.21	0.018198	6.82	25.26	17.77	0.94

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1557.66*	Q25	236.16	704.07	706.90	706.89	707.80	0.017413	7.71	32.62	19.82	0.96
Reach-1	1557.66*	Q50	294.26	704.07	707.21	707.21	708.22	0.016213	8.20	39.23	21.81	0.94
Reach-1	1557.66*	Q100	352.59	704.07	707.50	707.50	708.60	0.015465	8.64	45.62	23.24	0.94
Reach-1	1557.66*	Q 500	458.40	704.07	707.97	707.97	709.22	0.014225	9.27	57.29	25.55	0.93
Reach-1	1525.33*	Q2	54.63	703.28	705.08		705.40	0.017770	4.54	12.03	13.21	0.84
Reach-1	1525.33*	Q10	166.17	703.28	706.02	705.90	706.69	0.015099	6.64	26.34	17.51	0.87
Reach-1	1525.33*	Q25	236.16	703.28	706.43	706.34	707.29	0.014963	7.57	34.00	19.76	0.89
Reach-1	1525.33*	Q50	294.26	703.28	706.69	706.68	707.72	0.015507	8.31	39.48	21.22	0.93
Reach-1	1525.33*	Q100	352.59	703.28	706.94	706.99	708.11	0.015947	8.96	44.75	22.39	0.95
Reach-1	1525.33*	Q 500	458.40	703.28	707.38	707.48	708.75	0.015583	9.78	55.06	24.39	0.97
Reach-1	1493	Q2	54.63	702.50	704.38	704.33	704.79	0.022036	5.11	10.68	11.32	0.93
Reach-1	1493	Q10	166.17	702.50	705.34	705.34	706.16	0.018605	7.31	24.04	16.47	0.95
Reach-1	1493	Q25	236.16	702.50	705.81	705.81	706.78	0.016723	8.07	32.37	18.98	0.94
Reach-1	1493	Q50	294.26	702.50	706.16	706.16	707.23	0.015590	8.55	39.29	20.83	0.93
Reach-1	1493	Q100	352.59	702.50	706.45	706.48	707.63	0.015249	9.07	45.54	22.24	0.93
Reach-1	1493	Q 500	458.40	702.50	706.92	706.97	708.28	0.014785	9.85	56.32	23.92	0.94
Reach-1	1458.37*	Q2	54.63	701.71	703.61	703.54	704.00	0.021249	5.05	10.81	11.36	0.91
Reach-1	1458.37*	Q10	166.17	701.71	704.45	704.55	705.40	0.022896	7.87	22.21	15.68	1.05
Reach-1	1458.37*	Q25	236.16	701.71	704.83	705.04	706.05	0.023061	9.02	28.59	17.64	1.09
Reach-1	1458.37*	Q50	294.26	701.71	705.12	705.39	706.53	0.022857	9.75	33.81	19.09	1.10
Reach-1	1458.37*	Q100	352.59	701.71	705.40	705.71	706.94	0.022013	10.30	39.37	20.53	1.10
Reach-1	1458.37*	Q 500	458.40	701.71	705.85	706.20	707.61	0.020910	11.13	49.08	22.37	1.10
Reach-1	1423.75*	Q2	54.63	700.92	702.81	702.76	703.22	0.022177	5.13	10.64	11.25	0.93
Reach-1	1423.75*	Q10	166.17	700.92	703.75	703.78	704.62	0.019238	7.55	23.51	15.89	0.97
Reach-1	1423.75*	Q25	236.16	700.92	704.17	704.27	705.27	0.018953	8.57	30.61	17.94	1.00
Reach-1	1423.75*	Q50	294.26	700.92	704.46	704.63	705.74	0.019097	9.31	36.03	19.36	1.02
Reach-1	1423.75*	Q100	352.59	700.92	704.69	704.94	706.17	0.020225	10.13	40.46	20.32	1.07
Reach-1	1423.75*	Q 500	458.40	700.92	705.10	705.45	706.87	0.020512	11.18	49.17	21.94	1.10
Reach-1	1389.12*	Q2	54.63	700.14	702.04	701.97	702.44	0.020879	5.07	10.78	11.28	0.91
Reach-1	1389.12*	Q10	166.17	700.14	702.90	703.01	703.86	0.021935	7.95	22.33	15.36	1.03
Reach-1	1389.12*	Q25	236.16	700.14	703.32	703.50	704.53	0.021520	9.02	29.09	17.31	1.06
Reach-1	1389.12*	Q50	294.26	700.14	703.63	703.86	705.00	0.020743	9.67	34.81	18.81	1.06
Reach-1	1389.12*	Q100	352.59	700.14	703.90	704.18	705.43	0.020684	10.31	39.97	19.87	1.08

