FILE

Revised Structure Type Study

Ramp C over Norfolk Southern Tracks
SCI-823-1603

SCI-823-10.13
PID No. 79977

Prepared for

Ohio Department of Transportation

June 2007

CH2MHILL

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TABLE OF CONTENTS

APPENDIX F

- E-mails, Conversation Records, and Minutes of Meetings held with Norfolk Southern Corporation

APPENDIX G

- ODOT Review Comments of Original Structure Type Study with Consultant Responses

1. Introduction

On July 14, 2005, CH2M HILL submitted the Structure Type Study for the Ramp C Bridge over Norfolk Southern Corporation tracks located at the proposed US-23/SR-823 Interchange. This structure was originally recommended to have a conventional (stub) rear abutment supported on steel H-piles behind a 2:1 spill-through slope, and a conventional (stub) forward abutment supported on steel H-piles behind a Mechanically Stabilized Embankment (MSE) wall. Subsequent ODOT review comments of the Structure Type Study on October 14, 2005 recognized the economic benefit of recommending a MSE Wall forward abutment; however, ODOT Office of Structural Engineering (OSE) commented that *"The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure Type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office."*

All retaining wall justification and wall type studies were to be conducted by another consultant and coordinated with CH2M HILL. Since a Wall Type Study was not submitted, the Ramp C Bridge over Norfolk Southern tracks has not been approved by OSE to-date.

In October 2006, the project's geotechnical consultant, DLZ, submitted a revised *"Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23/SR 823 Interchange"* report, which included the design calculations requested by ODOT OSE. The report concluded that *"MSE walls can be safely constructed using staged construction and ground modification techniques at this interchange. However, due to the relatively poor subsurface conditions, the risk of detrimental differential settlement is greater when constructing MSE walls using staged construction."* Due to concerns over the existing soil conditions at the proposed interchange location, additional ground improvement and/or wall alternatives were investigated in a Wall Type Study in conjunction with revised Structure Type Studies for the three proposed bridges at Fairground Road; these reports were submitted to ODOT OSE in April 2007.

After reviewing DLZ's revised *"Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23/SR 823 Interchange"* report, ODOT provided comments via a memorandum from Peter Narsavage dated April 23, 2007. One of the comments read, *"From the report, we understand that undrained bearing capacity and differential settlement of the ramp MSE walls are of concern. The other stability checks, such as global stability, sliding, and drained bearing capacity result in acceptable safety factors. We believe that MSE walls could be built in two stages, without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. Where the height of the MSE wall was high enough to cause concern about differential settlement, slip joints can be provided at regular intervals. The top row of facing panels would not be fabricated until after settlement was substantially complete."* A subsequent follow-up conversation with Mr. Narsavage on April 26, 2007 resulted in ODOT directing CH2M HILL not to perform any further Wall Type Studies at the interchange location, and to assume that MSE walls will be built in two stages without surcharging or ground improvements. CH2M HILL will re-evaluate this assumption after final borings and testing have been completed.

Furthermore, OSE also requested that CH2M HILL investigate the use of a steel tub girder superstructure type with its October 2005 Structure Type Study review. One of the comments read, *"We cannot determine the best structure type at this point in time. We would like the Design Consultant to investigate the use of trapezoidal twin steel box girders for the one span alternate. Please provide the cost analysis for this alternate. The guideline of choosing the most economical structure as the best alternate might not apply in this location and that's why we are requesting the Design Consultant to investigate other structure types."* In response to this comment, CH2M HILL has included a trapezoidal twin steel box alternative in this Revised Structure Type Study; however, the required span length over the Norfolk Southern tracks has since increased to accommodate additional future tracks and there is no longer a one span alternative for this bridge. The trapezoidal twin steel box alternative was investigated and is presented as Alternative 3b in this report.

2. Major Developments

The following is a summary of the changes made to the previous Structure Type Study for the Ramp C Bridge over Norfolk Southern tracks.

- Discussions between Norfolk Southern and ODOT District 9 in March 2006 indicated that Norfolk Southern has plans to add two additional tracks at the interchange location as part of the 'Heartland Corridor' project. Norfolk Southern has not indicated when the two future tracks will be constructed. As a result, the bridge abutments/piers adjacent to the railroad must be situated to accommodate two future tracks that will be located outside of the two existing tracks.
- Six (6) bridge alternatives were considered to determine the most economical, combined structural system:

    1. Three span bridge with a steel I-girder superstructure behind a 2:1 spill-through slope at the rear end of the bridge and a MSE Wall at the forward end, with the pier east of the railroad tracks situated outside of the existing crushed aggregate ditch running alongside the railway;

    2. Two span bridge with a steel I-girder superstructure behind a 2:1 spill-through slope at the rear end of the bridge and a MSE Wall at the forward end, with the pier east of the railroad tracks situated inside of the existing crushed aggregate ditch running alongside the railway and relocating the ditch behind the pier in order to reduce the span lengths;

    3a. Two span bridge with a steel I-girder superstructure behind MSE Walls at both ends of the bridge, with the MSE Wall east of the railroad tracks situated outside of the existing crushed aggregate ditch running alongside the railway;

    3b. Two span bridge with a trapezoidal twin steel box girder superstructure behind MSE Walls at both ends of the bridge, with the MSE Wall east of the railroad tracks situated outside of the existing crushed aggregate ditch running alongside the railway;

4. Three span bridge with a steel I-girder superstructure behind a 2:1 spill-through slope at the rear end of the bridge and a MSE Wall at the forward end, with the pier east of the railroad tracks situated inside of the existing crushed aggregate ditch running alongside the railway and relocating the ditch behind the pier in order to reduce the span lengths; and

5. Two span bridge with a steel I-girder superstructure behind MSE Walls at both ends of the bridge utilizing a steel box straddle bent near the railroad tracks, with the straddle bent support east of the railroad tracks situated outside of the existing crushed aggregate ditch running alongside the railway

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

- All substructure units were placed outside of the 25' horizontal clear zone eliminating the need for crashwalls.
- New pricing information for several structural items in 2006 dollars was used in this Structure Type Study re-submittal.
- The foundation and wall recommendations were revised and are included in Appendix E.

3. Design Criteria

All proposed structure types are in accordance with the latest version of the Ohio Department of Transportation *Bridge Design Manual*, the 2002 *AASHTO Standard Specifications for Highway Bridges*, 17th edition, and the 2003 *AASHTO Guide Specifications for Horizontally Curved Steel Girder Highway Bridges*. Railroad clearances conform to the Norfolk Southern *Overhead Grade Separation Design Criteria* and the 2005 AREMA *Manual for Railway Engineering*.

4. Bridge Transverse Section and Alignment

At the proposed bridge location, Ramp C follows a 07°45'00" horizontal curve (739.30-foot radius) to the right. The proposed section consists of one 16-foot lane, a 6-foot left shoulder, and an 8-foot right shoulder. With two 1'-6" wide single slope outside deflector parapets, the out-to-out deck width is a constant 33'-0" for all alternatives. The Ramp C bridge will be superelevated at a constant 6.9 percent for the entire structure length.

The proposed Ramp C vertical alignment over the Norfolk Southern tracks consists of a -1.50 percent slope at the rear approach, followed by a 200-foot crest vertical curve to a -5.90 percent slope at the forward approach.

The existing railroad section consists of two tracks on approximately 26'-6" centers, proceeding north on an approximate 0.3% downgrade. Ramp C crosses the existing tracks at a skew angle of approximately 60°. No modifications to the existing railroad are anticipated as part of the project, however, apparent settlement of the tracks may require the railroad to realign the vertical profile in the future. Calculations show that realignment may

reduce the proposed vertical clearance by 3 5/8" at the existing west track and 4 3/4" at the existing east track; therefore, 23'-4 3/4" of vertical clearance shall be provided as a minimum. Allowing for this realignment is required per Norfolk Southern Corporation's publication, "Overhead Grade Separation Design Criteria". In addition, the bridge span over the railroad must be designed to accommodate for two future tracks that will be added to the outside of the two existing tracks. It is assumed that the vertical alignment of the proposed tracks will match the alignment of the adjacent existing track and will be located 14'-0" from the center of each existing track per conversations with the Norfolk Southern Corporation.

5. Proposed Maintenance of Traffic Solution

The proposed Ramp C alignment will carry traffic exiting westbound SR-823 onto northbound US-23. Because the Ramp C alignment is new construction over the railway, there are no maintenance of highway traffic concerns.

Coordination with railway traffic below the proposed bridge will be required during construction. All features have been located such that permanent and temporary works will be located outside the permanent or temporary clear zones as applicable. Appropriate railroad flagging and insurance will be required throughout construction.

6. Evaluation of Structure Alternatives

Common Considerations

Construction costs for each alternative have been developed for an identical length of improvement, equal to the out-to-out length of the longest alternative. Estimated construction costs for each alternative include all proposed work between these limits. The roadway profile has been set to provide adequate vertical clearance over the railroad (23'-0" above top of high rail) for a superstructure depth equal to 11'-3". Any savings associated with superstructure depths less than 11'-3" is considered to be negligible as the largest deviation from the 11'-3" superstructure depth is in Alternative 5, where the vertical clearance is controlled by the bottom of the straddle bent cap. Costs to relocate utilities, and costs for services or construction to be provided by Norfolk Southern Corporation are not included in this document. It is reasonable to assume that these costs will be similar for all alternatives, and would not influence the selection of the preferred alternative.

Railroad horizontal clearance is a primary consideration in determining the possible span arrangements. The following minimum horizontal clearances to the centerline of the adjacent future track were maintained for all alternatives:

- MSE wall abutments or piers without crash walls: 25'-0"
- Pier footings: 17'-0" (to allow for temporary shoring)

These horizontal clearances allow adequate room to maintain existing railroad drainage. Some minor ditch modifications will be required due to the future new tracks, but these are not anticipated to impact the railway roadbed nor decrease the capacity of the existing ditches. In addition, an open channel with crushed aggregate maintains flow east of the tracks, and directs the flow south into an existing culvert under the railroad. This railroad culvert is expected to serve adequately in its current location. Preservation of the existing

railroad culvert is desirable, because of the considerable costs associated with potential relocation of this drainage structure. As a result, several bridge alternatives (Alternatives 1, 3a, 3b, and 5) have substructures that are located to preserve the existing crushed aggregate open channel, consequently increasing span lengths for these alternatives. In order to shorten span lengths, bridge substructures in several alternatives (Alternatives 2 and 4) are located with a pier inside of the existing crushed aggregate open channel. This requires the existing open channel to be redirected around and behind the pier. At the May 2, 2007 meeting with Norfolk Southern representatives at ODOT Central Office, Norfolk Southern concluded that redirecting this open channel to allow shorter span lengths would be permitted.

The ramp horizontal alignment was optimized, within the constraints of the overall interchange geometry, to minimize the skew and the span length over the tracks. The resulting 60° skew, 54'-6" from outside future west track to outside future east track, adjacent open channel, and railroad horizontal clearance considerations require a minimum clear span (face-to-face of substructures) of approximately 231.0 feet along the construction baseline. Furthermore, Norfolk Southern has indicated that situating a pier in the railroad bed between existing tracks is unacceptable, as it would not provide acceptable horizontal clearance.

The possible superstructure types are limited by the site characteristics. Given the minimum clear span length of 231.0 feet, the degree of curvature, and the preference to use conventional deck overhangs (less than 4'-0"), the girders must be horizontally curved. Possible structure types include curved box girders (post-tensioned concrete or steel) and curved plate girders. The falsework required for a cast-in-place box is not compatible with maintaining railroad traffic (and Norfolk Southern will not allow a cast-in-place superstructure above its tracks), and the bridge size and site conditions do not permit segmental concrete construction to be competitive, so those two alternatives can be dismissed without further investigation. Of the two remaining superstructure types, experience suggests that steel tub girders are advantageous for tight radius curves and are sometimes considered aesthetically superior, but tend to be more expensive than plate girders. For this reason, all span arrangements are first investigated assuming curved steel plate I-girders. Alternative 3 is then re-investigated using curved trapezoidal twin steel tub girders. Unpainted weathering steel is selected in lieu of coated steel, to minimize initial construction and future lifecycle maintenance costs; this is consistent with the Department's recommendation to use weathering steel over railways. The use of weathering steel is also consistent with the proposed adjacent bridges carrying SR-823 and Ramp B – please refer to separate Structure Type Study submittals for these two structures.

Substructure types are also somewhat limited by the site characteristics. The portion of Ramp C beyond the bridge traveling upstation will be partially or totally retained by MSE walls, as dictated by the proximity of the railroad and the adjacent northbound US-23. Therefore, an MSE type abutment is a logical choice for the forward abutment. A retained-fill type and a spill-through type are both feasible options for the rear abutment. However, placement of a retained-fill type rear abutment must preserve the existing crushed aggregate open channel just east of the existing tracks, in order to prevent a closed drainage system from flowing through an MSE abutment wall and the considerable costs and maintenance issues associated with this. At either location, MSE abutment walls placed less

than 25'-0" but more than 22'-0" from the future track centerline would require a cast-in-place concrete crash wall. The significant expense of building such a wall is not likely to be overcome by the cost savings realized with a nominally shorter superstructure. Therefore, MSE abutment walls and piers within 25'-0" of the future track centerlines are not considered in this study. For Alternatives 1, 2, 3a, 3b, and 4, hammerhead piers are selected because their cantilever cap minimizes span lengths. Alternative 5 investigates the use of a straddle bent pier spanning the railroad tracks in order to minimize the overall bridge length.

Constructability issues are also investigated for all of these long curved steel superstructures. Each alternative will require temporary falsework bents to be built in order to accommodate steel erection. Locations of the falsework bents for all six alternatives are approximated, and a temporary falsework bent will be required between the two existing tracks for Alternatives 2, 3a, 3b, and 5. Alternatives 1 and 4 will require two temporary falsework bents to be constructed, but neither of the temporary bents will be located between the two existing railroad tracks.

As previously mentioned in the original Structure Type Study, FEMA estimates the 100-year flood at elevation 543 feet, due to backwater from the Scioto River. Piers located on the west side of the railroad and the forward abutment would be inundated in this event. It is anticipated that MSE walls at the forward abutment may require specialized fill material, rip-rap, or other means to protect against scour. The Department should consider authorizing both a Hydraulic Analysis and Scour Analysis to aid in selection of pier foundation details, MSE wall details, and foundation details at the forward abutment. Because of the horizontally curved superstructure, integral and semi-integral abutments are not feasible options per the ODOT *Bridge Design Manual*. Each abutment will require a deck joint.

Site horizontal geometry constraints effectively limit the number of feasible span arrangements. The alternatives selected for investigation are intended to represent the optimum layouts for two and three spans. While other arrangements are possible, the alternatives presented here are expected to capture the most economical solutions.

Alternative 1

Alternative 1 is a curved steel plate girder bridge with spans of 175'-0", 250'-0", and 175'-0" center-to-center of bearings along the construction baseline. The stub type rear abutment is on piles behind a spill-through 2:1 slope with 45 degree turn back wingwalls. The stub type forward abutment is on piles behind a three-sided MSE wall. Both hammerhead piers rest on a pile-supported rectangular footing. All piles will be driven to refusal on bedrock. The superstructure consists of four curved high-strength steel plate girders with 102-inch webs spaced at 9'-0" on center.

Both piers are located to provide 25'-0" minimum clear between the pier stem and the nearest future track centerline, with the pier east of the track located to preserve the existing crushed aggregate open channel. The location of both abutments is such that an end span ratio of at least 70% exists, thus eliminating any uplift due to live load effects at the bearings. All substructure units are set radial to the Ramp C baseline. Using radial substructures has the disadvantage of increasing the overall deck area required. However, the following

advantages are simultaneously realized: substructures and MSE walls with smaller widths and right angles are less expensive; a smaller pier cap permits use of a hammerhead pier, and the small pier footprint allows placement for more balanced spans; and regular bridge geometry facilitates repeatability in design, detailing, and construction.

The initial bridge construction cost for Alternative 1 is estimated to be $4,757,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $2,733,000, resulting in a total estimated ownership cost of $7,490,000 in year 2006 dollars.

Alternative 2

Alternative 2 is a curved steel plate girder bridge with spans of 185'-0" and 264'-0" center-to-center of bearings along the construction baseline. The stub type rear abutment is on piles behind a spill-through 2:1 slope, with 45 degree turn back wingwalls. The stub type forward abutment is on piles behind a three-sided MSE wall. The hammerhead pier rests on a pile-supported rectangular footing east of the existing tracks. All piles will be driven to refusal on bedrock. The superstructure consists of four curved high-strength steel plate girders with 120-inch webs spaced at 9'-0" on center.

The forward abutment is located to provide 25'-0" clear between the MSE wall and the nearest future track centerline. The pier is also located to provide 25'-0" clear between the pier stem and the nearest future track centerline; this substructure unit is located inside of the existing crushed aggregate open channel in order to decrease span lengths. The location of the rear abutment provides a span ratio of 70% to minimize uplift. For the load case DL+2.0(LL+I), an uplift of 97.3 kips exists at the rear abutment bearing of the girder at the exterior of the curve. The uplift may be resisted by anchoring the girder's bearing to the abutment seat and providing an abutment cap of sufficient weight to resist the uplift. All substructure units for Alternative 2 are set radial to the Ramp C baseline for all the same reasons discussed under Alternative 1.

The initial bridge construction cost for Alternative 2 is estimated to be $5,867,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $2,375,000, resulting in a total estimated ownership cost of $8,242,000 in year 2006 dollars.

Alternative 3a

Alternative 3a is a curved steel plate girder bridge with spans of 267'-0" and 187'-0" center-to-center of bearings along the construction baseline. Both stub type abutments are on piles behind a three-sided MSE wall. The hammerhead pier rests on a pile-supported rectangular footing west of the existing tracks. All piles will be driven to refusal on bedrock. The superstructure consists of four curved high-strength steel plate girders with 120-inch webs spaced at 9'-0" on center.

The rear abutment is located to provide 25'-0" minimum clear between the MSE wall and the nearest future track centerline; this substructure unit is located outside of the existing crushed aggregate open channel in order to prevent a closed drainage system from flowing through an MSE abutment wall and the considerable costs and maintenance issues associated with this. The pier is also located to provide 25'-0" clear between the pier stem

and the nearest future track centerline. The location of the forward abutment provides a span ratio of 70% to minimize span lengths. For the load case DL+2.0(LL+I), an uplift of 100.1 kips exists at the forward abutment bearing of the girder at the exterior of the curve. The uplift may be resisted by anchoring the girder's bearing to the abutment seat and providing an abutment cap of sufficient weight to resist the uplift. All substructure units for Alternative 3a are set radial to the Ramp C baseline for all the same reasons discussed under Alternative 1.

The initial bridge construction cost for Alternative 3a is estimated to be $5,329,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $2,411,000, resulting in a total estimated ownership cost of $7,740,000 in year 2006 dollars.

Alternative 3b

Alternative 3b is a curved trapezoidal twin steel tub girder bridge with spans of 267'-0" and 187'-0" center-to-center of bearings along the construction baseline. An integral steel pier cap may permit the use of a narrower pier shaft and a subsequent reduction in span lengths as compared to the bridge presented in Alternative 3a; however, for this analysis, the same span lengths presented in Alternative 3a are used. Both stub type abutments are on piles behind a three-sided MSE wall. The pier rests on a pile-supported rectangular footing west of the existing tracks. All piles will be driven to refusal on bedrock. The superstructure consists of two curved high-strength trapezoidal steel tub girders with 102-inch webs spaced at 18'-0" on center.