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1389.12*	Q 500	458.40	700.14	704.35	704.69	706.13	0.020162	11.23	49.32	21.60	1.09
Reach-1	1354.5*	Q2	54.63	699.35	701.22	701.19	701.65	0.022674	5.26	10.39	11.06	0.94
Reach-1	1354.5*	Q10	166.17	699.35	702.16	702.23	703.09	0.020312	7.85	22.86	15.33	1.00
Reach-1	1354.5*	Q25	236.16	699.35	702.59	702.72	703.76	0.019973	8.91	29.81	17.26	1.03
Reach-1	1354.5*	Q50	294.26	699.35	702.86	703.09	704.25	0.020679	9.76	34.72	18.44	1.06
Reach-1	1354.5*	Q100	352.59	699.35	703.14	703.42	704.69	0.020592	10.41	39.88	19.49	1.08
Reach-1	1354.5*	Q 500	458.40	699.35	703.58	703.93	705.40	0.020379	11.39	48.93	21.18	1.10
Reach-1	1319.87*	Q2	54.63	698.56	700.46	700.39	700.87	0.020189	5.15	10.65	11.10	0.90
Reach-1	1319.87*	Q10	166.17	698.56	701.35	701.46	702.33	0.021479	8.09	22.31	14.99	1.03
Reach-1	1319.87*	Q25	236.16	698.56	701.78	701.96	703.01	0.021038	9.16	29.14	16.86	1.05
Reach-1	1319.87*	Q50	294.26	698.56	702.09	702.33	703.50	0.020701	9.87	34.59	18.10	1.07
Reach-1	1319.87*	Q100	352.59	698.56	702.37	702.65	703.95	0.020623	10.53	39.73	19.15	1.08
Reach-1	1319.87*	Q 500	458.40	698.56	702.82	703.19	704.66	0.020251	11.49	48.91	20.88	1.10
Reach-1	1285.25*	Q2	54.63	697.78	699.62	699.60	700.08	0.023265	5.46	10.08	10.78	0.96
Reach-1	1285.25*	Q10	166.17	697.78	700.60	700.69	701.57	0.020514	8.07	22.61	14.90	1.01
Reach-1	1285.25*	Q25	236.16	697.78	701.02	701.20	702.26	0.020592	9.20	29.30	16.68	1.05
Reach-1	1285.25*	Q50	294.26	697.78	701.32	701.56	702.76	0.020603	9.97	34.57	17.84	1.07
Reach-1	1285.25*	Q100	352.59	697.78	701.60	701.90	703.21	0.020582	10.64	39.68	18.90	1.09
Reach-1	1285.25*	Q 500	458.40	697.78	702.07	702.44	703.93	0.020258	11.62	48.84	20.65	1.10
Reach-1	1250.62*	Q2	54.63	696.99	698.88	698.81	699.31	0.019216	5.22	10.62	10.89	0.89
Reach-1	1250.62*	Q10	166.17	696.99	699.80	699.91	700.81	0.021235	8.26	22.25	14.61	1.03
Reach-1	1250.62*	Q25	236.16	696.99	700.24	700.44	701.51	0.020623	9.32	29.21	16.41	1.05
Reach-1	1250.62*	Q50	294.26	696.99	700.55	700.81	702.01	0.020678	10.10	34.45	17.60	1.07
Reach-1	1250.62*	Q100	352.59	696.99	700.84	701.14	702.47	0.020532	10.75	39.66	18.70	1.09
Reach-1	1250.62*	Q 500	458.40	696.99	701.31	701.69	703.20	0.020200	11.74	48.87	20.51	1.10
Reach-1	1216	Q2	54.63	696.20	698.02	698.02	698.52	0.024062	5.67	9.78	10.48	0.98
Reach-1	1216	Q10	166.17	696.20	699.04	699.15	700.05	0.020436	8.26	22.52	14.52	1.02
Reach-1	1216	Q25	236.16	696.20	699.48	699.66	700.76	0.020611	9.42	29.19	16.24	1.05
Reach-1	1216	Q50	294.26	696.20	699.79	700.05	701.27	0.020640	10.21	34.48	17.49	1.08
Reach-1	1216	Q100	352.59	696.20	700.08	700.39	701.73	0.020549	10.88	39.70	18.63	1.09
Reach-1	1216	Q 500	458.40	696.20	700.55	700.95	702.47	0.020210	11.87	49.00	20.52	1.11
Reach-1	1180.*	Q2	54.63	695.43	697.09	697.06	697.46	0.023136	4.87	11.23	13.81	0.94

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1180.*	Q10	166.17	695.43	697.58	697.95	698.89	0.044393	9.21	18.59	16.16	1.41
Reach-1	1180.*	Q25	236.16	695.43	697.88	698.40	699.57	0.044027	10.52	23.70	17.61	1.46