The rear abutment is located to provide 25'-0" minimum clear between the MSE wall and the nearest future track centerline; this substructure unit is located outside of the existing crushed aggregate open channel in order to prevent a closed drainage system from flowing through an MSE abutment wall and the considerable costs and maintenance issues associated with this. The pier is also located to provide 25'-0" clear between the pier stem and the nearest future track centerline. The location of the forward abutment provides a span ratio of 70% to minimize span lengths. For the load case DL+2.0(LL+I), an uplift of 26.6 kips exists at the forward abutment bearing of the girder at the exterior of the curve. The uplift may be resisted by anchoring the girder's bearing to the abutment seat and providing an abutment cap of sufficient weight to resist the uplift. All substructure units for Alternative 3b are set radial to the Ramp C baseline for all the same reasons discussed under Alternative 1.

The initial bridge construction cost for Alternative 3b is estimated to be $6,312,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,489,000, resulting in a total estimated ownership cost of $7,801,000 in year 2006 dollars.

Alternative 4

Alternative 4 is a curved steel plate girder bridge with spans of 162'-0", 231'-0", and 162'-0" center-to-center of bearings along the construction baseline. The stub type rear abutment is on piles behind a spill-through 2:1 slope with 45 degree turn back wingwalls. The stub type forward abutment is on piles behind a three-sided MSE wall. Both hammerhead piers rest on a pile-supported rectangular footing. All piles will be driven to refusal on bedrock. The

superstructure consists of four curved high-strength steel plate girders with 96-inch webs spaced at 9'-0" on center.

Both piers are located to provide 25'-0" minimum clear between the pier stem and the nearest future track centerline, with the pier east of the track located inside the existing crushed aggregate open channel in order to reduce span lengths. The location of both abutments is such that an end span ratio of at least 70% exists, thus eliminating any uplift due to live load effects at the bearings. All substructure units for Alternative 4 are set radial to the Ramp C baseline for all the same reasons discussed under Alternative 1.

The initial bridge construction cost for Alternative 4 is estimated to be $4,328,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $2,451,000, resulting in a total estimated ownership cost of $6,779,000 in year 2006 dollars.

Alternative 5

Alternative 5 is a curved steel plate girder bridge with an integral straddle bent pier to accommodate spans of 150'-0" and 150'-0" center-to-center of bearings along the construction baseline. Both stub type abutments are on piles behind MSE walls. The straddle bent pier columns rest on a pile-supported rectangular footing. All piles will be driven to refusal on bedrock. The superstructure consists of four curved high-strength steel plate girders with 69-inch webs spaced at 9'-0" on center.

Both abutments, as well as the straddle bent columns, are located to provide 25'-0" clear between the substructures and the nearest future track centerline.

Concrete and steel sections were considered for the straddle bent cap beam. The Norfolk Southern Corporation will not permit concrete to be cast over their tracks, and therefore, a cast-in-place concrete cap beam was not considered. A precast post-tensioned concrete cap beam was considered, however the size and weight of the section required makes transporting and erection impractical. For those reasons, a steel box section was chosen for the cap. The steel box will be a fracture critical element and additional costs have been included in the life cycle cost analysis to account for the necessary inspections. The box will be large enough to permit internal inspections. The steel I-girders for the superstructure could either bear on the top flange of the box or they could be constructed integral with the cap beam. Bearing the I-girders on the top flange of the box would result in a significant increase in the vertical alignment of the ramp which would result in additional project costs. For that reason, an integral bent cap is proposed.

The straddle bent is positioned to accommodate a potential (optional) field splice in the steel straddle bent cap. If a field splice is used, then a falsework bent located between the two existing Norfolk Southern tracks will be required. The falsework must fall within a 6'-6" wide strip between the two existing tracks, which will provide at least 10'-0" of horizontal clearance to the track centerlines. This temporary horizontal clearance is acceptable to the Norfolk Southern Corporation as stated in a meeting held on May 2, 2007. Since the steel straddle bent cap will be integral with the steel superstructure, it is necessary to position the straddle bent so that the tie-in point between the I-girder and the straddle bent cap does not fall within this 6'-6" strip. When taking the tie-in points into consideration, the geometry of the structure allows the spans for this alternative to be symmetrical. The bottom of the

straddle bent cap is sloping parallel to the bottom of the bridge deck and controls the vertical clearance along the future east track. From the analysis, the straddle bent is oriented with a 0° skew to produce balanced span lengths and minimize differential deflections that result from variable girder lengths. As a result, all substructure units for Alternative 5 are set radial to the Ramp C baseline for all the same reasons discussed under Alternative 1.

The initial bridge construction cost for Alternative 5 is estimated to be $4,879,000 in year 2006 dollars. The present value life cycle maintenance costs for this alternative are estimated to be $1,323,000, resulting in a total estimated ownership cost of $6,202,000 in year 2006 dollars.

7. Other Alternatives

An alternate three span layout was also studied. It utilized single column "L" shaped piers. The pier type has one column located a minimum of 25' from the centerline of the proposed track. The cap is cantilevered from the column and the plate girders of the superstructure are built integral with the concrete cap. This type of pier has the advantage of allowing a bridge that is approximately 15' shorter than Alternative 4. However the pier has the disadvantages of:

- Large deflections at the end of the cantilever cap;
- Large demands on the column and cap that would likely require post-tensioning;
- Deep and large diameter rock coring would be required to "fix" the base of the column;
- A single column non-redundant pier adjacent to a railroad track;
- More complex design and construction requirements for post-tensioning integral pier caps.

This alternative is feasible but not practical and would not be the preferred alternative for the disadvantages stated above. Therefore, no drawings or cost estimates were developed.

8. Recommended Alternative

Six structural solutions for the construction of the proposed Ramp C over Norfolk Southern tracks have been evaluated in this Structure Type Study. All alternatives provide comparable operational characteristics and meet minimum horizontal and vertical clearance requirements. A comparison of the initial and total relative ownership costs is provided in the table below:

Alternative No.	Total Initial Construction Cost	Percent Difference from Lowest Total Initial Construction Cost Alternative	Total Relative Ownership Cost	Percent Difference from Total Relative Ownership Cost Alternative
1	$4,757,000	9.9%	$7,490,000	20.8%
2	$5,867,000	35.6%	$8,242,000	32.9%
3a	$5,329,000	23.1%	$7,740,000	24.8%
3b	$6,312,000	45.8%	$7,801,000	25.8%
4	$4,328,000	0.0%	$6,779,000	9.3%
5	$4,879,000	12.7%	$6,202,000	0.0%

Alternative 4 offers the following advantages:

- Lowest initial construction cost;
- Low total ownership costs that are within the range of the estimates accuracy;
- Avoidance of unique construction required for pier straddle bent;
- Elimination of uplift at the abutments;
- No falsework bents required between the two existing railroad tracks; and
- Regular geometry

Based on the foregoing advantages, **CH2M HILL recommends that the three-span bridge of ALTERNATIVE 4 be constructed for the bridge carrying Ramp C over Norfolk Southern tracks.** CH2M HILL recognizes that there is currently over 2' of excess vertical clearance for Alternative 4. Upon concurrence from ODOT on this recommendation, the Ramp C profile will be lowered to reduce the amount of excess vertical clearance.

9. Subsurface Conditions and Foundation Recommendation

Subsurface investigations for the SCI-823-10.13 project will be conducted in two or possibly three phases. The first phase is complete, and included all of the proposed pavement and embankment borings, and a limited number of bridge borings. The second phase will include the remaining bridge borings (if necessary), and the majority of the proposed MSE retaining wall borings. If required, a third phase will target specific boring locations or in-situ testing recommended in the bridge and retaining wall Preliminary Design Report submissions.

Nine borings at the Ramp C bridge over Norfolk Southern tracks were taken during the first phase. Based on these initial borings, preliminary foundation recommendations have been made. A copy of the preliminary report is included with this submission.

The recommended alternative, Alternative 4, consists of stub type rear and forward abutments, supported by HP 12x53 piles driven to refusal on bedrock. The rear abutment is behind a spill-through slope, and the forward abutment is behind an MSE wall. The final pile arrangement for the forward abutment should consider avoiding potential conflicts with typical MSE reinforcing strap patterns. The piers are supported by HP 12x53 piles driven to bedrock. The outer rows of pier piles will be battered to resist horizontal loads.

It is anticipated that some of the piles will be driven to refusal on sandstone. Others will develop adequate capacity bearing in the thin shale layer, which is overlying the sandstone bedrock. Where weathered shale bedrock was encountered at the top of rock, several of these layers contain thin sandstone layers. These interbedded sandstone layers are hard, and could potentially damage piles driven to refusal on these layers. Therefore, it is recommended that reinforced pile points be used to protect all the proposed piles while driving.

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

APPENDIX A

SCI-823-10.13

Ramp C Over Norfolk Southern Tracks

STRUCTURE TYPE STUDY

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_Structure Cost Comparison.xls]Substructure

By: SKT Date: 5/29/2007

Checked: JBA Date: 6/8/2007

ALTERNATIVE COST SUMMARY

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Framing Alternative	Proposed Stringer Section	Subtotal Superstructure Cost	Subtotal Substructure Cost	Approach Roadway Length (Note 1)	Approach Roadway Cost (Notes 2 & 3)	Structure Incidental Cost (16%) (Note 4)	Structure Contingency Cost (20%)	Roadway Incidental & Contingency Cost (30%) (Note 5)	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	3	175.00 - 250.00 - 175.00	600.00	4 ~ Steel Plate Girders	102" Steel Plate Girder	$2,792,000	$625,000	0.0	$0	$547,000	$793,000	$0	$4,757,000	$2,733,000	$7,490,000
2	2	185.00 - 264.00	449.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$2,860,000	$1,308,000	151.0	$50,000	$667,000	$967,000	$15,000	$5,867,000	$2,375,000	$8,242,000
3a	2	267.00 - 187.00	454.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$2,944,000	$840,000	146.0	$48,000	$605,000	$878,000	$14,000	$5,329,000	$2,411,000	$7,740,000
3b	2	267.00 - 187.00	454.00	2 ~ Steel Tub Girders	102" Steel Tub Girder	$3,665,000	$825,000	146.0	$48,000	$718,000	$1,042,000	$14,000	$6,312,000	$1,489,000	$7,801,000
4	3	162.00 - 231.00 - 162.00	555.00	4 ~ Steel Plate Girders	96" Steel Plate Girder	$2,374,000	$721,000	45.0	$15,000	$495,000	$718,000	$5,000	$4,328,000	$2,451,000	$6,779,000
5	2	150.00 - 150.00	300.00	4 ~ Steel Plate Girders	69" Steel Plate Girder	$1,091,000	$2,252,000	300.0	$173,000	$535,000	$776,000	$52,000	$4,879,000	$1,323,000	$6,202,000

NOTES:

1. Approach roadway length equals the difference between the maximum bridge length and the bridge length for the alternative being considered.

2. Use 2006 pavement cost = $46.00 /sq. yd.

   Pavement Widths:

Alternative	Average Rear Approach	Average Fwd. Approach	Combined Average
Alt. 1	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 2	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 3a	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 3b	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 4	33.00 ft.	33.00 ft.	33.00 ft.
Alt. 5	33.00 ft.	33.00 ft.	33.00 ft.

3. Use 2006 Concrete Barrier, Single Slope, Type D cost = $81.00 /ft.

4. Structure incidental cost allowance includes provision for structure excavation, porous backfill & drainage pipe, sealing of concrete surfaces, falsework bents, bearings, (minor) temporary shoring, crushed aggregate slope protection, pile driving equipment mobilization, shear connectors, settlement platforms, expansion joints, joint sealers, and joint fillers costs.

5. Roadway incidental cost allowance includes provision for drainage, maintenance of traffic, and traffic control costs.

6. The proposed profile provides adequate vertical clearance for all 6 alternatives. The minimum vertical clearance varies between 23.45' and 27.68'. Therefore, assume any potential savings that could be incurred by lowering the profile is negligble.

Alternative	Vertical Clearance Provided @ West NS RR (ft.)	Vertical Clearance Provided @ East NS RR (ft.)	Profile Adjustment Required (ft.)
Alt. 1	25.02'	26.04'	0.00'
Alt. 2	23.47'	24.44'	0.00'
Alt. 3a	23.45'	24.46'	0.00'
Alt. 3b	25.17'	26.03'	0.00'
Alt. 4	25.53'	26.53'	0.00'
Alt. 5	27.68'	23.87'	0.00'

SCI-823-10.13

Ramp C Over Norfolk Southern Tracks

STRUCTURE TYPE STUDY

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By: SKT Date: 5/29/2007

Checked: JBA Date: 6/8/2007

SUPERSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Total Span Length (ft.)	Deck Length (ft.)*	Deck Area (sq. ft.)	Deck Volume** (cu. yd.)	Deck Concrete Cost	Deck Reinforcing Cost	Approach Slab Cost	Framing Alternative	Proposed Stringer Section	Structural Steel Weight (pounds)	Structural Steel Cost	Initial Painting Cost	Initial Superstructure Cost
1	3	175.00 - 250.00 - 175.00	600.00	605.68	20,000	768	$377,100	$177,300	$45,300	4 ~ Steel Plate Girders	102" Steel Plate Girder	1505500	$2,192,000	$0	**$2,792,000**
2	2	185.00 - 264.00	449.00	453.25	15,000	575	$282,200	$132,700	$45,300	4 ~ Steel Plate Girders	120" Steel Plate Girder	1648200	$2,399,800	$0	**$2,860,000**
3a	2	267.00 - 187.00	454.00	458.30	15,100	581	$285,300	$134,100	$45,300	4 ~ Steel Plate Girders	120" Steel Plate Girder	1702800	$2,479,300	$0	**$2,944,000**
3b	2	267.00 - 187.00	454.00	458.30	15,100	581	$285,300	$134,100	$45,300	2 ~ Steel Tub Girders	102" Steel Tub Girder	1318200	$2,900,000	$300,100	**$3,665,000**
4	3	162.00 - 231.00 - 162.00	555.00	560.26	18,500	710	$348,800	$164,000	$45,300	4 ~ Steel Plate Girders	96" Steel Plate Girder	1247400	$1,816,200	$0	**$2,374,000**
5	2	150.00 - 150.00	300.00	302.84	10,000	384	$188,500	$88,600	$45,300	4 ~ Steel Plate Girders	69" Steel Plate Girder	422200	$768,400	$0	**$1,091,000**

* Deck Length Measured along Centerline of Bridge rather than Baseline

** Includes deck and parapets

Deck Cross-Sectional Area:

Parapets:

	No.	Individual Area (sq. ft.)	Parapet Area (sq. ft.)
Parapets	2	4.26	8.52

Slab:

	T (ft.)	Ave. W (ft.)	Slab Area	Haunch & Overhang Area	Total Concrete Area (sq. ft.)
Alt. 1	0.71	33.00	23.4	2.3	34.2
Alt. 2	0.71	33.00	23.4	2.3	34.2
Alt. 3a	0.71	33.00	23.4	2.3	34.2
Alt. 3b	0.71	33.00	23.4	2.3	34.2
Alt. 4	0.71	33.00	23.4	2.3	34.2
Alt. 5	0.71	33.00	23.4	2.3	34.2

Note: Deck width measured as average width.
10% of deck area allowed for haunches and overhangs

QC/QA Concrete, Class QSC2

Unit Cost ($/cu. yd):

	Year 2005	Annual Escalation	Year 2006
Deck	$512.91	3.0%	$528.00
Parapets	$370.36	3.0%	$381.00
Weighted Average (Alt. 1 - Alt. 5) =			$491.00

Based on parapet and slab percentages of total concrete area

Epoxy Coated Reinforcing Steel

Unit Cost ($/lb):

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

	Year 2005	Annual Escalation	Year 2006
Deck Reinforcing	$0.79	3.0%	$0.81

Structural Steel Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2006
Rolled Beams - Grade 50 (level 2)	n/a	$0.95	12.0%	$1.06
Plate Girders - Grade 50 (level 4)	n/a	$1.15	12.0%	$1.29
Plate Girders - Grade 50 (level 5)	n/a	$1.30	12.0%	$1.46
Hybrid Plate Girders - Grade 50/70W	1.10	$1.43	12.0%	$1.60
Tub Girders - Grade 50 (level 6)	n/a	n/a		$2.20
Plate Girders - Grade 50 (level 5) constructed w/ Integral Steel Straddle Bent	1.25	$1.63	12.0%	$1.82

Reinforced Concrete Approach Slabs (T=17")

Unit Cost ($/sq. yd.):

Alt. 1 - 5

Length = 30 ft. Width = 33.00 ft

Area = 110 sq. yd.

	Year 2005	Annual Escalation	Year 2006
Approach Slabs	$199.78	3.0%	$206.00

Structural Steel Painting: (Initial painting inside of Steel Tub Girder and Straddle Bent)

Structural Steel Area:

	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (in.)	Nominal Girder Area (sq. ft.)	Secondary Member Allowance	Total Steel Area (sq. ft.)
Alt. 3b	105.14	2	458.30	57.00	20,416	20%	24,500
Alt. 5*	98	1	132.42	50.00	3,266	20%	3,900

Painting Cost per sq. ft.:

	Year 2005	Annual Escalation	Year 2006	
Prep.	$6.88	3.0%	$6.88	
Prime	$1.62	3.0%	$1.62	
Intermed.	$1.89	3.0%	$1.89	
Finish	$1.86	3.0%	$1.86	
Total			$12.25	For Superstructure Components

* Note - Cost of painting steel straddle bent cap for Alternative 5 is included in the substructure cost summary.

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By: SKT Date: 5/29/2007
Checked: JBA Date: 6/8/2007

SUBSTRUCTURE

Alternative No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Proposed Stringer Section	Pier Concrete Cost	Pier Reinforcing Cost	Pier Structural Steel Cost	Steel Initial Painting Cost	Abutment Concrete Cost	Abutment Reinforcing Cost	Pile Foundation Cost	MSE Abutment & Wingwall Cost	Approach Embankment Cost	Initial Substructure Cost
1	3	175.00 - 250.00 - 175.00	4 ~ Steel Plate Girders	102" Steel Plate Girder	$108,000	$22,100	$0	$0	$88,800	$12,700	$84,400	$282,900	$46,400	$625,000
2	2	185.00 - 264.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$53,900	$11,000	$0	$0	$72,100	$13,300	$67,900	$1,033,700	$56,000	$1,308,000
3a	2	267.00 - 187.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$50,900	$10,600	$0	$0	$55,600	$10,200	$62,400	$518,800	$132,000	$840,000
3b	2	267.00 - 187.00	2 ~ Steel Tub Girders	102" Steel Tub Girder	$38,400	$10,500	$0	$0	$51,800	$9,500	$64,200	$518,800	$132,000	$825,000
4	3	182.00 - 231.00 - 182.00	4 ~ Steel Plate Girders	96" Steel Plate Girder	$108,800	$22,200	$0	$0	$67,700	$12,500	$80,800	$349,200	$80,100	$721,000
5	2	150.00 - 150.00	4 ~ Steel Plate Girders	69" Steel Plate Girder	$70,800	$29,200	$506,700	$47,800	$48,100	$8,900	$59,400	$1,349,100	$132,000	$2,252,000

*Note - Weight of Integral Steel Pier Cap for Alternative 3b is included in the weight of the Superstructure steel and thereby included in the Superstructure Cost Summary for Alternative 3b.