Reach-1	1180.*	Q50	294.26	695.43	698.11	698.71	700.08	0.043676	11.42	27.73	18.67	1.48
Reach-1	1180.*	Q100	352.59	695.43	698.31	699.00	700.54	0.043262	12.19	31.64	19.61	1.50
Reach-1	1180.*	Q 500	458.40	695.43	698.65	699.47	701.28	0.042366	13.36	38.53	21.10	1.52
Reach-1	1144.*	Q2	54.63	694.67	696.24	696.20	696.54	0.022786	4.41	12.39	17.38	0.92
Reach-1	1144.*	Q10	166.17	694.67	696.90	696.95	697.62	0.023481	6.83	25.02	21.28	1.04
Reach-1	1144.*	Q25	236.16	694.67	697.21	697.33	698.13	0.022952	7.78	32.07	23.22	1.06
Reach-1	1144.*	Q50	294.26	694.67	697.37	697.60	698.54	0.025973	8.79	35.80	24.00	1.15
Reach-1	1144.*	Q100	352.59	694.67	697.51	697.85	698.93	0.028754	9.71	39.21	24.70	1.22
Reach-1	1144.*	Q 500	458.40	694.67	697.75	698.27	699.60	0.032483	11.14	45.21	25.88	1.32
Reach-1	1108.*	Q2	54.63	693.90	695.46		695.69	0.019562	3.89	14.04	21.27	0.84
Reach-1	1108.*	Q10	166.17	693.90	695.99	696.06	696.64	0.026011	6.49	26.01	25.53	1.06
Reach-1	1108.*	Q25	236.16	693.90	696.19	696.38	697.12	0.029793	7.75	31.54	27.28	1.17
Reach-1	1108.*	Q50	294.26	693.90	696.41	696.63	697.45	0.027522	8.24	37.69	28.61	1.15
Reach-1	1108.*	Q100	352.59	693.90	696.59	696.83	697.76	0.027062	8.78	42.95	29.52	1.17
Reach-1	1108.*	Q 500	458.40	693.90	696.86	697.18	698.29	0.028017	9.80	50.83	30.48	1.21
Reach-1	1072.*	Q2	54.63	693.13	694.65	694.61	694.88	0.022700	3.81	14.32	25.04	0.89
Reach-1	1072.*	Q10	166.17	693.13	695.16	695.21	695.72	0.026044	6.05	28.01	31.57	1.05
Reach-1	1072.*	Q25	236.16	693.13	695.47	695.50	696.11	0.021250	6.51	38.12	33.15	0.99
Reach-1	1072.*	Q50	294.26	693.13	695.64	695.71	696.41	0.021558	7.11	43.97	33.76	1.02
Reach-1	1072.*	Q100	352.59	693.13	695.76	695.89	696.69	0.023893	7.86	47.92	34.06	1.08
Reach-1	1072.*	Q 500	458.40	693.13	695.99	696.20	697.16	0.025337	8.85	55.92	34.60	1.14
Reach-1	1036.*	Q2	54.63	692.37	693.94	693.82	694.11	0.016343	3.25	16.85	30.82	0.75
Reach-1	1036.*	Q10	166.17	692.37	694.44	694.37	694.85	0.019219	5.19	33.46	36.32	0.90
Reach-1	1036.*	Q25	236.16	692.37	694.57	694.63	695.20	0.025839	6.48	38.35	37.27	1.06
Reach-1	1036.*	Q50	294.26	692.37	694.71	694.81	695.48	0.026556	7.11	43.81	37.58	1.10
Reach-1	1036.*	Q100	352.59	692.37	694.89	694.99	695.72	0.024357	7.43	50.60	37.97	1.08
Reach-1	1036.*	Q 500	458.40	692.37	695.15	695.27	696.14	0.023934	8.17	60.22	38.51	1.09
Reach-1	1000	Q2	54.63	691.60	693.01	693.01	693.26	0.028524	4.04	13.89	28.00	0.98
Reach-1	1000	Q10	166.17	691.60	693.55	693.55	693.98	0.025209	5.34	32.54	39.02	1.00
Reach-1	1000	Q25	236.16	691.60	693.79	693.79	694.32	0.023189	5.94	41.98	40.70	1.00
Reach-1	1000	Q50	294.26	691.60	693.88	693.96	694.58	0.028035	6.83	45.56	41.32	1.11

HEC-RAS Plan: Existing River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1000	Q100	352.59	691.60	694.11	694.12	694.80	0.021894	6.80	55.17	41.89	1.01
Reach-1	1000	Q 500	458.40	691.60	694.34	694.38	695.19	0.022269	7.57	64.68	42.35	1.05

HEC-RAS Plan: Proposed   River: RIVER-1   Reach: Reach-1

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	2086	Q2	54.63	723.90	725.70	725.70	726.17	0.025274	5.46	10.00	10.80	0.99