Pier QC/QA Concrete, Class QSC1 Cost:

Alt 1; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	42.7	$555.68	3.0%	$572.00	$24,400
Footing	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 1 Concrete Cost					$55,600

Alt 1; Pier 2

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	37.1	$555.68	3.0%	$572.00	$21,200
Footing	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 2 Concrete Cost					$52,400

Alt 2; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	39.6	$555.68	3.0%	$572.00	$22,700
Footings	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 1 Concrete Cost					$53,900

Alt 3a; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	34.5	$555.68	3.0%	$572.00	$19,700
Footings	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 1 Concrete Cost					$50,900

Alt 3b; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	0.0	$555.68	3.0%	$572.00	$0
Stem	49.8	$555.68	3.0%	$572.00	$28,500
Footings	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 1 Concrete Cost					$38,400

Alt 4; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	43.1	$555.68	3.0%	$572.00	$24,700
Footing	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 1 Concrete Cost					$55,900

Alt 4; Pier 2

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Cap	37.3	$555.68	3.0%	$572.00	$21,300
Stem	38.0	$555.68	3.0%	$572.00	$21,700
Footing	32.0	$300.31	3.0%	$309.00	$9,900
Total Pier 2 Concrete Cost					$52,900

Alt 5; Pier 1

	Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Columns	67.9	$555.68	3.0%	$572.00	$38,800
Footings	103.7	$300.31	3.0%	$309.00	$32,000
Total Straddle Bent 1 Concrete Cost					$70,800

Pier Structural Steel Cost:

Structural Steel Unit Costs ($/lb.):

	Cost Ratio	Year 2005	Annual Escalation	Year 2006
Plate Girders - Grade 50 (level 5)	n/a	$1.30	12.0%	$1.46
Steel Box Bent Cap - Grade 70 (level 5) constructed integral w/ Plate Girder Bridge Beams	1.50	$1.95	12.0%	$2.18

Alt 5; Pier 1

Estimate Structural Steel Weight = 232450 lbs
Total Cost of Straddle Bent Structural Steel = $506,700

Pile Foundation Unit Cost ($/ft.):

HP Steel Piles, Furnished & Driven

Pier Piles:

	Number Pier 1	Number Pier 2	Top Elevation Pier 1	Top Elevation Pier 2	Bottom Elevation Pier 1	Bottom Elevation Pier 2	Length Per Pier 1 Pile	Length Per Pier 2 Pile	Total Pile Length	Total Cost	Pile Size
Alt. 1	24	24	540.0	538.0	522.2	516.6	25	30	1,320	$47,900	HP14 x 73
Alt. 2	24	0	540.0	0.0	522.2	0.0	25	0	600	$21,800	HP14 x 73
Alt. 3a	24	0	538.0	0.0	516.6	0.0	30	0	720	$26,100	HP14 x 73
Alt. 3b	24	0	538.0	0.0	516.6	0.0	30	0	720	$26,100	HP14 x 73
Alt. 4	24	24	540.0	538.0	522.2	516.6	25	30	1,320	$39,500	HP12 x 53
Alt. 5	32	0	541.0	0.0	521.3	0.0	25	0	800	$23,900	HP12 x 53

Abutment Piles:

	Number Rear	Number Forward	Top Elevation Rear	Top Elevation Forward	Bottom Elevation Rear	Bottom Elevation Fwd.	Length Per Rear Pile	Length Per Forward Pile	Total Pile Length	Total Cost	Pile Size
Alt. 1	16	10	575.1	557.8	536.2	516.6	45	50	1,220	$36,500	HP12 x 53
Alt. 2	16	10	573.5	584.3	536.2	516.6	45	55	1,270	$48,100	HP14 x 73
Alt. 3a	10	10	571.4	555.6	525.4	516.6	55	45	1,000	$35,300	HP14 x 73
Alt. 3b	10	10	573.3	557.4	525.4	516.6	55	50	1,050	$38,100	HP14 x 73
Alt. 4	16	10	575.1	559.1	528.6	516.6	55	50	1,380	$41,300	HP12 x 53
Alt. 5	10	10	575.8	568.7	525.4	516.6	60	60	1,200	$35,500	HP10 x 42

Abutment QC/QA Concrete, Class QSC1 Cost:

Alt. 1

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	70.0	$384.26	3.0%	$396.00	$27,700
	Fwd	66.7	$384.26	3.0%	$396.00	$26,400
Wingwalls						
	Rear	37.2	$384.26	3.0%	$396.00	$14,700
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$68,800

Alt. 2

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	72.8	$384.26	3.0%	$396.00	$28,800
	Fwd	70.4	$384.26	3.0%	$396.00	$27,900
Wingwalls						
	Rear	39.0	$384.26	3.0%	$396.00	$15,400
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$72,100

Alt. 3a

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	70.3	$384.26	3.0%	$396.00	$27,800
	Fwd	69.9	$384.26	3.0%	$396.00	$27,700
Wingwalls						
	Rear	0.0	$384.26	3.0%	$396.00	$0
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$55,500

Alt. 3b

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	65.3	$384.26	3.0%	$396.00	$25,900
	Fwd	65.4	$384.26	3.0%	$396.00	$23,900
Wingwalls						
	Rear	0.0	$384.26	3.0%	$396.00	$0
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$51,800

Alt. 4

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	69.0	$384.26	3.0%	$396.00	$27,300
	Fwd	65.5	$384.26	3.0%	$396.00	$25,900
Wingwalls						
	Rear	36.6	$384.26	3.0%	$396.00	$14,500
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$67,700

Alt. 5

Component		Volume (cu. yd.)	Year 2005	Annual Escalation	Year 2006	Total Cost
Abutment						
	Rear	60.7	$384.26	3.0%	$396.00	$24,000
	Fwd	60.8	$384.26	3.0%	$396.00	$24,100
Wingwalls						
	Rear	0.0	$384.26	3.0%	$396.00	$0
	Fwd	0.0	$384.26	3.0%	$396.00	$0
Total Abutment Cost						$48,100

Reinforcing Steel Unit Cost ($/lb):

Assume 125 lbs of reinforcing steel per cubic yard of pier concrete.
Assume 210 lbs of reinforcing steel per cubic yard of straddle bent concrete.
Assume 90 lbs of reinforcing steel per cubic yard of abutment concrete.

	Year 2005	Annual Escalation	Year 2006
Pier	$0.79	3.0%	$0.81
Abutment	$0.79	3.0%	$0.81

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

	Area (sq. ft.) Rear	Area (sq. ft.) Forward	Total Area (sq. ft.)	Year 2006
Alt. 1	0	3409	3409	$83.00
Alt. 2	0	12921	12921	$80.00
Alt. 3a	3248	2640	5888	$88.00
Alt. 3b	3248	2548	5896	$88.00
Alt. 4	0	4256	4256	$82.00
Alt. 5	3385	13067	16452	$82.00

Note: Unit Cost of MSE Walls was adjusted from typical price of $85/sq. ft. to account for the savings incurred from turn-back retaining walls sharing granular fill due to overlapping strap lengths.

Embankment Unit Cost ($/sq. ft.):

	Volume (cu. yd.) Rear	Volume (cu. yd.) Forward	Total Volume (cu. yd.)	Year 2006
Alt. 1	3888	0	3888	$12.00
Alt. 2	4664	0	4664	
Alt. 3a	10997	0	10997	
Alt. 3b	10997	0	10997	
Alt. 4	6877	0	6877	
Alt. 5	10997	0	10997	

Note: Limits of non-retaining wall embankment are set by the limits of the rear approach slab for the bridge alternative that ends furthest back station (Alternative 1) and by the limits of the embankment included in the cost of the retaining walls. Limits of embankment included with the retaining walls is dictated by the ends of the MSE Walls as they are turn-back retaining walls.
See attached section cuts for embankment volume calculations.

HP10 x 42 Steel Piles, Furnished & Driven

	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$17.50	6.0%	$18.60
Driven	$10.69	3.0%	$11.00
Total			$29.60

HP12 x 53 Steel Piles, Furnished & Driven

	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$19.02	6.0%	$20.20
Driven	$9.38	3.0%	$9.70
Total			$29.90

HP14 x 73 Steel Piles, Furnished & Driven

	Year 2005 Unit Cost	Annual Escalation	Year 2006
Furnished	$27.30	6.0%	$28.90
Driven	$7.19	3.0%	$7.40
Total			$36.30

SCI-823-10.13

Ramp C Over Norfolk Southern Tracks

STRUCTURE TYPE STUDY

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By: SKT Date: 5/29/2007

Checked: JBA Date: 6/8/2007

LIFE CYCLE MAINTENANCE COST

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Structural Steel Painting (5) Cost Per Cycle	Structural Steel Painting (5) Number of Maintenance Cycles	Structural Steel Painting (5) Total Life Cycle Cost	Superstructure Sealing (5) Cost Per Cycle	Superstructure Sealing (5) Number of Maintenance Cycles	Superstructure Sealing (5) Total Life Cycle Cost	Additional Bridge Inspection Costs (7) Cost Per Cycle	Additional Bridge Inspection Costs (7) Number of Maintenance Cycles	Additional Bridge Inspection Costs (7) Total Life Cycle Cost	Approach Pavement Resurfacing (8) Cost Per Cycle	Approach Pavement Resurfacing (8) Number of Maintenance Cycles	Approach Pavement Resurfacing (8) Total Life Cycle Cost
1	3	175.00 - 250.00 - 175.00	4 ~ Steel Plate Girders	$834,800	2	$1,669,600	$0	0	$0	$0	0	$0	$0	7	$0
2	2	185.00 - 264.00	4 ~ Steel Plate Girders	$776,700	2	$1,553,400	$0	0	$0	$0	0	$0	$2,400	7	$16,800
3a	2	267.00 - 187.00	4 ~ Steel Plate Girders	$791,900	2	$1,583,800	$0	0	$0	$0	0	$0	$2,300	7	$16,100
3b	2	267.00 - 187.00	2 ~ Steel Tub Girders	$305,600	2	$611,200	$0	0	$0	$2,000	25	$50,000	$2,300	7	$16,100
4	3	162.00 - 231.00 - 162.00	4 ~ Steel Plate Girders	$730,000	2	$1,460,000	$0	0	$0	$0	0	$0	$700	7	$4,900
5	2	150.00 - 150.00	4 ~ Steel Plate Girders	$346,000	2	$692,000	$0	0	$0	$2,000	25	$50,000	$4,800	7	$33,600

Alt. No.	Span Arrangement No. Spans	Lengths	Framing Alternative	Bridge Deck Overlay (5) Deck Demo & Chipping	Deck Overlay	Deck Joint Gland (2)	Number of Maintenance Cycles	Total Life Cycle Cost	Bridge Redecking (5) Deck Concrete Cost (3)	Deck Reinforcing Cost (3)	Deck Joint Cost (2)	Deck Removal Cost	Number of Maintenance Cycles	Total Life Cycle Cost	Superstructure Life Cycle Maintenance Cost (1)	Total Initial Construction Cost	Total Relative Ownership Cost
1	3	175.00 - 250.00 - 175.00	4 ~ Steel Plate Girders	$64,300	$74,600	$5,200	2	$288,200	$377,100	$177,300	$20,800	$200,000	1	$775,200	**$2,733,000**	**$4,757,000**	**$7,490,000**
2	2	185.00 - 264.00	4 ~ Steel Plate Girders	$48,200	$56,000	$5,200	2	$218,800	$282,200	$132,700	$20,800	$150,000	1	$585,700	**$2,375,000**	**$5,867,000**	**$8,242,000**
3a	2	267.00 - 187.00	4 ~ Steel Plate Girders	$48,500	$56,300	$5,200	2	$220,000	$285,300	$134,100	$20,800	$151,000	1	$591,200	**$2,411,000**	**$5,329,000**	**$7,740,000**
3b	2	267.00 - 187.00	2 ~ Steel Tub Girders	$48,500	$56,300	$5,200	2	$220,000	$285,300	$134,100	$20,800	$151,000	1	$591,200	**$1,489,000**	**$6,312,000**	**$7,801,000**
4	3	162.00 - 231.00 - 162.00	4 ~ Steel Plate Girders	$59,400	$69,000	$5,200	2	$257,200	$348,800	$164,000	$20,800	$185,000	1	$718,600	**$2,451,000**	**$4,328,000**	**$6,779,000**
5	2	150.00 - 150.00	4 ~ Steel Plate Girders	$32,100	$37,300	$5,200	2	$149,200	$188,500	$88,600	$20,800	$100,000	1	$397,900	**$1,323,000**	**$4,879,000**	**$6,202,000**

Structural Steel Painting:

Structural Steel Area:

	Web Depth (in.)	No. Stringers	Total Span Length (ft.)	Assumed Ave. Bot. Flange Width (in.)	Nominal Exposed Girder Area (sq. ft.)	Secondary Member Allowance	Total Exposed Steel Area (sq. ft.)
Alt. 1	Supstr. 102	4	605.7	23.00	55,117	20%	66,100
Alt. 2	Supstr. 120	4	453.3	33.00	51,217	20%	61,500
Alt. 3a	Supstr. 120	4	458.3	34.00	52,246	20%	62,700
Alt. 3b	Supstr. 102	2	458.3	60.00	20,165	20%	24,200
Alt. 4	Supstr. 96	4	560.3	22.00	48,182	20%	57,800
Alt. 5	Substr 69	4	302.8	20.00	19,987	20%	24,000
Alt. 5	Substr 102	1	132.4	52.00	3,399	0%	3,400

Painting Cost per sq. ft.:

	Year 2005	Annual Escalation	Year 2006	
Prep.	$6.88	3.0%	$7.09	
Prime	$1.62	3.0%	$1.67	
Intermed.	$1.89	3.0%	$1.95	
Finish	$1.86	3.0%	$1.92	
Total			$12.63	For I-Girder Superstructure Components

Superstructure Sealing:

PS Concrete I-Beam Area:

54" 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		23		2	46.00
Upper Fillets	6	6	8.49	2	16.97
Top Flange		8		2	16.00
Total Exposed Perimeter					146.43 in.

PS Concrete Area:

	No. Stringers	Total Span Length (ft.)	Nominal Exposed Beam Area (sq. ft.)	Secondary Member Allowance	Total Exposed Concrete Area (sq. yd.)
Alt. 1	0	600.00	0	10%	0
Alt. 2	0	449.00	0	10%	0
Alt. 3a	0	454.00	0	10%	0
Alt. 3b	0	454.00	0	10%	0
Alt. 4	0	555.00	0	10%	0
Alt. 5	0	300.00	0	10%	0

Sealing Cost per sq. yd.:

	Year 2005	Annual Escalation	Year 2006
Epoxy-Urethane Sealer	$10.44	3.0%	$10.75

Bridge Redecking:

Bridge Deck Joint Cost per foot:

	Year 2005	Annual Escalation	Year 2006
Structural Expansion Joint Including Elastomeric Strip Seal	$305.45	3.0%	$314.62

	Bridge Width (ft.)	No. Joints
Alt. 1	33.00	2
Alt. 2	33.00	2
Alt. 3a	33.00	2
Alt. 3b	33.00	2
Alt. 4	33.00	2
Alt. 5	33.00	2

Bridge Deck Removal Cost:

	Deck Area (3) (sq. ft.)	Year 2006	Deck Removal Cost
Alt. 1	20,000	$10.00	$200,000
Alt. 2	15,000	$10.00	$150,000
Alt. 3a	15,100	$10.00	$151,000
Alt. 3b	15,100	$10.00	$151,000
Alt. 4	18,500	$10.00	$185,000
Alt. 5	10,000	$10.00	$100,000

Bridge Deck Overlay (Item 848):

Bridge Deck MSC Overlay Cost per sq. yd.:

	Year 2005	Annual Escalation	Year 2006
Micro Silica Modified Concrete Overlay Using Hydrodemolition (1.25" thick) Surface Preparation Using Hydrodemolition	$29.57	3.0%	$30.46
	$25.93	3.0%	$26.71
Hand Chipping (10% of deck area)	$85.66	3.0%	$88.23
Bridge Deck MSC Overlay Cost per cu. yd.: Micro Silica Modified Concrete Overlay (Variable Thickness), Material Only	$145.00	3.0%	$149.35

	Deck Area (3) (sq. ft.)	Deck Area (sq. yd.)	Hand Chipping (sq. yd.)	Variable Thickness Repair (cu. yd.)
Alt. 1	20,000	2,222	56	46
Alt. 2	15,000	1,667	42	35
Alt. 3a	15,100	1,678	42	35
Alt. 3b	15,100	1,678	42	35
Alt. 4	18,500	2,056	51	43
Alt. 5	10,000	1,111	28	23

Assume 25% of deck area requires removal to depth of 4.5" (3.00" additional removal).

Bridge Deck Joint Gland Replacement Cost per foot:

	Year 2005	Annual Escalation	Year 2006
Elastomeric Strip Seal Gland	$76.37	3.0%	$78.66

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 (2006) dollars.
2. Bridges with straight girders are assumed to have semi-integral abutments, therefore strip seal deck joints are only included for curved girder bridges.
3. See Superstructure Cost sheet.
4. See Alternative Cost Summary sheet.
5. Assume bridge deck overlay at Year 20 & Year 60 and bridge deck replacement at Year 40.
   Assume steel superstructures (including weathering steel) are painted at Year 25, then on a 25-year recurrence interval
   Assume concrete superstructures are sealed on a 15-year 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.
7. Assume Steel Box and Steel Tub Girders have an additional inspection cost of $2000 per inspection, and assume steel to be inspected every 2 years beginning in Year 25. (Assume tubs and straddle bent do not need to be painted on the inside)
8. Assume approach pavement resurfacing on a 10-year recurrence interval.

Approach Pavement Resurfacing:

Resurfacing Units Costs:

	Year 2005	Annual Escalation	Year 2006
Pavement Planing, Asphalt Concrete, per sq. yd. (Item 254)	$0.95	3.0%	$0.98
Asphalt Concrete Surface Course, per cu. yd.	$78.03	3.0%	$80.37

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	33.0	0	1.50	0.0
Alt. 2	151.0	33.0	554	1.50	23.1
Alt. 3a	146.0	33.0	535	1.50	22.3
Alt. 3b	146.0	33.0	535	1.50	22.3
Alt. 4	45.0	33.0	165	1.50	6.9
Alt. 5	300.0	33.0	1,100	1.50	45.8

SCI-823-10.13

Ramp C Over Norfolk Southern Tracks

STRUCTURE TYPE STUDY

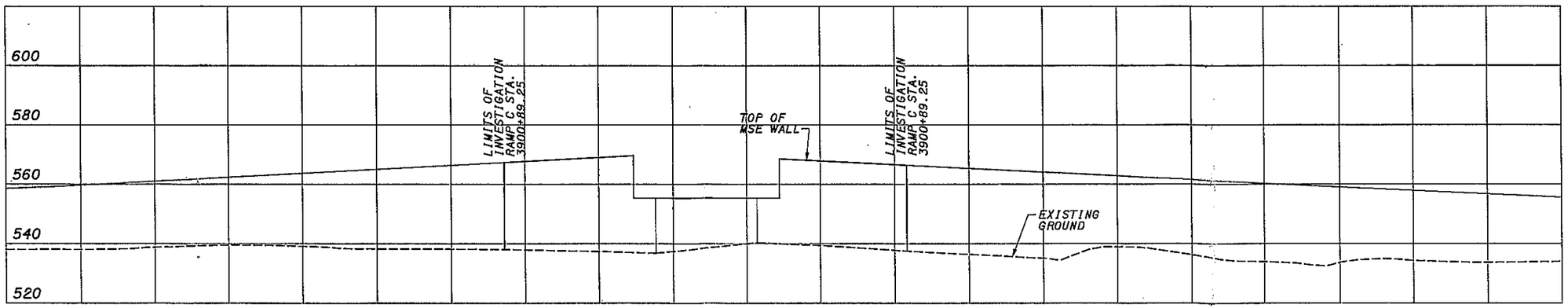
Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_Structure Cost Comparison.xls]Substructure

By: SKT Date: 5/29/2007

Checked: JBA Date: 6/8/2007

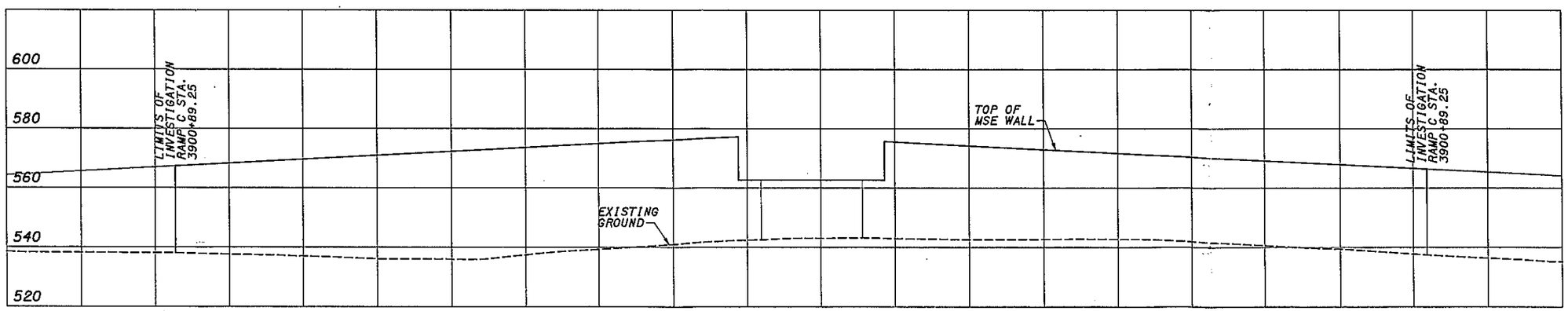
COST COMPARISON SUMMARY

Alternative No.	Span Arrangement No. Spans	Span Arrangement Lengths	Framing Alternative	Proposed Stringer Section	Total Initial Superstructure Cost	Total Initial Substructure Cost	Total Initial Construction Cost	Superstructure Life Cycle Maintenance Cost	Total Relative Ownership Cost
1	3	175.00 - 250.00 - 175.00	4 ~ Steel Plate Girders	102" Steel Plate Girder	$2,792,000	$625,000	$4,757,000	$2,733,000	**$7,490,000**
2	2	185.00 - 264.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$2,860,000	$1,308,000	$5,867,000	$2,375,000	**$8,242,000**
3a	2	267.00 - 187.00	4 ~ Steel Plate Girders	120" Steel Plate Girder	$2,944,000	$840,000	$5,329,000	$2,411,000	**$7,740,000**
3b	2	267.00 - 187.00	2 ~ Steel Tub Girders	102" Steel Tub Girder	$3,665,000	$825,000	$6,312,000	$1,489,000	**$7,801,000**
4	3	162.00 - 231.00 - 162.00	4 ~ Steel Plate Girders	96" Steel Plate Girder	$2,374,000	$721,000	$4,328,000	$2,451,000	**$6,779,000**
5	2	150.00 - 150.00	4 ~ Steel Plate Girders	69" Steel Plate Girder	$1,091,000	$2,252,000	$4,879,000	$1,323,000	**$6,202,000**



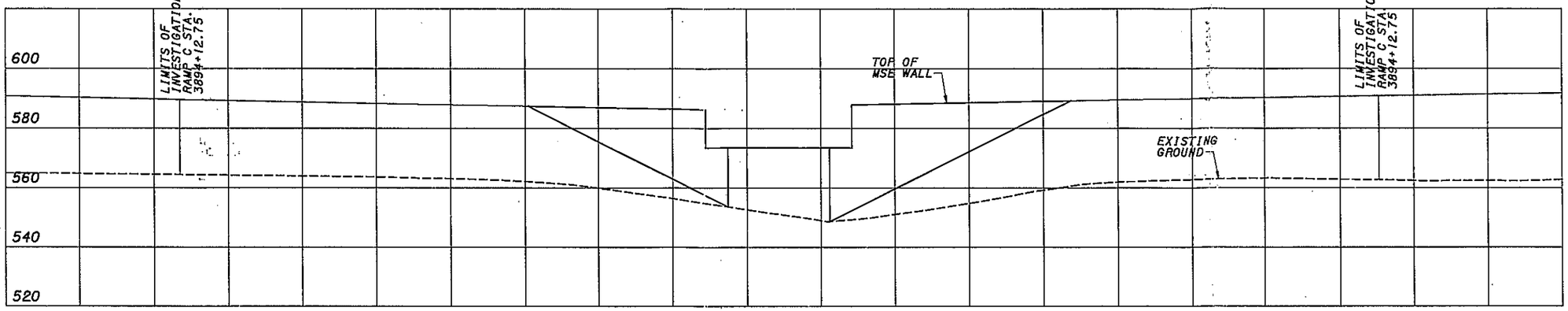
WALL 5B - FORWARD END OF BRIDGE
3409 SF

RAMP C BRIDGE OVER NS TRACKS
ALTERNATIVE I

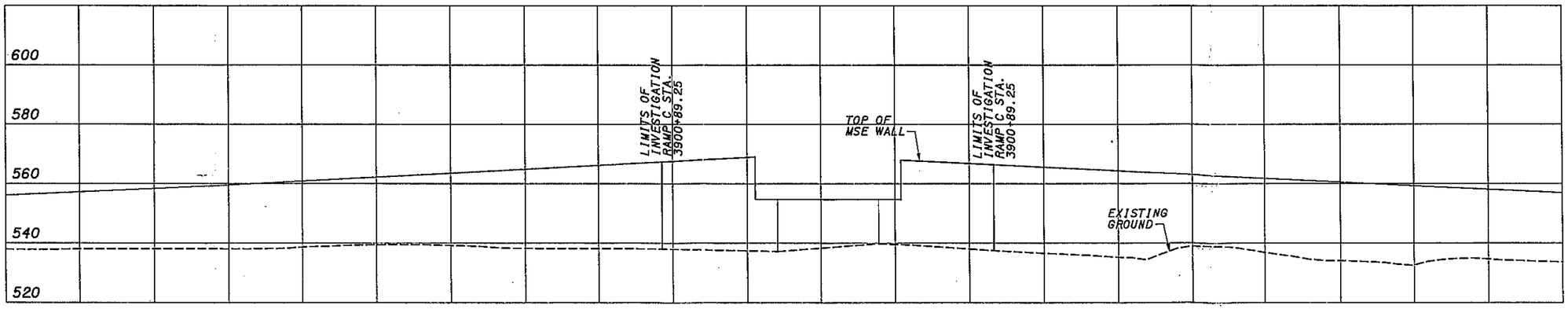


WALL 5B - FORWARD END OF BRIDGE
12921 SF

RAMP C BRIDGE OVER NS TRACKS
ALTERNATIVE 2

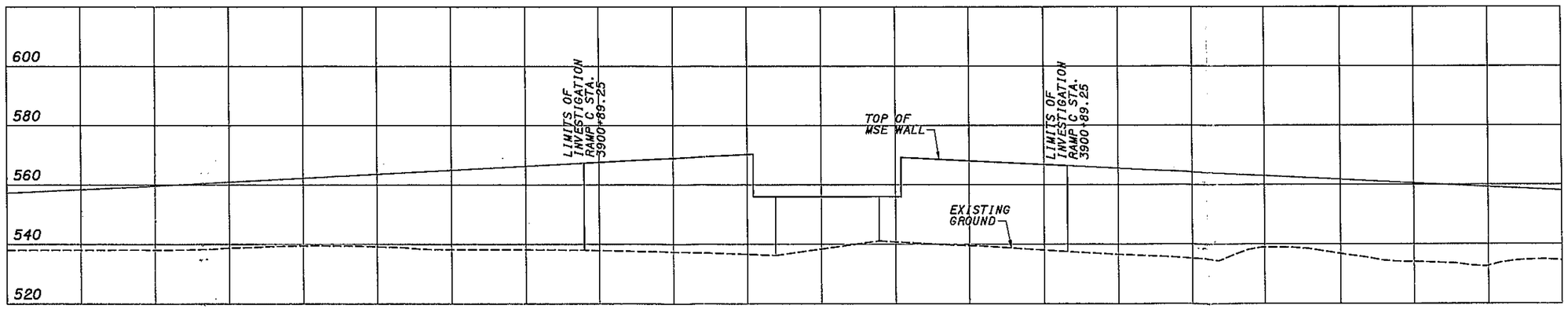


WALL 5A - REAR END OF BRIDGE
3248 SF



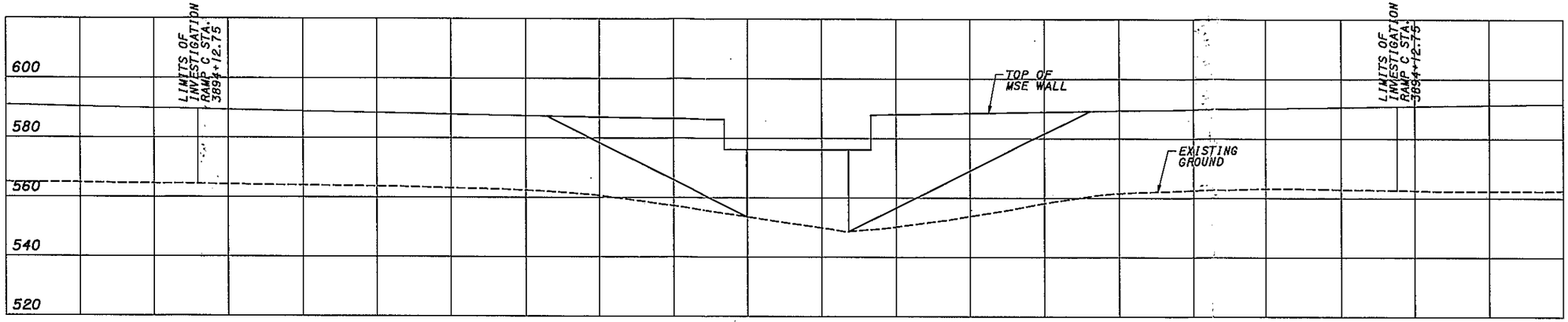
WALL 5B - FORWARD END OF BRIDGE
2648 SF

RAMP C BRIDGE OVER NS TRACKS
ALTERNATIVE 3

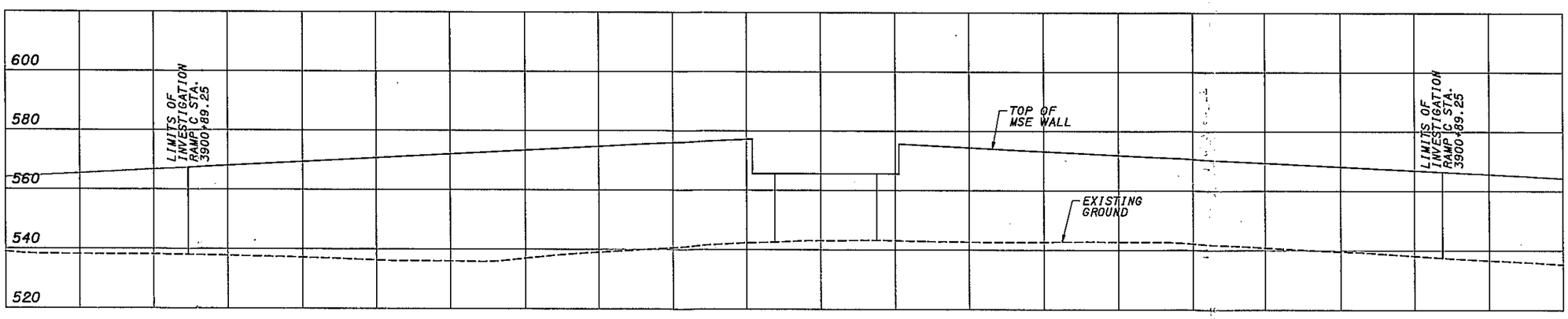


WALL 5B - FORWARD END OF BRIDGE
4258 SF

RAMP C BRIDGE OVER NS TRACKS
ALTERNATIVE 4



WALL 5A - REAR END OF BRIDGE
3385 SF



WALL 5B - FORWARD END OF BRIDGE
13067 SF

RAMP C BRIDGE OVER NS TRACKS
ALTERNATIVE 5

baukarma
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EMBANKMENT QUANTITIES FOR
RAMP C BRIDGE OVER NS TRACKS

REAR ABUTMENT

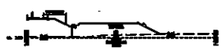
END SPILL THROUGH SLOPE	0 SF	3894+80.38	
			1295 CY
B/FACE OF BACKWALL	1834 SF	3894+42.25	
B/FACE OF BACKWALL	2372 SF	3894+42.25	
			2573 CY
ALT. I APPR. SLAB LIMITS	2337 SF	3894+12.75	

ALTERNATIVE I

3868 CY GRAND TOTAL

EMBANKMENT QUANTITIES FOR RAMP C BRIDGE OVER NS TRACKS

REAR ABUTMENT

END SPILL THROUGH SLOPE		0 SF	3894+89.54	1302 CY
B/FACE OF BACKWALL		1836 SF	3894+51.25	
B/FACE OF BACKWALL		2378 SF	3894+51.25	3362 CY
ALT. I APPR. SLAB LIMITS		2337 SF	3894+12.75	

ALTERNATIVE 2

4664 CY GRAND TOTAL

EMBANKMENT QUANTITIES FOR RAMP C BRIDGE OVER NS TRACKS

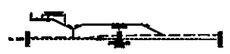
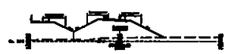
REAR ABUTMENT

BEGIN MSE WALL LIMITS		2482 SF	3895+35.98
			10997 CY
ALT. I APPR. SLAB LIMITS		2337 SF	3894+12.75

ALTERNATIVE 3

10997 CY GRAND TOTAL

EMBANKMENT QUANTITIES FOR RAMP C BRIDGE OVER NS TRACKS

REAR ABUTMENT				
END SPILL THROUGH SLOPE		0 SF	3895+12.38	
				1284 CY
B/FACE OF BACKWALL		1818 SF	3894+74.25	
B/FACE OF BACKWALL		2398 SF	3894+74.25	
				5393 CY
ALT. I APPR. SLAB LIMITS		2337 SF	3894+12.75	

ALTERNATIVE 4

6677 CY GRAND TOTAL

EMBANKMENT QUANTITIES FOR
RAMP C BRIDGE OVER NS TRACKS

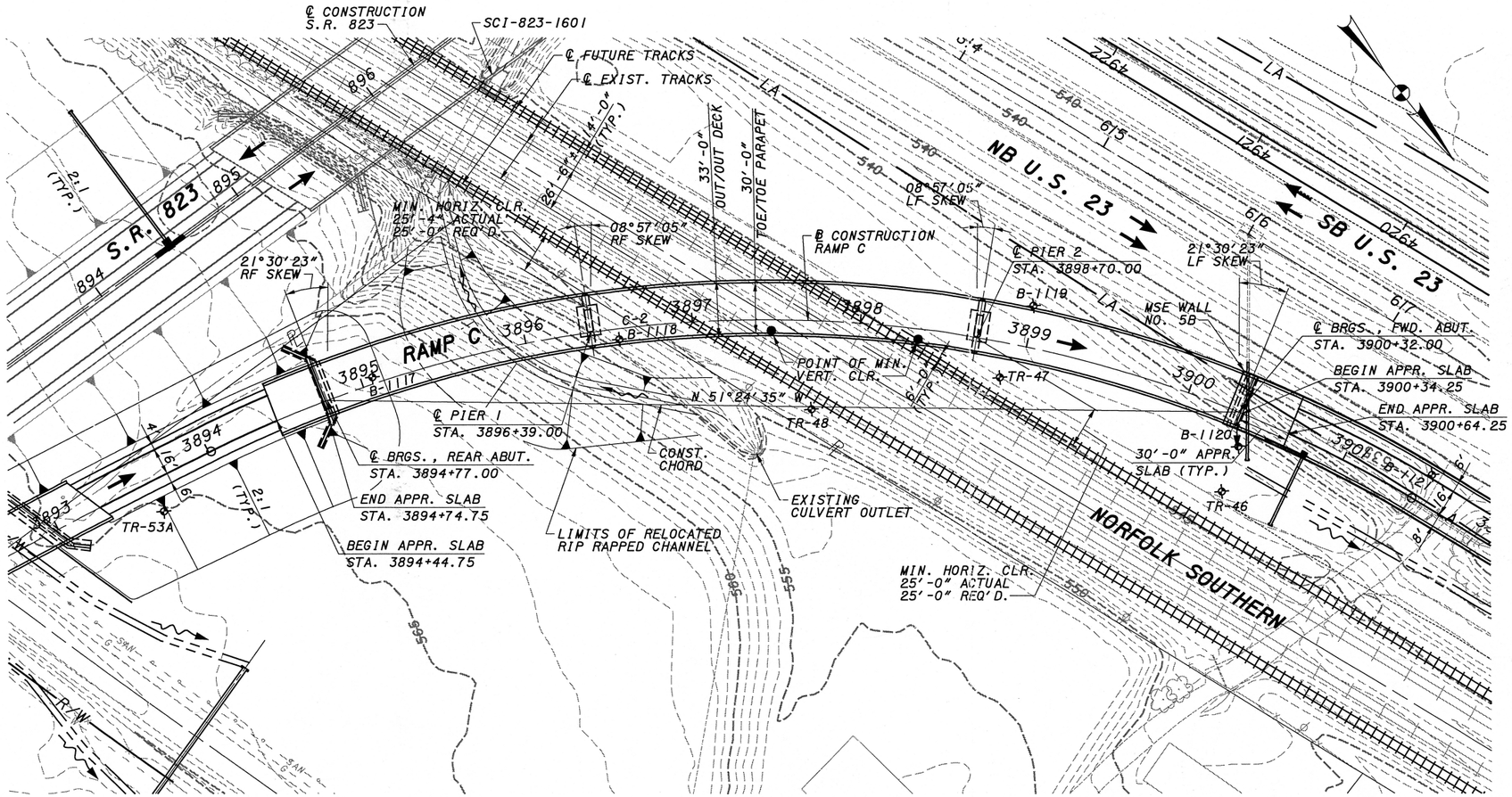
REAR ABUTMENT

BEGIN MSE WALL LIMITS		2482 SF	3895+35.98
			10997 CY
ALT. I APPR. SLAB LIMITS		2337 SF	3894+12.75

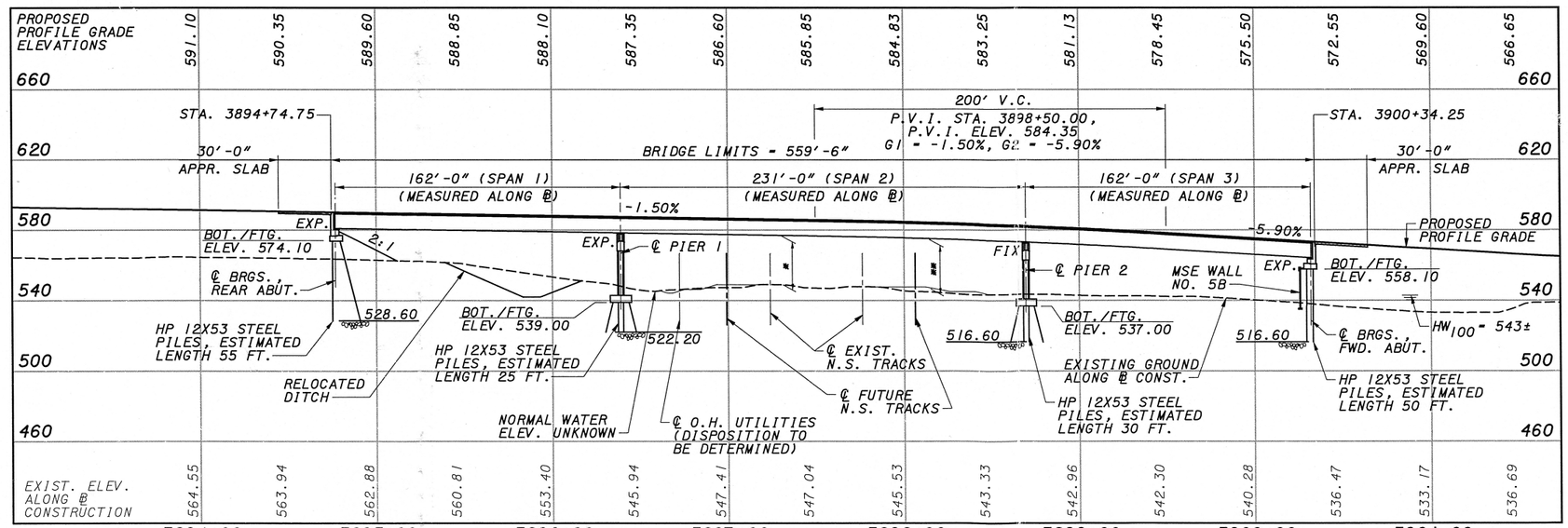
ALTERNATIVE 5

10997 CY GRAND TOTAL

APPENDIX B



PLAN



PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* MIN. VERT. CLR. 26'-6" ACTUAL 23'-4¼" REQ'D.