Reach-1	2086	Q10	166.17	723.90	726.73	726.73	727.59	0.018923	7.46	23.31	15.02	0.96
Reach-1	2086	Q25	236.16	723.90	727.22	727.22	728.25	0.016873	8.24	31.20	17.14	0.95
Reach-1	2086	Q50	294.26	723.90	727.58	727.58	728.72	0.015788	8.76	37.63	18.69	0.94
Reach-1	2086	Q100	352.59	723.90	727.80	727.80	729.17	0.017267	9.65	41.88	21.08	0.99
Reach-1	2086	Q 500	458.40	723.90	728.77	728.77	729.69	0.008880	8.37	81.05	52.77	0.75
Reach-1	2050.66*	Q2	54.63	722.87	724.60	724.63	725.10	0.029653	5.68	9.62	11.10	1.07
Reach-1	2050.66*	Q10	166.17	722.87	725.34	725.66	726.57	0.035185	8.95	19.22	14.93	1.28
Reach-1	2050.66*	Q25	236.16	722.87	725.68	726.13	727.27	0.034884	10.22	24.71	16.78	1.32
Reach-1	2050.66*	Q50	294.26	722.87	725.94	726.44	727.77	0.034308	11.04	29.24	18.40	1.33
Reach-1	2050.66*	Q100	352.59	722.87	726.20	726.79	728.20	0.032602	11.62	34.22	20.04	1.33
Reach-1	2050.66*	Q 500	458.40	722.87	726.58	727.58	728.95	0.032323	12.77	42.74	25.54	1.35
Reach-1	2015.33*	Q2	54.63	721.83	723.55	723.58	724.03	0.029093	5.55	9.86	11.79	1.06
Reach-1	2015.33*	Q10	166.17	721.83	724.43	724.57	725.37	0.023667	7.85	22.69	17.51	1.07
Reach-1	2015.33*	Q25	236.16	721.83	724.75	725.05	726.01	0.025676	9.19	28.75	20.52	1.15
Reach-1	2015.33*	Q50	294.26	721.83	724.98	725.41	726.48	0.026960	10.12	33.73	23.88	1.20
Reach-1	2015.33*	Q100	352.59	721.83	725.15	725.50	726.93	0.029222	11.07	38.03	26.23	1.26
Reach-1	2015.33*	Q 500	458.40	721.83	725.43	726.37	727.64	0.032316	12.52	45.75	29.59	1.35
Reach-1	1980.*	Q2	54.63	720.80	722.53	722.53	722.95	0.025479	5.17	10.59	12.92	0.99
Reach-1	1980.*	Q10	166.17	720.80	723.21	723.50	724.30	0.031111	8.46	21.16	18.46	1.21
Reach-1	1980.*	Q25	236.16	720.80	723.56	723.98	724.91	0.030280	9.56	28.47	24.99	1.23
Reach-1	1980.*	Q50	294.26	720.80	723.76	724.26	725.34	0.031368	10.44	33.84	27.24	1.28
Reach-1	1980.*	Q100	352.59	720.80	723.94	724.47	725.73	0.032481	11.23	39.00	29.74	1.32
Reach-1	1980.*	Q 500	458.40	720.80	724.24	725.06	726.31	0.033114	12.33	48.39	32.85	1.36
Reach-1	1944.66*	Q2	54.63	719.77	721.43	721.46	721.87	0.029773	5.37	10.21	13.55	1.06
Reach-1	1944.66*	Q10	166.17	719.77	722.18	722.43	723.13	0.026784	7.97	23.94	26.41	1.13
Reach-1	1944.66*	Q25	236.16	719.77	722.43	722.81	723.69	0.030624	9.39	30.64	29.13	1.24
Reach-1	1944.66*	Q50	294.26	719.77	722.62	723.07	724.07	0.031514	10.21	36.56	31.66	1.28
Reach-1	1944.66*	Q100	352.59	719.77	722.79	723.37	724.41	0.032453	10.93	41.98	33.18	1.31
Reach-1	1944.66*	Q 500	458.40	719.77	723.06	723.78	724.96	0.033804	12.07	51.25	35.91	1.37
Reach-1	1909.33*	Q2	54.63	718.73	720.39	720.39	720.79	0.025225	5.07	10.93	14.86	0.99
Reach-1	1909.33*	Q10	166.17	718.73	720.99	721.30	721.98	0.032115	8.26	24.25	29.30	1.22
Reach-1	1909.33*	Q25	236.16	718.73	721.27	721.62	722.44	0.031583	9.22	32.95	33.19	1.25

HEC-RAS Plan: Proposed River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1909.33*	Q50	294.26	718.73	721.44	721.85	722.78	0.032909	10.04	38.75	34.69	1.29
Reach-1	1909.33*	Q100	352.59	718.73	721.61	722.06	723.07	0.033037	10.65	44.71	36.28	1.32