** MIN. VERT. CLR. 25'-6" ACTUAL 23'-3⅝" REQ'D.

BENCHMARKS

CURVE C-2
P.I. STA. = 3898+09.03
Δ = 57°43'34" (RT.)
Dc = 07°45'00"
R = 739.30'
T = 407.49'
L = 744.85'
E = 104.87'
emax = 0.069

TRAFFIC DATA

CURRENT ADT (2010) = 6200
DESIGN ADT (2030) = 9400
DESIGN ADTT = 1320

LEGEND

⌖ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: THREE-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENT (REAR) AND JOINTED STUB ABUTMENT ON MSE WALL (FWD.) WITH T-TYPE PIERS

LENGTH OF SPAN: 162'-0", 231'-0", 162'-0" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 21°30'23" RF (REAR ABUTMENT), 08°57'05" RF (PIER 1), 08°57'05" LF (PIER 2), 21°30'23" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

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

DESIGNED SKT | DRAWN JBA | REVIEWED SCJ | DATE 06/07
CHECKED DGS | REVISED | STRUCTURE FILE NUMBER 7306814

SCIOTO COUNTY
STA. 3894+74.75
TO STA. 3900+34.25

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 4

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PID 79977

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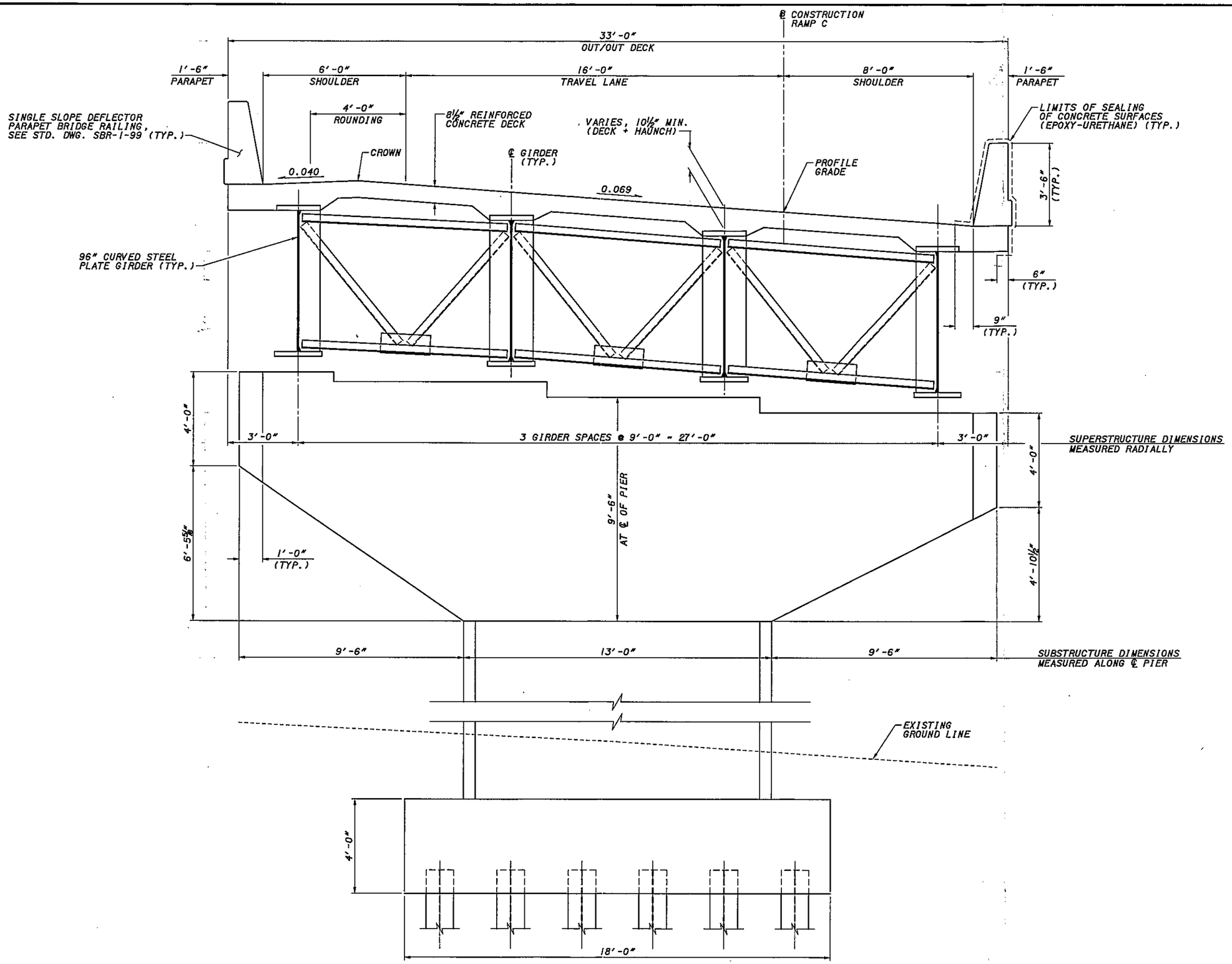

TYPICAL TRANSVERSE SECTION

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

DESIGNED	DRAWN	REVIEWED	DATE
SKT	JBA	SCJ	06/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS		7306814	

TYPICAL TRANSVERSE SECTION
BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 4

SCI-823-10.13
PID 79977

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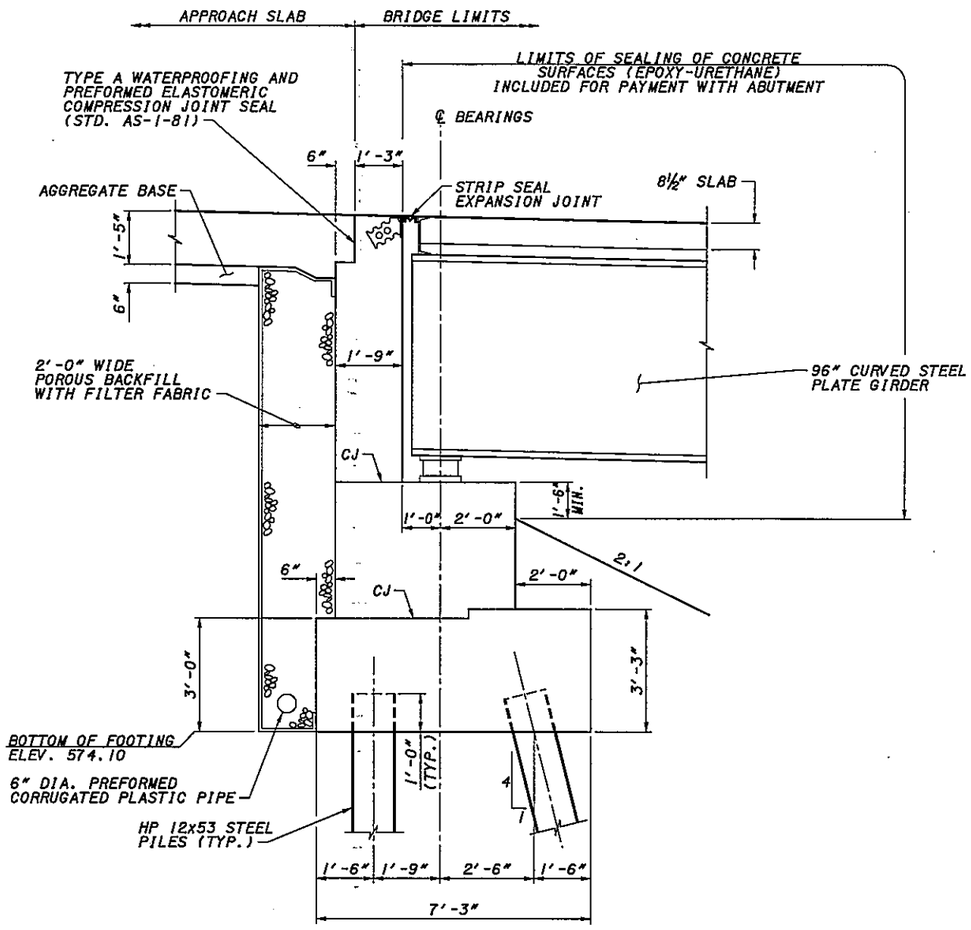

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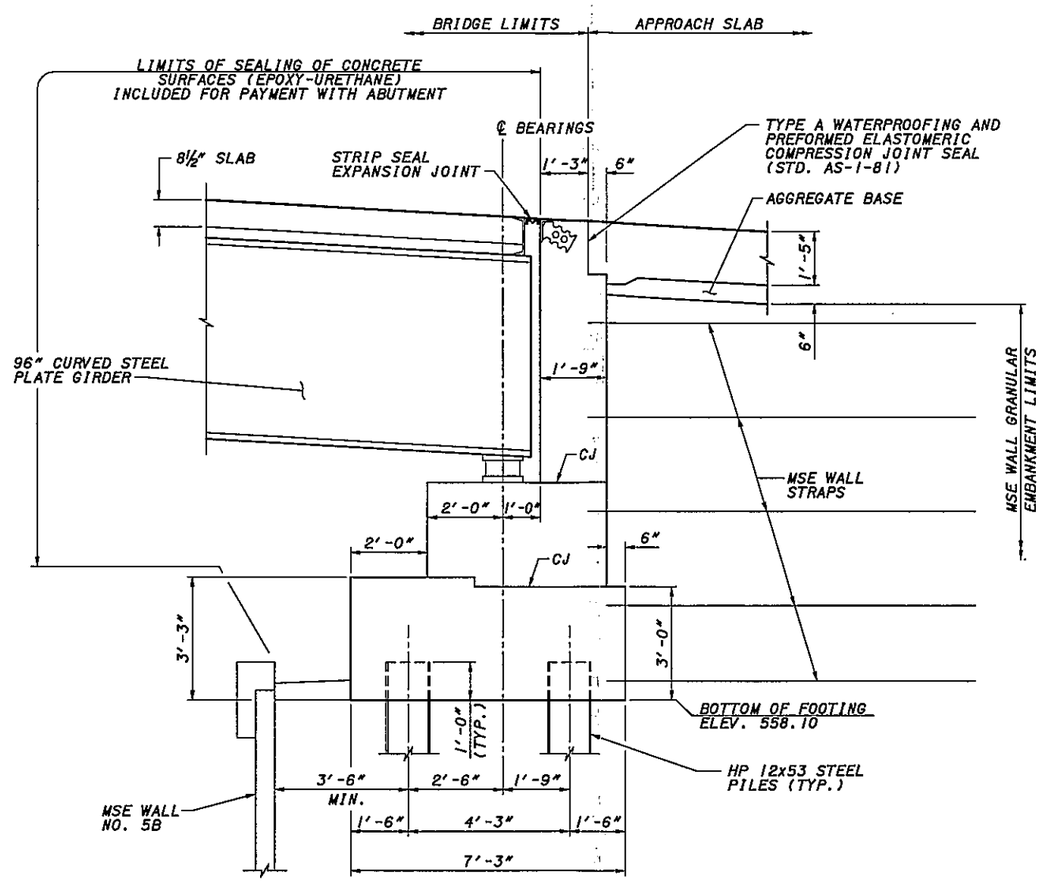
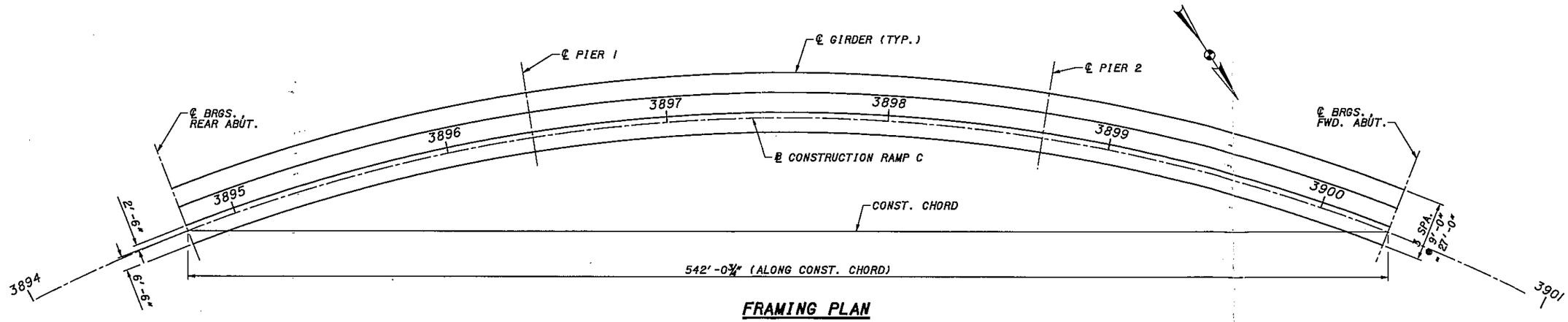


FORWARD ABUTMENT SECTION



FRAMING PLAN

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

DESIGNED SKT | DRAWN JBA | REVIEWED SCJ | DATE 06/07
CHECKED DGS | REVISED | STRUCTURE FILE NUMBER 7306814

ABUTMENT SECTION AND FRAMING PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 4

SCI-823-0.00
PID 19415

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APPENDIX C

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: JTC Date: 5/3/2007

Checked: SKT Date: 5/23/2007

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 1 - 102" Curved Steel Plate Girders

PROFILE DATA - NORFOLK SOUTHERN TRACKS

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	549.78
2	Top of Rail	West	n/a	548.61

PROFILE DATA - RAMP C

Linear:

PVT Sta.	3893+50.00	PVC Sta.	3897+50.00
PVT Elev.	591.85	PVC Elev.	585.85
g	-1.50%		

Vertical Curve:

PVC Sta.	3897+50.00	PVI Sta.	3898+50.00	PVT Sta.	3899+50.00
PVC Elev.	585.85	PVI Elev.	584.35	PVT Elev.	578.45
g1	-1.50%				
g2	-5.90%				
LVC	200				

Linear:

PVT Sta.	3899+50.00	PVC Sta.	3903+20.00
PVT Elev.	578.45	PVC Elev.	556.62
g	-5.90%		

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+96.26	-4.0%	6.9%	-6.9%
3900+97.77	-4.0%	6.9%	-6.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3897+47.03	6.50	585.89	-4.0%	6.9%	-6.9%	585.45
2	RT. FASCIA GIRDER	3898+35.55	6.50	583.76	-4.0%	6.9%	-6.9%	583.31

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH

Haunch + Max. Top Flange = 3.750 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	102" Steel Plate Girder	8.50	2.88	0.875	102	1.25	-	115.50 in
2	102" Steel Plate Girder	8.50	2.00	1.750	102	2.00	-	116.25 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		MINIMUM VERT.
1	RT. FASCIA GIRDER	585.45	115.500	575.82	549.78	**26.04**	OK	CLR = 23'-4 3/4"
2	RT. FASCIA GIRDER	583.31	116.250	573.63	548.61	**25.02**	OK	CLR = 23'-3 5/8"

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: SKT Date: 5/23/2007

Checked: JBA Date: 6/5/2007

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 2 - 120" Curved Steel Plate Girders

PROFILE DATA - NORFOLK SOUTHERN TRACKS

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	549.78
2	Top of Rail	West	n/a	548.61

PROFILE DATA - RAMP C

Linear:

PVT Sta.	3893+50.00	PVC Sta.	3897+50.00
PVT Elev.	591.85	PVC Elev.	585.85
g	-1.50%		

Vertical Curve:

PVC Sta.	3897+50.00	PVI Sta.	3898+50.00	PVT Sta.	3899+50.00
PVC Elev.	585.85	PVI Elev.	584.35	PVT Elev.	578.45
g1	-1.50%				
g2	-5.90%				
LVC	200				

Linear:

PVT Sta.	3899+50.00	PVC Sta.	3903+20.00
PVT Elev.	578.45	PVC Elev.	556.62
g	-5.90%		

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+96.26	-4.0%	6.9%	-6.9%
3900+97.77	-4.0%	6.9%	-6.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3897+47.03	6.50	585.89	-4.0%	6.9%	-6.9%	585.45
2	RT. FASCIA GIRDER	3898+35.55	6.50	583.76	-4.0%	6.9%	-6.9%	583.31

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.250 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	120" Steel Plate Girder	8.50	2.25	2.000	120	2.00	-	134.75 in
2	120" Steel Plate Girder	8.50	2.25	2.000	120	2.00	-	134.75 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		MINIMUM VERT.
1	RT. FASCIA GIRDER	585.45	134.750	574.22	549.78	**24.44**	OK	CLR = 23'-4 3/4"
2	RT. FASCIA GIRDER	583.31	134.750	572.08	548.61	**23.47**	OK	CLR = 23'-3 5/8"

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: SKT Date: 5/24/2007

Checked: DGS Date: 6/6/2007

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 3a - 120" Curved Steel Plate Girders

PROFILE DATA - NORFOLK SOUTHERN TRACKS

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	549.78
2	Top of Rail	West	n/a	548.61

PROFILE DATA - RAMP C

Linear: PVT Sta. 3893+50.00 PVC Sta. 3897+50.00

PVT Elev. 591.85 PVC Elev. 585.85

g -1.50%

Vertical Curve: PVC Sta. 3897+50.00 PVI Sta. 3898+50.00 PVT Sta. 3899+50.00

PVC Elev. 585.85 PVI Elev. 584.35 PVT Elev. 578.45

g1 -1.50%

g2 -5.90%

LVC 200

Linear: PVT Sta. 3899+50.00 PVC Sta. 3903+20.00

PVT Elev. 578.45 PVC Elev. 556.62

g -5.90%

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+96.26	-4.0%	6.9%	-6.9%
3900+97.77	-4.0%	6.9%	-6.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3897+47.03	6.50	585.89	-4.0%	6.9%	-6.9%	585.45
2	RT. FASCIA GIRDER	3898+35.55	6.50	583.76	-4.0%	6.9%	-6.9%	583.31

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH Haunch + Max. Top Flange = 4.000 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	120" Steel Plate Girder	8.50	2.00	2.000	120	2.00	-	134.50 in
2	120" Steel Plate Girder	8.50	2.00	2.000	120	2.50	-	135.00 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		MINIMUM VERT.
1	RT. FASCIA GIRDER	585.45	134.500	574.24	549.78	**24.46**	OK	CLR = 23'-4 3/4"
2	RT. FASCIA GIRDER	583.31	135.000	572.06	548.61	**23.45**	OK	CLR = 23'-3 5/8"

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: SKT Date: 5/24/2007

Checked: DGS Date: 6/7/2008

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 3b - 102" Curved Steel Tub Girders

PROFILE DATA - NORFOLK SOUTHERN RAILWAY

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	549.79
2	Top of Rail	West	n/a	548.62

PROFILE DATA - RAMP C

Linear:

PVT Sta.	3893+50.00	PVC Sta.	3897+50.00
PVT Elev.	591.85	PVC Elev.	585.85
g	-1.50%		

Vertical Curve:

PVC Sta.	3897+50.00	PVI Sta.	3898+50.00	PVT Sta.	3899+50.00
PVC Elev.	585.85	PVI Elev.	584.35	PVT Elev.	578.45
g1	-1.50%				
g2	-5.90%				
LVC	200				

Linear:

PVT Sta.	3899+50.00	PVC Sta.	3903+20.00
PVT Elev.	578.45	PVC Elev.	556.62
g	-5.90%		

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+96.26	-4.0%	6.9%	-6.9%
3900+97.77	-4.0%	6.9%	-6.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3897+43.69	4.50	585.94	-4.0%	6.9%	-6.9%	585.63
2	RT. FASCIA GIRDER	3898+30.94	4.50	583.92	-4.0%	6.9%	-6.9%	583.60

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH

Haunch + Max. Top Flange = 4.500 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	102" Steel Tub Girder	8.50	2.00	2.500	102	2.75	-	117.75 in
2	102" Steel Tub Girder	8.50	2.00	2.500	102	2.75	-	117.75 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		MINIMUM VERT.
1	RT. FASCIA GIRDER	585.63	117.750	575.82	549.79	**26.03**	OK	CLR = 23'-4 3/4"
2	RT. FASCIA GIRDER	583.60	117.750	573.79	548.62	**25.17**	OK	CLR = 23'-3 5/8"

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: JTC Date: 5/3/2007

Checked: SKT Date: 5/23/2007

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 4 - 96" Curved Steel Plate Girders

PROFILE DATA - NORFOLK SOUTHERN TRACKS

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	East	n/a	549.78
2	Top of Rail	West	n/a	548.61

PROFILE DATA - RAMP C

Linear:

PVT Sta.	3893+50.00	PVC Sta.	3897+50.00
PVT Elev.	591.85	PVC Elev.	585.85
g	-1.50%		

Vertical Curve:

PVC Sta.	3897+50.00	PVI Sta.	3898+50.00	PVT Sta.	3899+50.00
PVC Elev.	585.85	PVI Elev.	584.35	PVT Elev.	578.45
g1	-1.50%				
g2	-5.90%				
LVC	200				

Linear:

PVT Sta.	3899+50.00	PVC Sta.	3903+20.00
PVT Elev.	578.45	PVC Elev.	556.62
g	-5.90%		

Superelevation Data:

Station	Left Shoulder	Pavement	Right Shoulder
3894+96.26	-4.0%	6.9%	-6.9%
3900+97.77	-4.0%	6.9%	-6.9%

POINT	RAMP C LOCATION DESCRIPTION	STA.	OFF.*	RAMP C PG ELEV.	LT. SHOULDER X-SLOPE	PVMT X-SLOPE	RT. SHOULDER X-SLOPE	RAMP C - FINISHED GRADE @ POINT
1	RT. FASCIA GIRDER	3897+47.03	6.50	585.89	-4.0%	6.9%	-6.9%	585.45
2	RT. FASCIA GIRDER	3898+35.55	6.50	583.76	-4.0%	6.9%	-6.9%	583.31

* For Offsets allow positive (+) to denote an offset to the right of the baseline and negative (-) to denote an offset to the left of the baseline

STRUCTURE DEPTH

Haunch + Max. Top Flange = 3.750 in

POINT	GIRDER DESCRIPTION	Slab	Haunch	Top Flange	Web	Bot. Flange	Splice	Total
1	96" Steel Plate Girder	8.50	2.88	0.88	96	1.375	-	109.63 in
2	96" Steel Plate Girder	8.50	2.00	1.75	96	1.875	-	110.13 in

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN

POINT	LOCATION	RAMP C - FINISHED GRADE @ POINT	STRUCTURE DEPTH (in.)	BOT. GIRDER ELEVATION	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)		MINIMUM VERT.
1	RT. FASCIA GIRDER	585.45	109.625	576.31	549.78	**26.53**	OK	CLR = 23'-4 3/4"
2	RT. FASCIA GIRDER	583.31	110.125	574.14	548.61	**25.53**	OK	CLR = 23'-3 5/8"

SCI-823-10.13

RAMP C OVER NORFOLK SOUTHERN TRACKS

VERTICAL CLEARANCES

Filename: \\aries\proj\TranSystems\319861\19415\structures\Documents\Step 7 - Type Study\Bridge Type Study\Bridge SCI823-1603C Ramp C over Railroad\[RampC_RR_ Vert_Clr.xls]Alternative 5

By: SKT Date: 6/8/2007

Checked: DGS Date: 6/13/2007

LEGEND:

User Input - Not Critical

User Input - Critical to Output

Alternative 5 - 69" Steel Plate Girder w/ Integral Straddle Bent

PROFILE DATA - NORFOLK SOUTHERN TRACKS

Use existing top of high rail elevations, as profile adjustments to the railroad are not anticipated in this project.

POINT	RAILROAD LOCATION		RAILROAD STATION	RAILROAD - EXISTING ELEV. @ POINT
1	Top of Rail	West	n/a	548.68
2	Top of Rail	West	n/a	548.69
3	Top of Rail	East	n/a	549.75
4	Top of Rail	East	n/a	549.72

INTEGRAL STRADDLE BENT CAP - LOW STRUCTURAL MEMBER

Bot. of Cap Elevation at Left End = 579.72

Bot. of Cap Elevation at Right End = 572.16

Length of Straddle Bent Cap = 128.3028 ft.

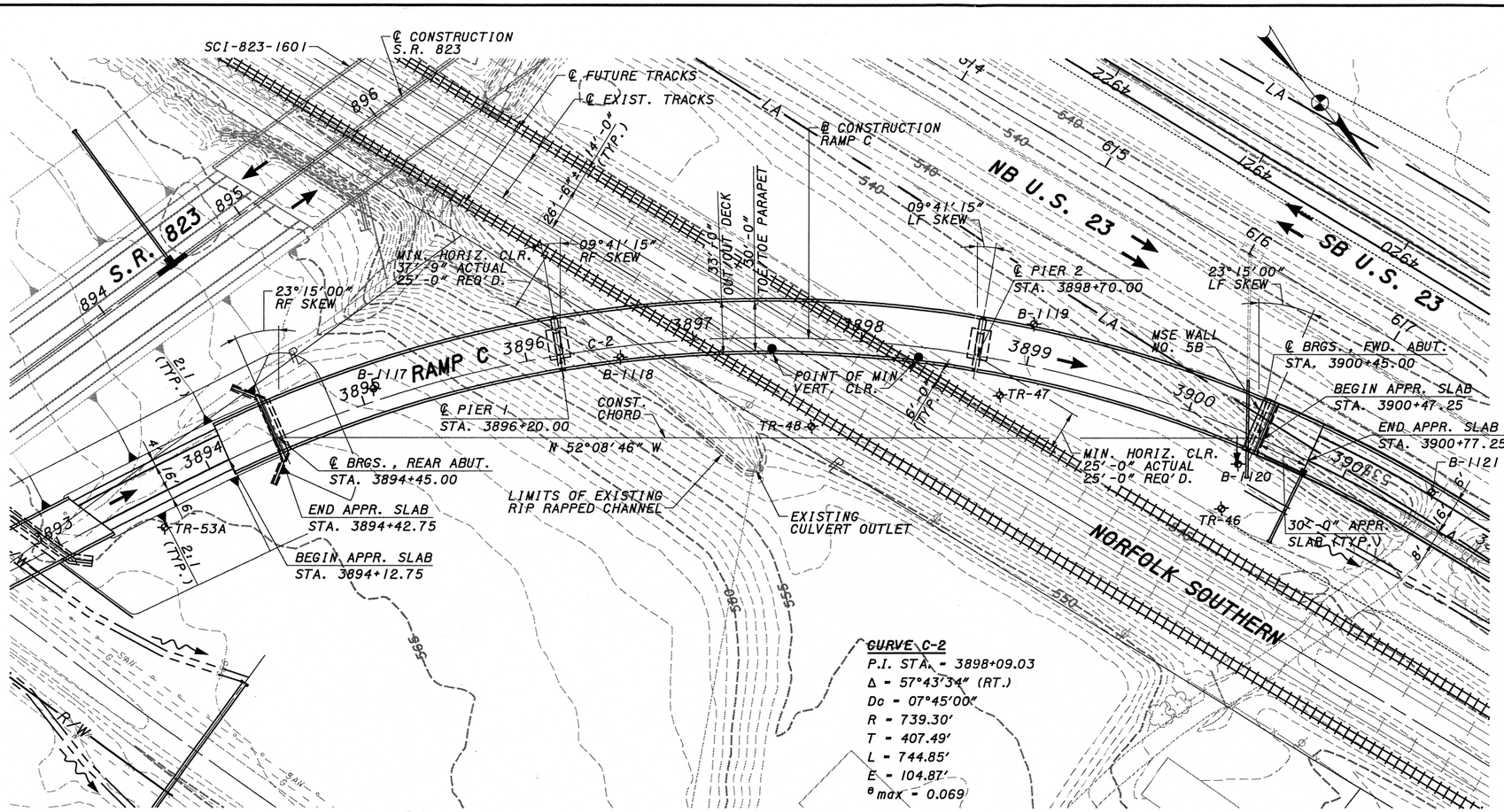
POINT	DISTANCE FROM LEFT END OF STRADDLE BENT	BOTTOM OF STRADDLE BENT ELEV. @ POINT
1	40.6146'	577.33
2	56.8750'	576.37
3	87.7292'	574.55
4	103.9792'	573.59

VERTICAL CLEARANCE - RAMP C OVER NORFOLK SOUTHERN TRACKS

POINT	LOCATION	BOT. OF STRADDLE BENT ELEV.	RAILROAD - FINISHED GRADE @ POINT	VERTICAL CLEARANCE (ft.)	CHECK MINIMUM VERTICAL CLEARANCE *	
1	FUTURE RAIL - WEST	577.33	548.68	**28.65**	OK	MINIMUM VERT. CLR =
2	EXISTING RAIL - WEST	576.37	548.69	**27.68**	OK	23.30'
3	FUTURE RAIL - EAST	574.55	549.75	**24.80**	OK	MINIMUM VERT. CLR =
4	EXISTING RAIL - EAST	573.59	549.72	**23.87**	OK	23.40'

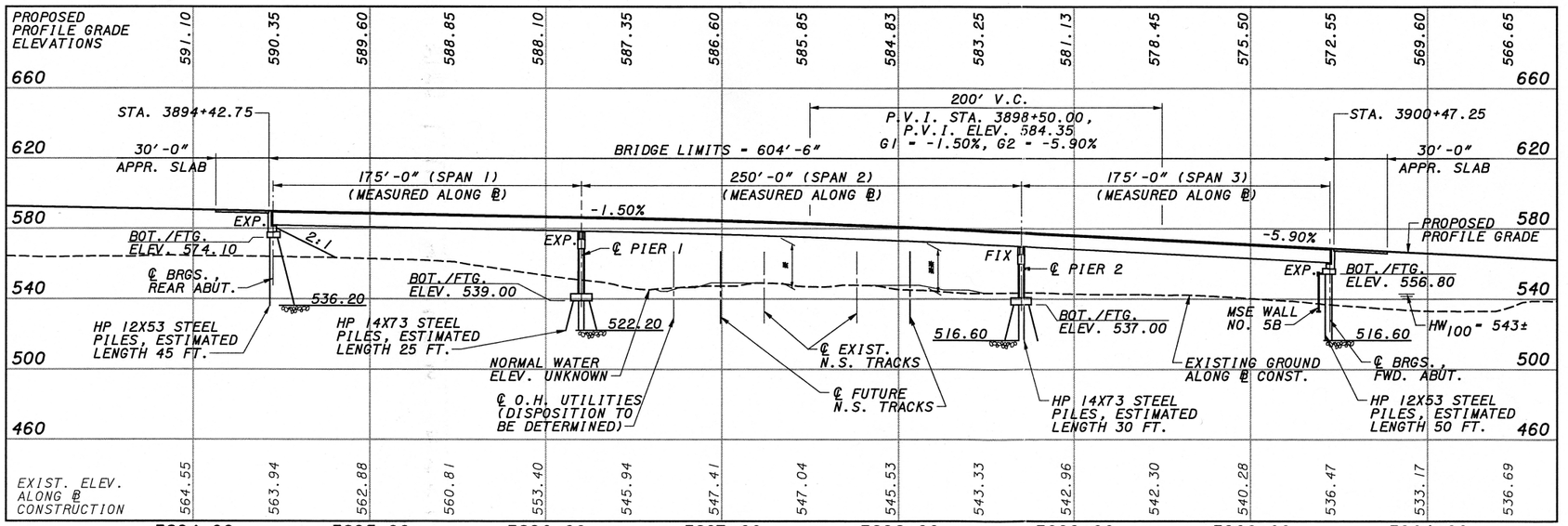
* ALLOWABLE MINIMUM VERTICAL CLEARANCE WAS INCREASED ABOVE 23'-0" TO ACCOUNT FOR POTENTIAL OF REMOVING THE SAG VERTICAL CURVE ON THE TRACK ALIGNMENT.

APPENDIX D



PLAN

CURVE C-2
P.I. STA. = 3898+09.03
Δ = 57°43'34" (RT.)
Dc = 07°45'00"
R = 739.30'
T = 407.49'
L = 744.85'
E = 104.87'
e max = 0.069

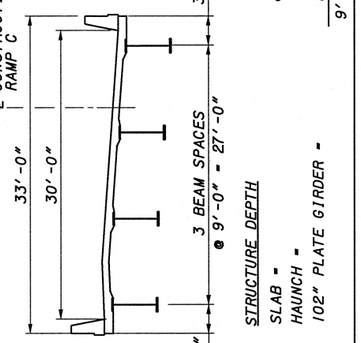


PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* MIN. VERT. CLR. 26'-0" ACTUAL 23'-4¾" REQ'D.

** MIN. VERT. CLR. 25'-0" ACTUAL 23'-3⅝" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH
SLAB - 8½"
HAUNCH - 2"
102" PLATE GIRDER - 10⅝"
9'-8¼"

N.T.S.

LEGEND

⊕ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: THREE-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENT (REAR) AND JOINTED STUB ABUTMENT ON MSE WALL (FWD.) WITH T-TYPE PIERS

LENGTH OF SPAN: 175'-0", 250'-0", 175'-0" C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 23°15'00" RF (REAR ABUTMENT), 09°41'15" RF (PIER 1), 09°41'15" LF (PIER 2), 23°15'00" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 1

SCI-823-10.13
PID 79977

SCIOTO COUNTY
STA. 3894+42.75
TO STA. 3900+47.25

DESIGNED SKT | DRAWN JBA | REVIEWED SCJ | DATE 06/07
CHECKED DGS | REVISED | | STRUCTURE FILE NUMBER 7306814

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

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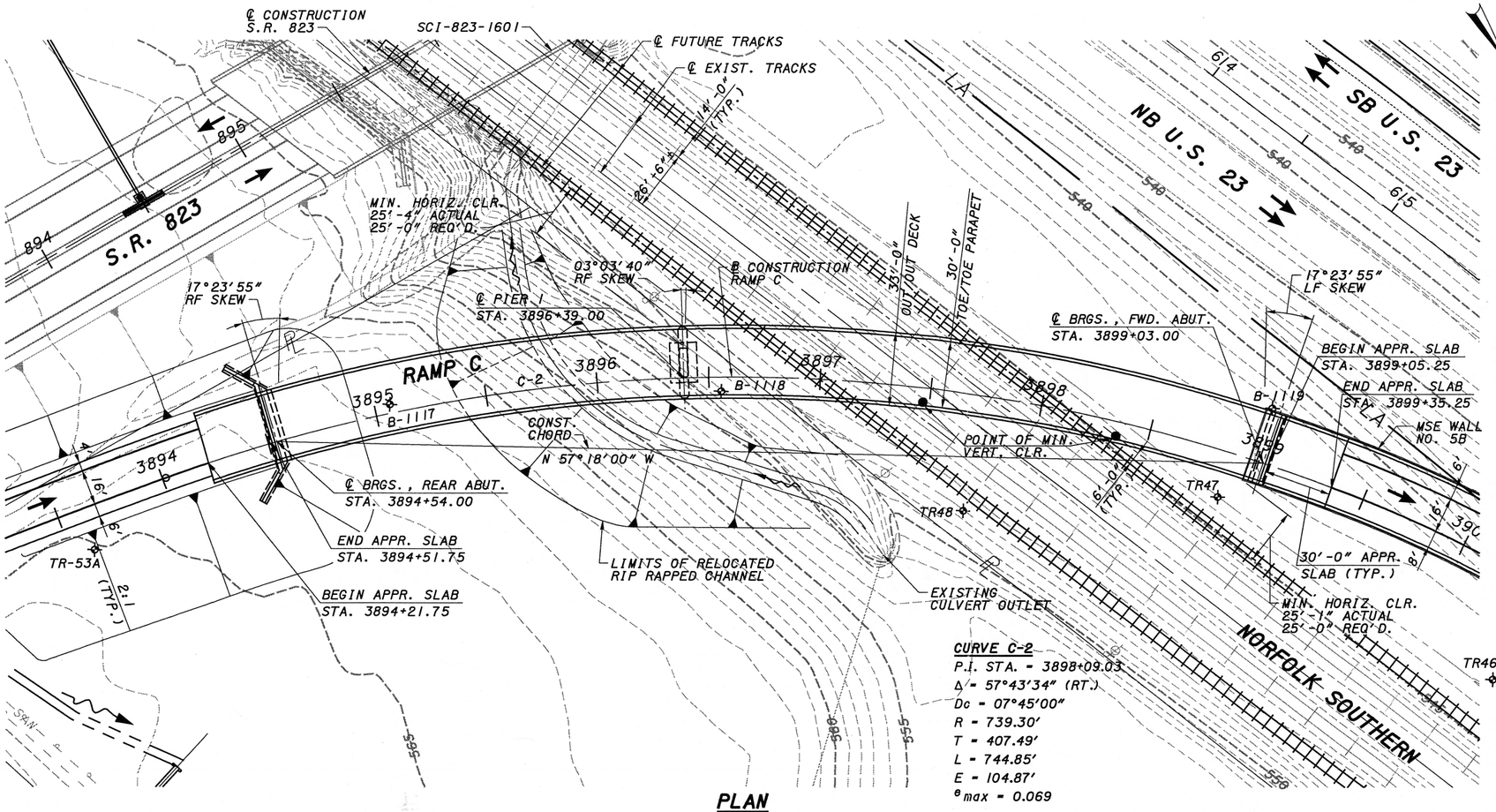
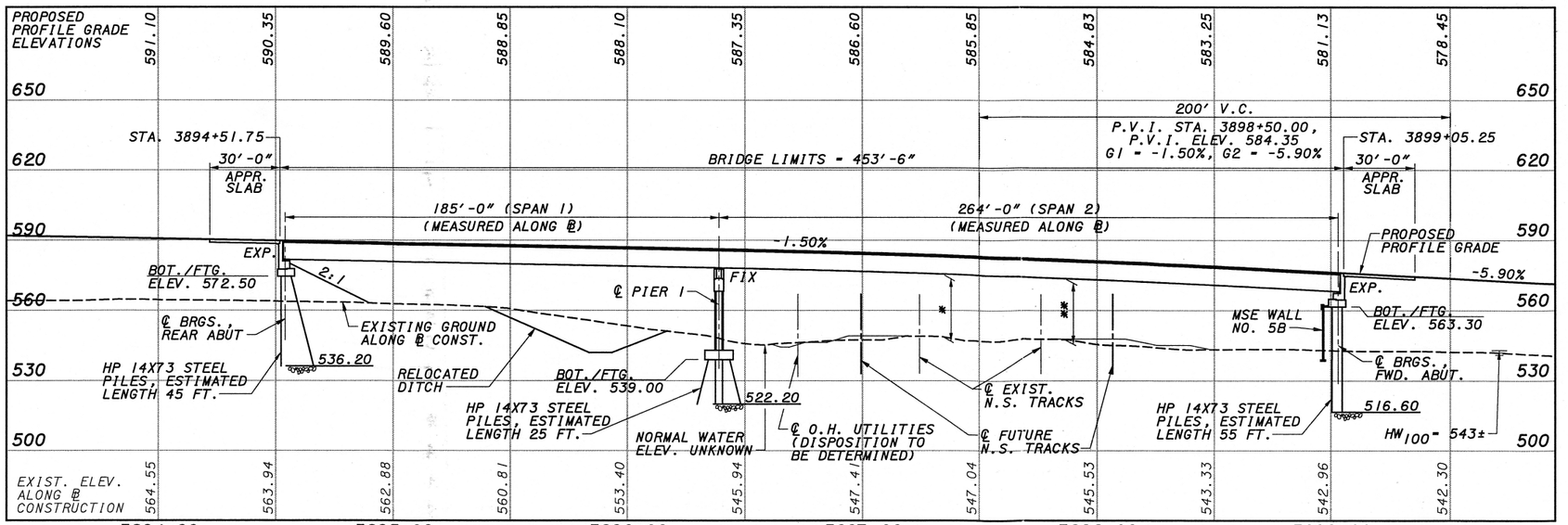