Reach-1	1909.33*	Q 500	458.40	718.73	721.86	722.51	723.57	0.034172	11.72	54.28	38.78	1.36
Reach-1	1874	Q2	54.63	717.70	719.28	719.36	719.71	0.030343	5.31	10.49	15.54	1.07
Reach-1	1874	Q10	166.17	717.70	719.87	720.11	720.71	0.030574	7.84	27.47	34.10	1.18
Reach-1	1874	Q25	236.16	717.70	720.09	720.40	721.14	0.033137	9.01	35.15	36.14	1.26
Reach-1	1874	Q50	294.26	717.70	720.27	720.60	721.44	0.033278	9.68	41.55	37.70	1.29
Reach-1	1874	Q100	352.59	717.70	720.41	720.80	721.72	0.033984	10.34	47.31	39.13	1.32
Reach-1	1874	Q 500	458.40	717.70	720.67	720.98	722.17	0.034334	11.29	57.47	41.55	1.36
Reach-1	1833.42*	Q2	54.63	716.23	717.57	717.76	718.26	0.059103	6.65	8.23	13.58	1.48
Reach-1	1833.42*	Q10	166.17	716.23	718.29	718.69	719.49	0.038542	8.96	20.68	21.28	1.36
Reach-1	1833.42*	Q25	236.16	716.23	718.66	719.08	719.98	0.032074	9.60	29.75	28.02	1.29
Reach-1	1833.42*	Q50	294.26	716.23	718.90	719.32	720.32	0.029786	10.10	36.89	31.25	1.27
Reach-1	1833.42*	Q100	352.59	716.23	719.10	719.54	720.62	0.028776	10.60	43.34	32.86	1.27
Reach-1	1833.42*	Q 500	458.40	716.23	719.43	719.92	721.09	0.027123	11.32	54.68	35.52	1.27
Reach-1	1792.85*	Q2	54.63	714.77	716.13	716.22	716.64	0.035662	5.75	9.56	13.88	1.18
Reach-1	1792.85*	Q10	166.17	714.77	716.71	717.11	718.05	0.043622	9.41	19.18	19.21	1.45
Reach-1	1792.85*	Q25	236.16	714.77	717.00	717.53	718.68	0.042842	10.66	25.14	21.60	1.48
Reach-1	1792.85*	Q50	294.26	714.77	717.24	717.84	719.08	0.040022	11.30	30.55	23.66	1.46
Reach-1	1792.85*	Q100	352.59	714.77	717.47	718.10	719.43	0.037171	11.77	36.24	25.93	1.44
Reach-1	1792.85*	Q 500	458.40	714.77	717.84	718.53	719.99	0.034018	12.54	46.35	29.53	1.41
Reach-1	1752.28*	Q2	54.63	713.30	714.49	714.67	715.16	0.050193	6.53	8.36	12.77	1.42
Reach-1	1752.28*	Q10	166.17	713.30	715.17	715.60	716.55	0.042227	9.55	18.64	18.00	1.46
Reach-1	1752.28*	Q25	236.16	713.30	715.47	716.02	717.21	0.041214	10.82	24.43	20.42	1.49
Reach-1	1752.28*	Q50	294.26	713.30	715.69	716.32	717.67	0.040190	11.63	29.15	22.03	1.51
Reach-1	1752.28*	Q100	352.59	713.30	715.89	716.59	718.08	0.039383	12.34	33.74	23.38	1.52
Reach-1	1752.28*	Q 500	458.40	713.30	716.24	717.05	718.72	0.037176	13.30	42.27	25.83	1.51
Reach-1	1711.71*	Q2	54.63	711.83	712.99	713.13	713.59	0.040015	6.23	8.77	12.65	1.31
Reach-1	1711.71*	Q10	166.17	711.83	713.61	714.07	715.07	0.042295	9.79	18.01	16.98	1.50
Reach-1	1711.71*	Q25	236.16	711.83	713.92	714.50	715.76	0.041207	11.09	23.54	19.31	1.53
Reach-1	1711.71*	Q50	294.26	711.83	714.14	714.82	716.25	0.040570	11.98	27.96	20.88	1.55
Reach-1	1711.71*	Q100	352.59	711.83	714.34	715.08	716.69	0.039798	12.72	32.35	22.28	1.57
Reach-1	1711.71*	Q 500	458.40	711.83	714.67	715.55	717.39	0.038418	13.82	40.13	24.29	1.58

HEC-RAS Plan: Proposed River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1671.14*	Q2	54.63	710.36	711.40	711.59	712.10	0.045107	6.70	8.15	11.91	1.43
Reach-1	1671.14*	Q10	166.17	710.36	712.06	712.54	713.60	0.042066	10.01	17.51	16.28	1.54