PLAN

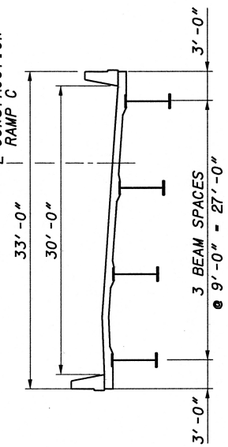


PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* MIN. VERT. CLR. 24'-5" ACTUAL 23'-4¾" REQ'D.

** MIN. VERT. CLR. 23'-5" ACTUAL 23'-3⅝" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB - 8½"

HAUNCH - 2"

120" PLATE GIRDER - 124¾" = 11'-3¼"

N.T.S.

LEGEND

⊕ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: TWO-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENT (REAR) AND JOINTED STUB ABUTMENT ON MSE WALL (FWD.) WITH T-TYPE PIER

LENGTH OF SPAN: 185'-0", 264'-0", C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 17°23'55" RF (REAR ABUTMENT), 03°03'40" RF (PIER), 17°23'55" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

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

DESIGNED	DRAWN	REVIEWED	DATE
SKT	JBA	SCJ	06/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS		7306814	

SCIOTO COUNTY
STA. 3894+51.75
TO STA. 3899+05.25

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 2

SCI-823-10.13
PID 79977

- / -

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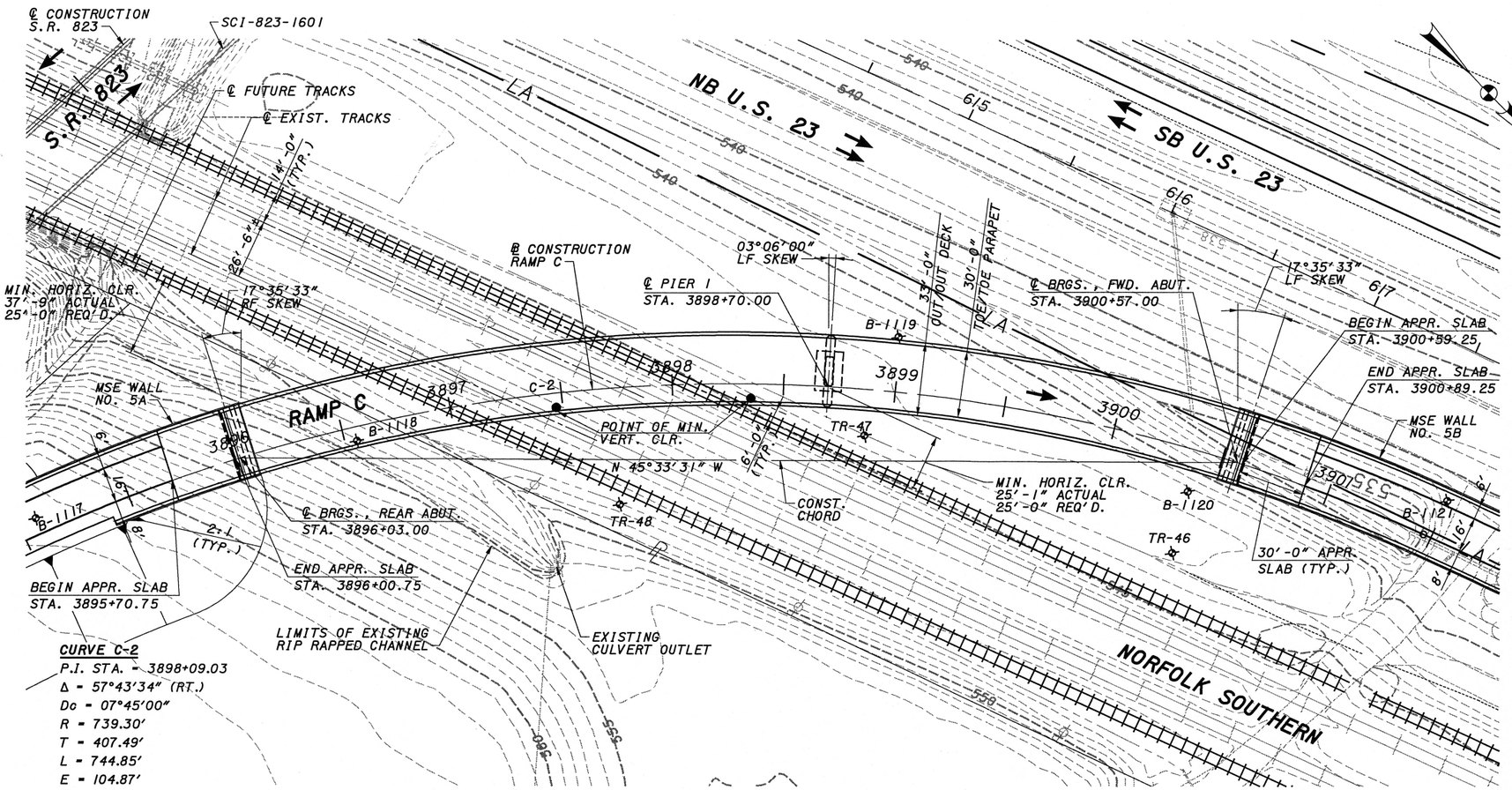
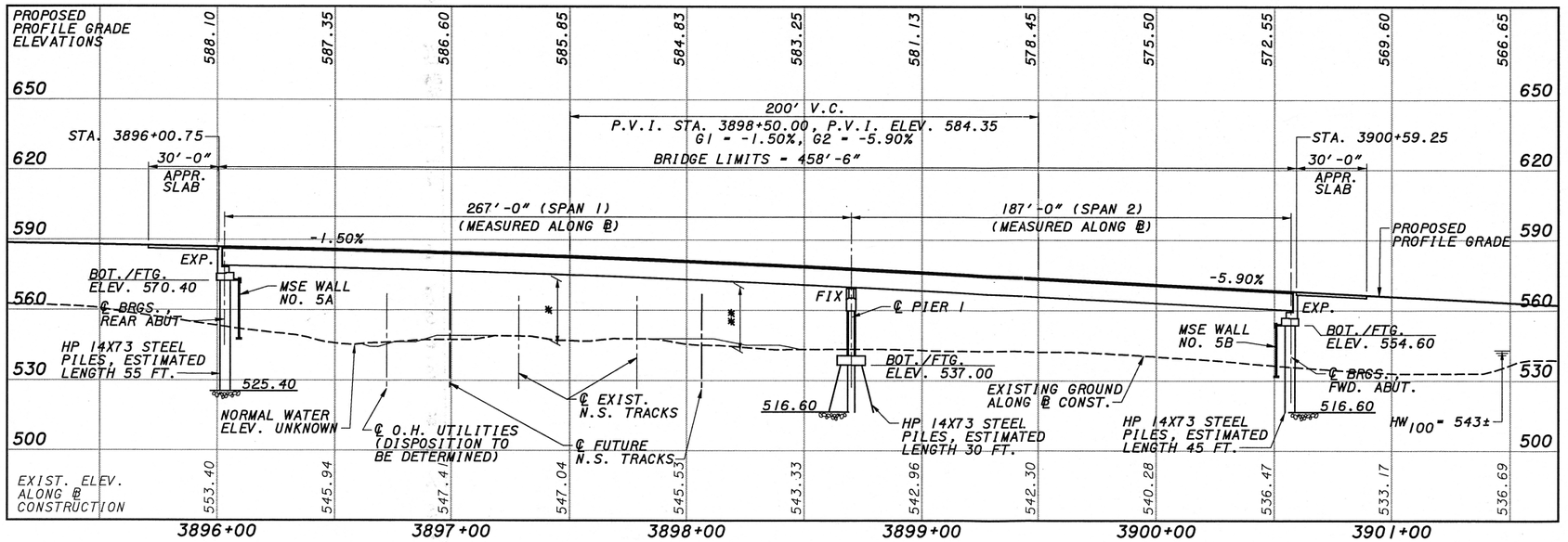


CURVE C-2
P.I. STA. = 3898+09.03
Δ = 57°43'34" (RT.)
Dc = 07°45'00"
R = 739.30'
T = 407.49'
L = 744.85'
E = 104.87'
e max = 0.069

PLAN

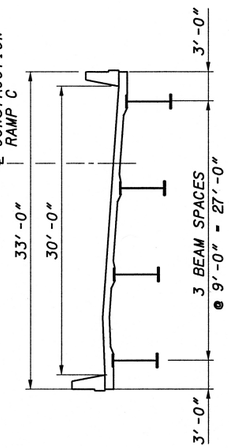


PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* MIN. VERT. CLR. 24'-5" ACTUAL 23'-4¾" REQ'D.

** MIN. VERT. CLR. 23'-5" ACTUAL 23'-3⅝" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH
SLAB - 8½"
HAUNCH - 2"
120" PLATE GIRDER - 124½"
11'-3"

N.T.S.

LEGEND

⌖ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: TWO-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENTS BEHIND MSE WALLS WITH T-TYPE PIER

LENGTH OF SPAN: 267'-0", 187'-0", C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 17°35'33" RF (REAR ABUTMENT), 03°06'00" LF (PIER), 17°35'33" LF (FORWARD ABUTMENT) MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

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

DESIGNED SKT | DRAWN JBA | REVIEWED SCJ | DATE 06/07
CHECKED DGS | REVISED | STRUCTURE FILE NUMBER 7306814

SCIOTO COUNTY
STA. 3896+00.75
TO STA. 3900+59.25

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 3A

SCI-823-10.13
PID 79977

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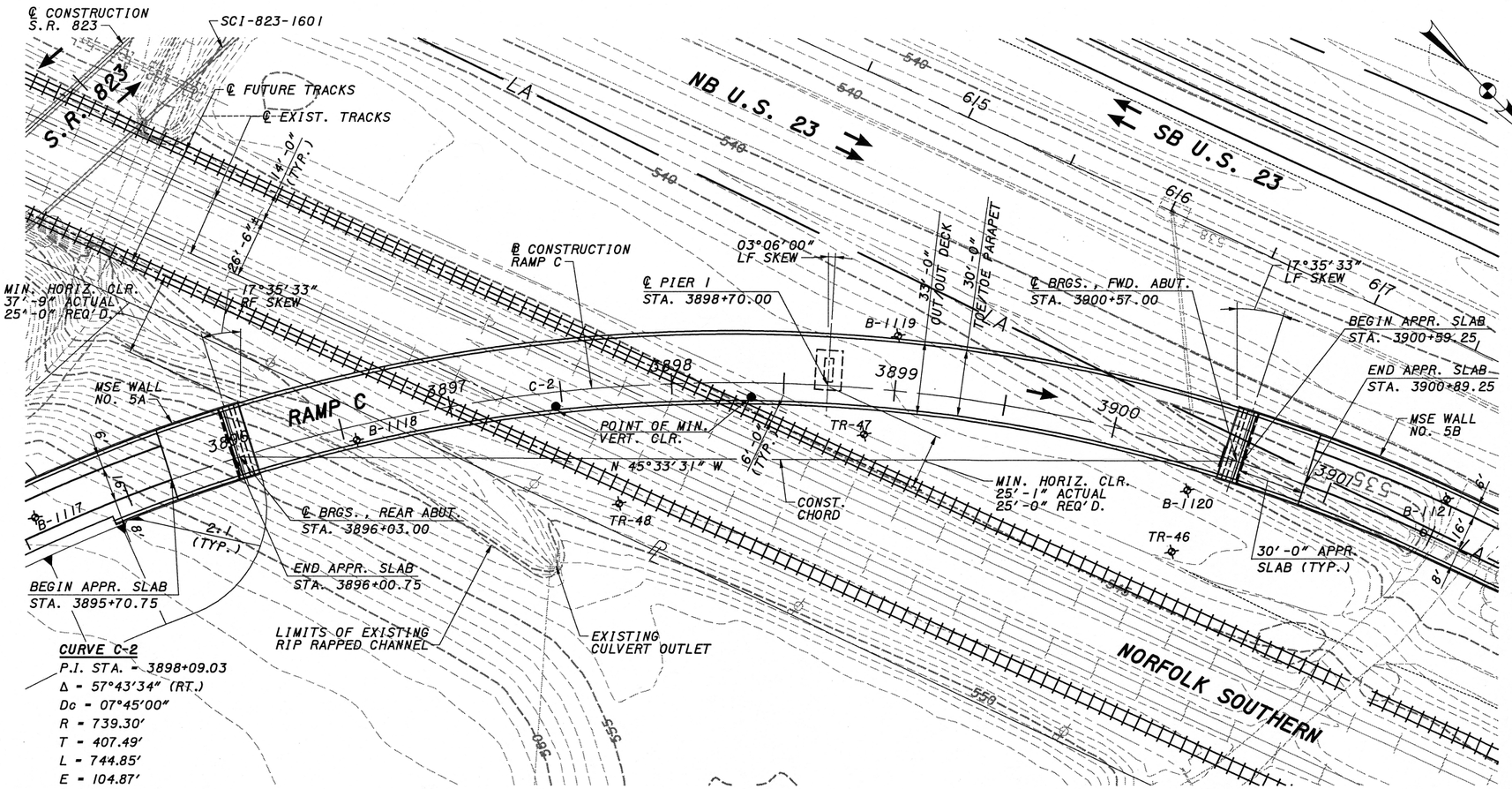

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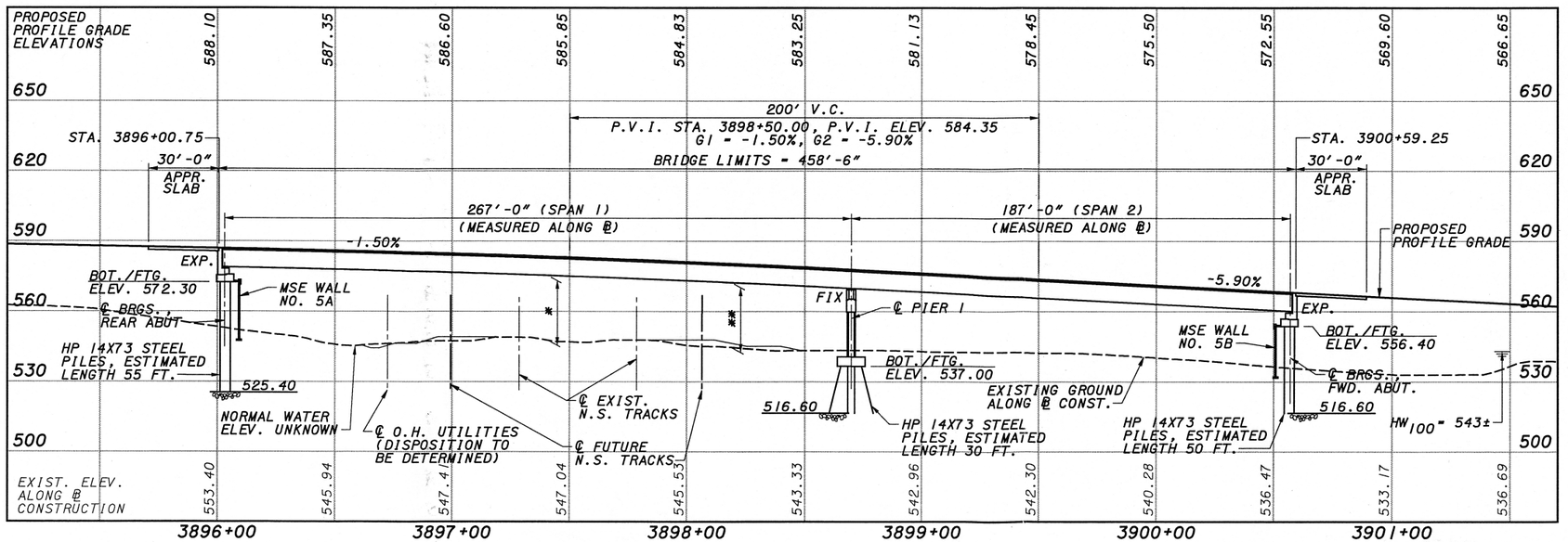
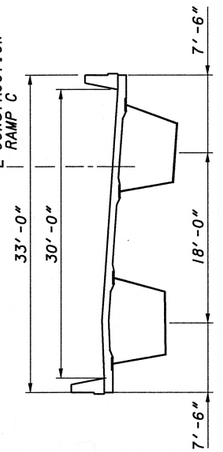


PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* MIN. VERT. CLR. 26'-0" ACTUAL 23'-4¾" REQ'D.

** MIN. VERT. CLR. 25'-2" ACTUAL 23'-3⅝" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB -	8½"
HAUNCH -	2"
102" TUB GIRDER -	107"
	9'-9½"

N.T.S.