Reach-1	1671.14*	Q25	236.16	710.36	712.36	712.99	714.32	0.041482	11.40	22.71	18.39	1.58
Reach-1	1671.14*	Q50	294.26	710.36	712.59	713.31	714.83	0.040605	12.29	26.99	19.91	1.60
Reach-1	1671.14*	Q100	352.59	710.36	712.79	713.60	715.30	0.039868	13.07	31.20	21.28	1.61
Reach-1	1671.14*	Q 500	458.40	710.36	713.13	714.06	716.03	0.038653	14.23	38.68	23.39	1.63
Reach-1	1630.57*	Q2	54.63	708.90	709.89	710.07	710.57	0.042608	6.61	8.27	11.81	1.39
Reach-1	1630.57*	Q10	166.17	708.90	710.54	711.03	712.11	0.043079	10.15	17.22	15.88	1.56
Reach-1	1630.57*	Q25	236.16	708.90	710.84	711.48	712.86	0.042649	11.57	22.26	17.79	1.60
Reach-1	1630.57*	Q50	294.26	708.90	711.05	711.81	713.40	0.042236	12.53	26.32	19.21	1.63
Reach-1	1630.57*	Q100	352.59	708.90	711.26	712.11	713.87	0.041505	13.33	30.38	20.50	1.64
Reach-1	1630.57*	Q 500	458.40	708.90	711.59	712.55	714.64	0.040435	14.55	37.56	22.60	1.66
Reach-1	1590	Q2	54.63	707.43	708.80	708.55	709.06	0.007965	4.03	13.92	14.25	0.67
Reach-1	1590	Q10	166.17	707.43	709.01	709.51	710.63	0.041853	10.30	16.92	15.46	1.58
Reach-1	1590	Q25	236.16	707.43	709.31	709.97	711.39	0.041277	11.74	21.89	17.28	1.62
Reach-1	1590	Q50	294.26	707.43	709.53	710.31	711.94	0.040773	12.70	25.88	18.62	1.64
Reach-1	1590	Q100	352.59	707.43	709.74	710.62	712.45	0.040387	13.55	29.77	19.83	1.67
Reach-1	1590	Q 500	458.40	707.43	710.07	711.08	713.25	0.039422	14.81	36.77	21.85	1.69
Reach-1	1541.5		Bridge									
Reach-1	1493	Q2	54.63	703.25	704.37	704.37	704.79	0.018930	5.23	10.48	12.72	0.99
Reach-1	1493	Q10	166.17	703.25	704.58	705.33	707.12	0.085885	12.83	13.22	13.95	2.18
Reach-1	1493	Q25	236.16	703.25	704.85	705.79	708.02	0.079778	14.38	17.27	15.60	2.18
Reach-1	1493	Q50	294.26	703.25	705.06	706.12	708.62	0.074128	15.30	20.76	16.88	2.16
Reach-1	1493	Q100	352.59	703.25	705.27	706.45	709.14	0.069499	16.06	24.28	18.09	2.13
Reach-1	1493	Q 500	458.40	703.25	705.62	706.90	709.89	0.061501	17.04	30.98	20.19	2.07
Reach-1	1453.42*	Q2	54.63	702.24	703.33	703.43	703.89	0.029891	5.97	9.16	11.66	1.18
Reach-1	1453.42*	Q10	166.17	702.24	704.24	704.43	705.25	0.020124	8.17	22.11	16.75	1.10
Reach-1	1453.42*	Q25	236.16	702.24	704.51	704.89	705.97	0.024132	9.87	26.82	18.25	1.24
Reach-1	1453.42*	Q50	294.26	702.24	704.72	705.23	706.50	0.026232	11.00	30.69	19.39	1.31
Reach-1	1453.42*	Q100	352.59	702.24	704.91	705.56	706.99	0.027770	11.97	34.48	20.45	1.37
Reach-1	1453.42*	Q 500	458.40	702.24	705.23	706.02	707.79	0.029303	13.39	41.39	22.25	1.44

HEC-RAS Plan: Proposed River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1413.85*	Q2	54.63	701.49	702.76	702.76	703.20	0.020117	5.36	10.21	11.79	0.99
Reach-1	1413.85*	Q10	166.17	701.49	703.72	703.76	704.59	0.015425	7.62	24.06	16.85	0.98
Reach-1	1413.85*	Q25	236.16	701.49	704.17	704.24	705.23	0.014406	8.50	32.17	19.21	0.98
Reach-1	1413.85*	Q50	294.26	701.49	704.55	704.60	705.68	0.012888	8.89	39.81	21.20	0.95
Reach-1	1413.85*	Q100	352.59	701.49	704.89	704.91	706.09	0.011950	9.25	47.14	22.52	0.94
Reach-1	1413.85*	Q 500	458.40	701.49	705.27	705.41	706.76	0.012892	10.40	56.01	23.71	0.99
Reach-1	1374.28*	Q2	54.63	700.23	701.41	701.58	702.11	0.041326	6.74	8.11	10.43	1.35
Reach-1	1374.28*	Q10	166.17	700.23	702.19	702.62	703.67	0.035934	9.85	17.84	14.37	1.40
Reach-1	1374.28*	Q25	236.16	700.23	702.58	703.11	704.37	0.032466	10.91	23.88	16.30	1.39
Reach-1	1374.28*	Q50	294.26	700.23	702.87	703.48	704.87	0.030641	11.63	28.76	17.72	1.38
Reach-1	1374.28*	Q100	352.59	700.23	703.13	703.79	705.31	0.029179	12.24	33.63	19.03	1.37
Reach-1	1374.28*	Q 500	458.40	700.23	703.60	704.30	705.99	0.026080	12.98	43.00	21.07	1.33
Reach-1	1334.71*	Q2	54.63	699.22	700.68	700.68	701.15	0.022406	5.50	9.97	11.06	0.99
Reach-1	1334.71*	Q10	166.17	699.22	701.71	701.74	702.60	0.016604	7.72	23.81	15.86	0.97
Reach-1	1334.71*	Q25	236.16	699.22	702.07	702.24	703.28	0.018304	9.07	29.87	17.54	1.04
Reach-1	1334.71*	Q50	294.26	699.22	702.33	702.61	703.78	0.019410	10.01	34.55	18.74	1.09
Reach-1	1334.71*	Q100	352.59	699.22	702.56	702.92	704.24	0.020304	10.84	39.02	19.72	1.14
Reach-1	1334.71*	Q 500	458.40	699.22	702.95	703.45	704.98	0.021169	12.06	46.96	21.07	1.18
Reach-1	1295.14*	Q2	54.63	698.21	699.78	699.78	700.26	0.023523	5.56	9.87	10.78	0.99
Reach-1	1295.14*	Q10	166.17	698.21	700.63	700.86	701.79	0.025165	8.75	20.65	14.53	1.14
Reach-1	1295.14*	Q25	236.16	698.21	701.09	701.37	702.47	0.022964	9.69	27.71	16.54	1.13
Reach-1	1295.14*	Q50	294.26	698.21	701.40	701.74	702.97	0.022322	10.41	33.10	17.93	1.14
Reach-1	1295.14*	Q100	352.59	698.21	701.67	702.08	703.42	0.022099	11.07	38.16	19.02	1.15
Reach-1	1295.14*	Q 500	458.40	698.21	702.11	702.60	704.15	0.022026	12.14	46.72	20.53	1.18
Reach-1	1255.57*	Q2	54.63	697.21	698.85	698.89	699.40	0.027960	5.94	9.24	10.32	1.07
Reach-1	1255.57*	Q10	166.17	697.21	699.92	700.01	700.90	0.019099	8.13	22.71	14.83	1.01
Reach-1	1255.57*	Q25	236.16	697.21	700.30	700.52	701.61	0.020647	9.48	28.69	16.45	1.08
Reach-1	1255.57*	Q50	294.26	697.21	700.60	700.91	702.12	0.020857	10.31	33.80	17.70	1.11
Reach-1	1255.57*	Q100	352.59	697.21	700.86	701.23	702.59	0.021144	11.05	38.61	18.66	1.13
Reach-1	1255.57*	Q 500	458.40	697.21	701.33	701.78	703.32	0.020661	12.03	47.69	20.36	1.14
Reach-1	1216	Q2	54.63	696.20	698.03	698.03	698.53	0.024464	5.70	9.71	10.35	0.99
Reach-1	1216	Q10	166.17	696.20	699.00	699.17	700.08	0.022814	8.55	21.57	14.22	1.07
Reach-1	1216	Q25	236.16	696.20	699.45	699.69	700.79	0.021932	9.61	28.45	16.04	1.08

HEC-RAS Plan: Proposed River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1216	Q50	294.26	696.20	699.77	700.05	701.30	0.021693	10.38	33.77	17.31	1.10
Reach-1	1216	Q100	352.59	696.20	700.05	700.41	701.77	0.021609	11.06	38.87	18.45	1.11
Reach-1	1216	Q 500	458.40	696.20	700.52	700.97	702.51	0.021405	12.09	47.86	20.31	1.14
Reach-1	1180.*	Q2	54.63	695.43	697.10	697.07	697.47	0.023237	4.88	11.20	13.68	0.95
Reach-1	1180.*	Q10	166.17	695.43	697.61	697.97	698.88	0.042217	9.07	18.87	16.15	1.38
Reach-1	1180.*	Q25	236.16	695.43	697.90	698.40	699.58	0.043527	10.49	23.73	17.55	1.45
Reach-1	1180.*	Q50	294.26	695.43	698.12	698.72	700.09	0.043573	11.41	27.68	18.62	1.48
Reach-1	1180.*	Q100	352.59	695.43	698.32	699.01	700.55	0.043248	12.19	31.58	19.57	1.50
Reach-1	1180.*	Q 500	458.40	695.43	698.66	699.49	701.30	0.042481	13.38	38.42	21.05	1.53
Reach-1	1144.*	Q2	54.63	694.67	696.24	696.20	696.55	0.022755	4.42	12.37	17.31	0.92
Reach-1	1144.*	Q10	166.17	694.67	696.91	696.96	697.63	0.023421	6.83	25.00	21.18	1.04
Reach-1	1144.*	Q25	236.16	694.67	697.22	697.34	698.15	0.023089	7.79	31.96	23.18	1.06
Reach-1	1144.*	Q50	294.26	694.67	697.38	697.61	698.55	0.026092	8.80	35.70	23.97	1.15
Reach-1	1144.*	Q100	352.59	694.67	697.52	697.87	698.95	0.028953	9.74	39.07	24.66	1.23
Reach-1	1144.*	Q 500	458.40	694.67	697.76	698.28	699.61	0.032626	11.16	45.09	25.85	1.33
Reach-1	1108.*	Q2	54.63	693.90	695.47		695.70	0.019568	3.90	14.02	21.23	0.84
Reach-1	1108.*	Q10	166.17	693.90	696.00	696.05	696.65	0.025662	6.46	26.10	25.47	1.06
Reach-1	1108.*	Q25	236.16	693.90	696.20	696.38	697.13	0.029782	7.75	31.51	27.26	1.17
Reach-1	1108.*	Q50	294.26	693.90	696.42	696.63	697.46	0.027516	8.24	37.66	28.61	1.15
Reach-1	1108.*	Q100	352.59	693.90	696.61	696.85	697.77	0.026979	8.77	42.97	29.54	1.16
Reach-1	1108.*	Q 500	458.40	693.90	696.87	697.20	698.30	0.028017	9.80	50.81	30.49	1.21
Reach-1	1072.*	Q2	54.63	693.13	694.66	694.61	694.88	0.022822	3.82	14.29	25.02	0.89
Reach-1	1072.*	Q10	166.17	693.13	695.17	695.22	695.73	0.025338	6.00	28.25	31.58	1.03
Reach-1	1072.*	Q25	236.16	693.13	695.47	695.50	696.12	0.021584	6.54	37.92	33.15	1.00
Reach-1	1072.*	Q50	294.26	693.13	695.64	695.70	696.42	0.022226	7.18	43.52	33.74	1.03
Reach-1	1072.*	Q100	352.59	693.13	695.76	695.89	696.70	0.024092	7.88	47.79	34.07	1.09
Reach-1	1072.*	Q 500	458.40	693.13	696.00	696.20	697.17	0.025437	8.86	55.85	34.61	1.14
Reach-1	1036.*	Q2	54.63	692.37	693.95	693.83	694.11	0.016385	3.26	16.82	30.60	0.76
Reach-1	1036.*	Q10	166.17	692.37	694.28	694.38	694.86	0.032944	6.15	27.86	34.70	1.15
Reach-1	1036.*	Q25	236.16	692.37	694.58	694.64	695.21	0.025015	6.42	38.73	37.29	1.05
Reach-1	1036.*	Q50	294.26	692.37	694.73	694.83	695.48	0.025390	7.02	44.43	37.62	1.08
Reach-1	1036.*	Q100	352.59	692.37	694.90	694.99	695.72	0.024323	7.42	50.60	37.97	1.08
Reach-1	1036.*	Q 500	458.40	692.37	695.15	695.28	696.14	0.023959	8.18	60.18	38.51	1.10

HEC-RAS Plan: Proposed River: RIVER-1 Reach: Reach-1 (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(cfs)	(ft)	(ft)	(ft)	(ft)	(ft/ft)	(ft/s)	(sq ft)	(ft)	
Reach-1	1000	Q2	54.63	691.60	693.01	693.01	693.26	0.028524	4.04	13.89	28.00	0.98
Reach-1	1000	Q10	166.17	691.60	693.55	693.55	693.98	0.025209	5.34	32.54	39.02	1.00
Reach-1	1000	Q25	236.16	691.60	693.71	693.79	694.33	0.030173	6.45	38.54	40.10	1.13
Reach-1	1000	Q50	294.26	691.60	693.90	693.96	694.57	0.026087	6.68	46.63	41.48	1.08
Reach-1	1000	Q100	352.59	691.60	694.12	694.12	694.80	0.021221	6.73	55.71	41.92	1.00
Reach-1	1000	Q 500	458.40	691.60	694.33	694.38	695.19	0.022466	7.59	64.50	42.34	1.05

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PID 14915
Morris Ln. Hyd.