LEGEND

⊕ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: TWO-SPAN COMPOSITE CURVED STEEL TUB GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENTS BEHIND MSE WALLS WITH RECTANGULAR PIER STEM

LENGTH OF SPAN: 267'-0", 187'-0", C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 17°35'33" RF (REAR ABUTMENT), 03°06'00" LF (PIER), 17°35'33" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

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

DESIGNED	DRAWN	REVIEWED	DATE
SKT	JBA	SCJ	06/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS		7306814	

SCIOTO COUNTY
STA. 3896+00.75
TO STA. 3900+59.25

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 3B

SCI-823-10.13
PID 79977

- / -

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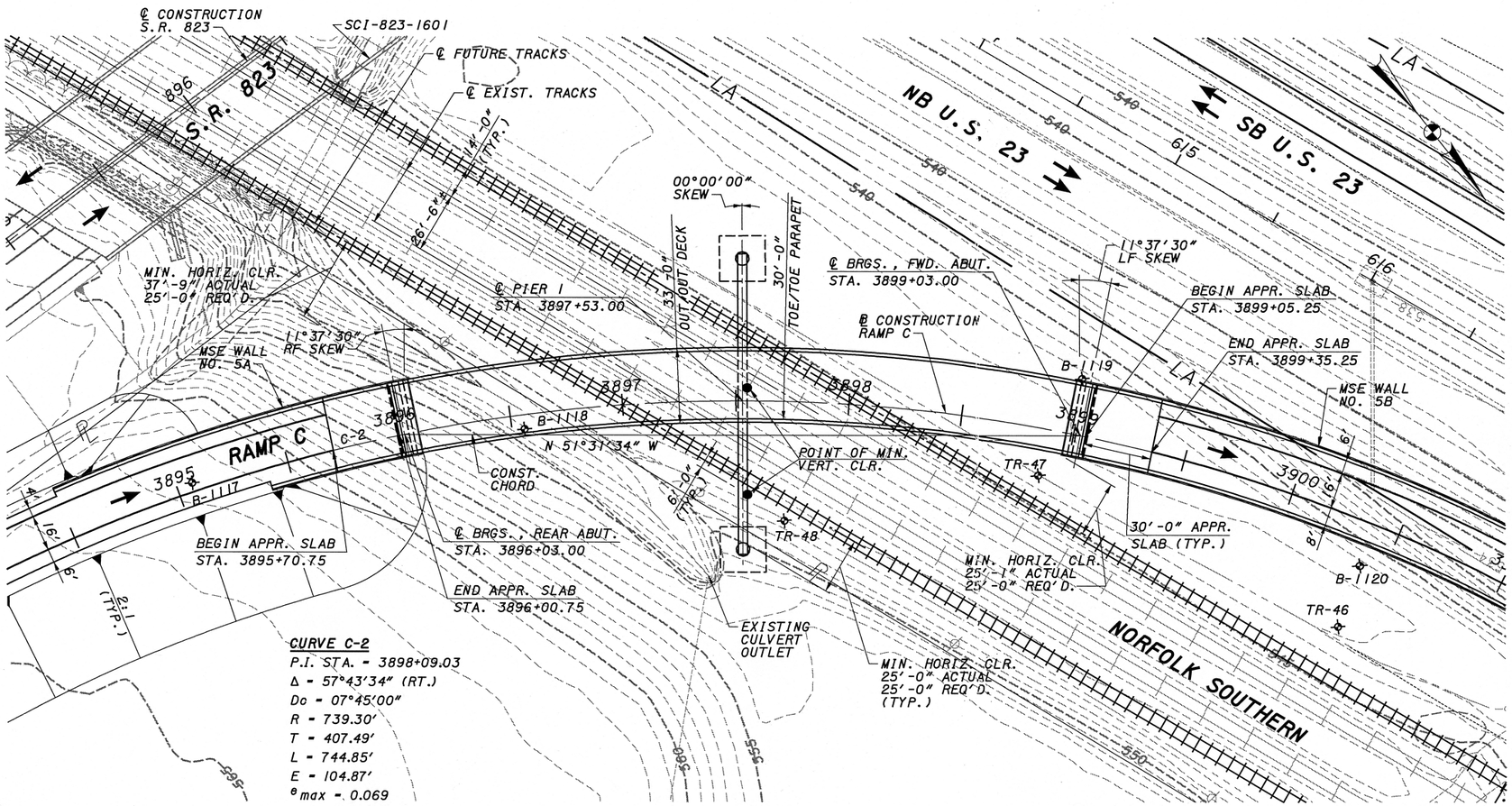
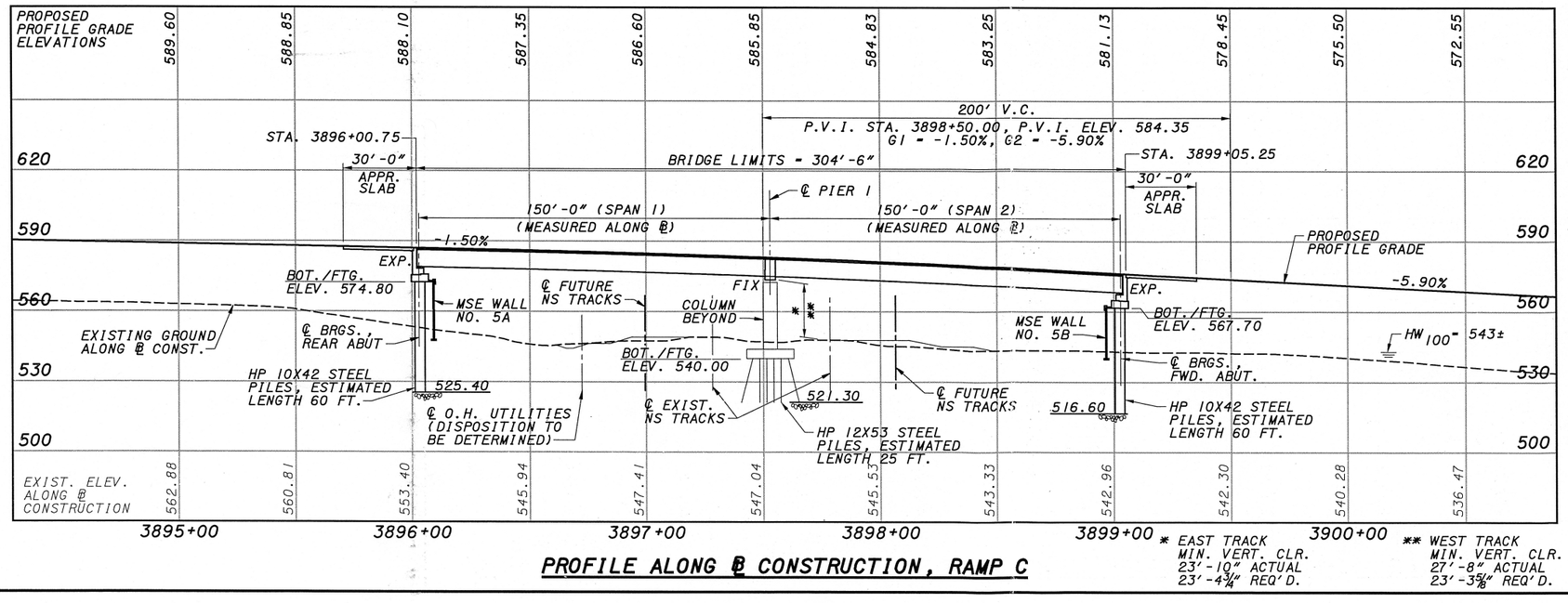


PLAN

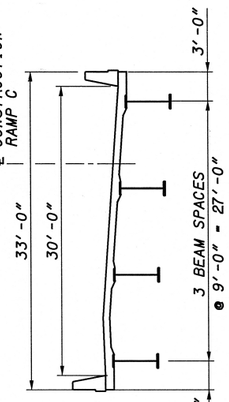


PROFILE ALONG ℄ CONSTRUCTION, RAMP C

* EAST TRACK MIN. VERT. CLR. 23'-10" ACTUAL 23'-4¾" REQ'D.

** WEST TRACK MIN. VERT. CLR. 27'-8" ACTUAL 23'-3⅝" REQ'D.

SUPERSTRUCTURE DATA



STRUCTURE DEPTH

SLAB - 8½"

HAUNCH - 2"

69" PLATE GIRDER - 73⅜" / 6'-11⅞"

N.T.S.

LEGEND

⌖ DENOTES SOIL BORING LOCATION

NOTE

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

PROPOSED STRUCTURE

TYPE: TWO-SPAN COMPOSITE CURVED STEEL PLATE GIRDERS (WEATHERED ASTM A709, GR 50W) WITH REINFORCED CONCRETE DECK ON JOINTED STUB ABUTMENTS BEHIND MSE WALLS WITH INTEGRAL STRADDLE BENT PIER

LENGTH OF SPAN: 150'-0", 150'-0", C-C BEARINGS, MEASURED ALONG ℄ CONSTRUCTION

ROADWAY: 30'-0" TOE/TOE PARAPETS

SIDEWALK: NONE

DESIGN LOADING: HS25 (CASE II) AND THE ALTERNATE MILITARY LOADING, FWS = 60 LB/FT²

SKEW: 11°37'30" RF (REAR ABUTMENT), 00°00'00" (PIER), 11°37'30" LF (FORWARD ABUTMENT), MEASURED FROM THE NORMAL TO THE CONSTRUCTION CHORD

WEARING SURFACE: MONOLITHIC CONCRETE

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

ALIGNMENT: HORIZONTALLY CURVED (℄ RADIUS= 739.30 FT.)

SUPERELEVATION: 0.069 FT/FT

LATITUDE: N 38°53'34"

LONGITUDE: W 82°59'57"

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

DESIGNED	DRAWN	REVIEWED	DATE
SKT	JBA	SCJ	06/07
CHECKED	REVISED	STRUCTURE FILE NUMBER	
DGS		7306814	

SCIOTO COUNTY
STA. 3896+00.75
TO STA. 3899+05.25

SITE PLAN

BRIDGE NO. SCI-823-1603
RAMP C OVER NORFOLK SOUTHERN - ALT. 5

SCI-823-10.13
PID 79977

- / -

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APPENDIX E

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

May 25, 2007

Mr. Rob Miller, AICP
Project Manager
CH2M Hill
5775 Perimeter Drive Suite 190
Dublin, Ohio 43017

Re: **SR 823 and US 23 Interchange – Ramp C over N-S Railroad**
Preliminary Bridge Foundation Recommendations
Project SCI-823-10.13
PID No.: 79977
DLZ Job No.: 0121-3070.03

Dear Mr. Miller:

This letter reports additional preliminary recommendations for the proposed bridge foundations at the SR 823 over the Norfolk Southern Railroad and US 23 site. The information contained in this document supercedes our report of Preliminary Structural Foundation Recommendations, dated May 2, 2005. Additional recommendations for other structures at the interchange will be presented in separate documents.

It is anticipated that one bridge will carry proposed Ramp C from westbound SR 823 to northbound US 23, crossing over the Norfolk Southern railroad. Several configurations have been presented for the proposed structure. This document will detail foundation options for Alternatives 1 through 3 and 5. It is understood that MSE retaining walls will be used to contain the roadway embankment at the abutment locations. See attached boring plans, which show the various structure configurations relative to the boring locations.

The findings and recommendations presented in this document should be considered preliminary. Additional borings will be necessary to finalize the recommendations for the "approved" bridge and retaining wall configurations.

Preliminary Bridge Foundation Recommendations

In the area of the proposed structures, borings generally encountered bedrock at depths ranging from 20.5 to 33.0 feet below the ground surface. Bedrock encountered in the borings generally consisted of soft to medium hard shale and sandstone, which was highly to moderately weathered and moderately fractured.

It is recommended that driven H-piles be used to support the proposed structure. Pile tip elevations have been estimated for HP 12x53, 70-ton piles driven to refusal on bedrock. Other H-piles could also be considered to support the bridge abutments. For preliminary purposes, the pile tip elevations provided for the HP 12x53 piles are also considered to be representative of HP 10x42 and HP 14x73 piles. Piles driven for substructure elements east of the Norfolk Southern railroad tracks will encounter shale bedrock at the top of rock. It is anticipated that the piles will penetrate two to three feet into the severely weathered shale bedrock. Because of the tendency of some shales to relax, it is recommended that the contractor restrike these piles at least 24 hours (preferably 3 days) after installation to ensure the allowable bearing capacity of the pile is met.

It is anticipated that some of the piles will be driven to refusal on sandstone. Others will develop adequate capacity bearing in the thin shale layer, which is overlying the sandstone bedrock. Where weathered shale bedrock was encountered at the top of rock, several of these layers contain thin sandstone layers. These interbedded sandstone layers are hard, and could potentially damage piles driven to refusal on these layers. Therefore, it is recommended that reinforced pile points be used to protect the piles while driving.

A table summarizing the site conditions and foundation recommendations is presented in the following table.

Summary of Foundation Recommendations, HP 12x53, 70 ton Driven Piles*

Structure	Element	Boring Number	Existing Ground Surface Elevation (Feet)	Estimated Pile Tip Elevation (Feet)
US 23 Ramp C over N-S Railroad Alt. 1	Rear Abutment	B-1117	562.6	526.6
	Pier 1	B-1118	546.2	521.2
	Pier 2	B-1119	542.0	517.0
	Forward Abutment	B-1120	542.7	514.2
US 23 Ramp C over N-S Railroad Alt. 2	Rear Abutment	B-1117	562.6	526.6
	Pier	B-1118	546.2	521.2
	Forward Abutment	B-1119	542.0	517.0

Summary of Foundation Recommendations, HP 12x53, 70 ton Driven Piles - continued*

Structure	Element	Boring Number	Existing Ground Surface Elevation (Feet)	Estimated Pile Tip Elevation (Feet)
US 23 Ramp C over N-S Railroad Alt. 3	Rear Abutment	B-1118	546.2	521.2
	Pier	B-1119	542.0	517.0
	Forward Abutment	B-1120	542.7	514.2
US 23 Ramp C over N-S Railroad Alt. 5	Rear Abutment	B-1118	546.2	521.2
	Pier – Left	TR-48	546.3	521.3
	Pier – Right	TR-48	546.3	521.3
	Forward Abutment	B-1119	542.0	517.0

** Cited pile tip elevations are considered representative of all H-piles being considered.*

It is understood that minor uplift forces will be produced for alternatives 2 and 3. The resistance to uplift forces was computed assuming the soil profile encountered in boring B-1118. Preliminary analyses have indicated that an allowable uplift resistance of 16.7 kips per pile could be used to design the substructure elements for Ramp C. If the piles cannot resist the anticipated uplift forces or lateral loading, consideration could be given to the use of drilled shafts socketed into bedrock to support the proposed structure. Parameters for the design of drilled shafts can be provided upon request.

Special consideration must be given to the diameter, spacing, and location of drilled shaft foundations behind MSE walls. The drilled shafts should be set back from the MSE wall panels a sufficient distance to allow reinforcing straps to be splayed around the shafts at an angle of 15 degrees or less. Typically this equates to a distance of approximately 2B.

Due to the multiple-span configurations, spread footings bearing in the MSE fill are not being considered to support the abutments. If the configuration should change, DLZ should be notified so that we may revise our recommendations as necessary.

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

Closing

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

Sincerely,

DLZ OHIO, INC.

Steven J. Riedy
Geotechnical Engineer

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

Attachments: Plan and Profile Drawing with Boring Locations (Alt.1 through Alt. 3 and Alt. 5)
Boring Logs
Pile Uplift Calculations

cc: File

sjr

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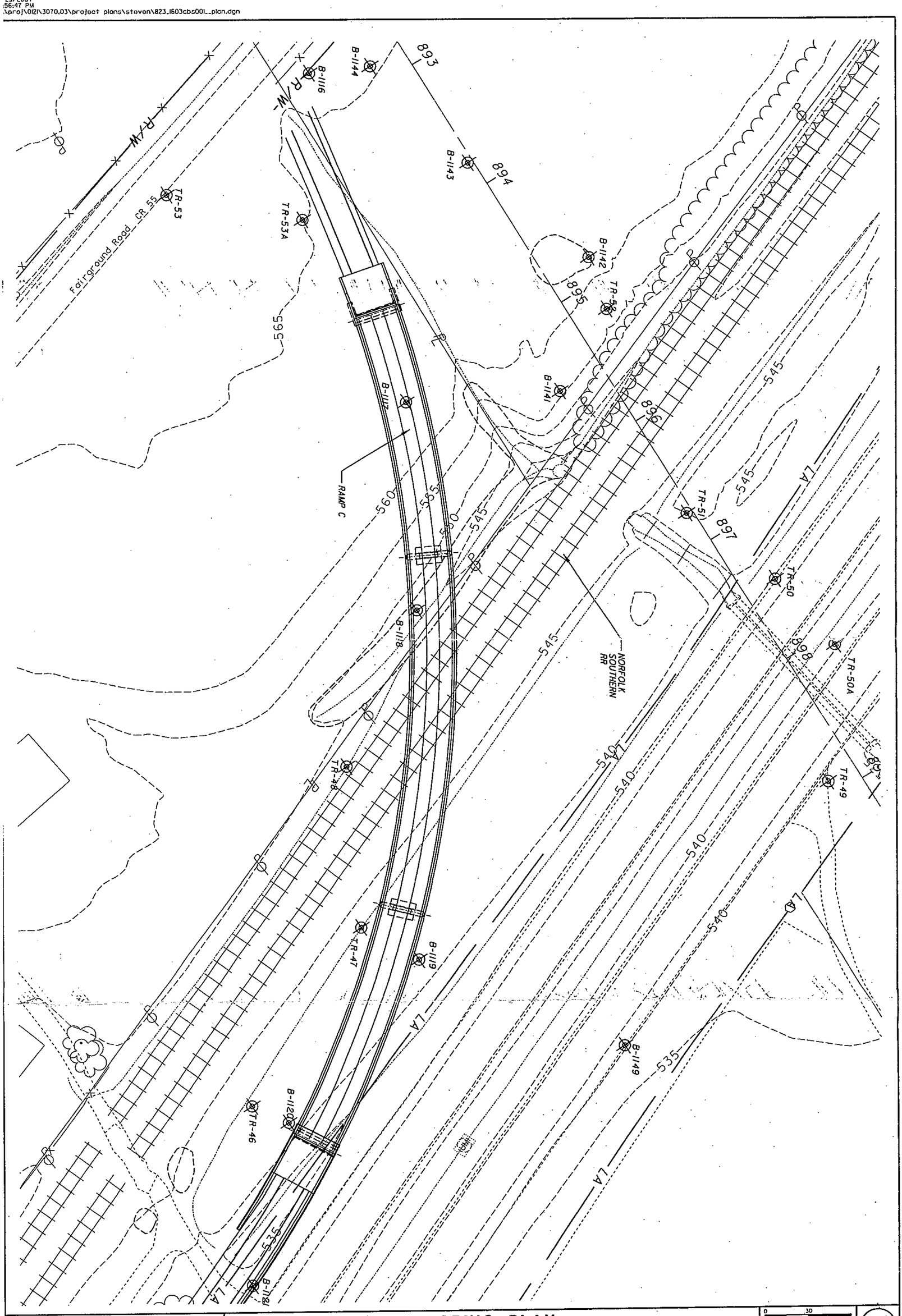

SCI-823-10.13
PID 79977

BORING PLAN
RAMP C - ALTERNATIVE 1

HORIZONTAL SCALE IN FEET
0 15 30 60

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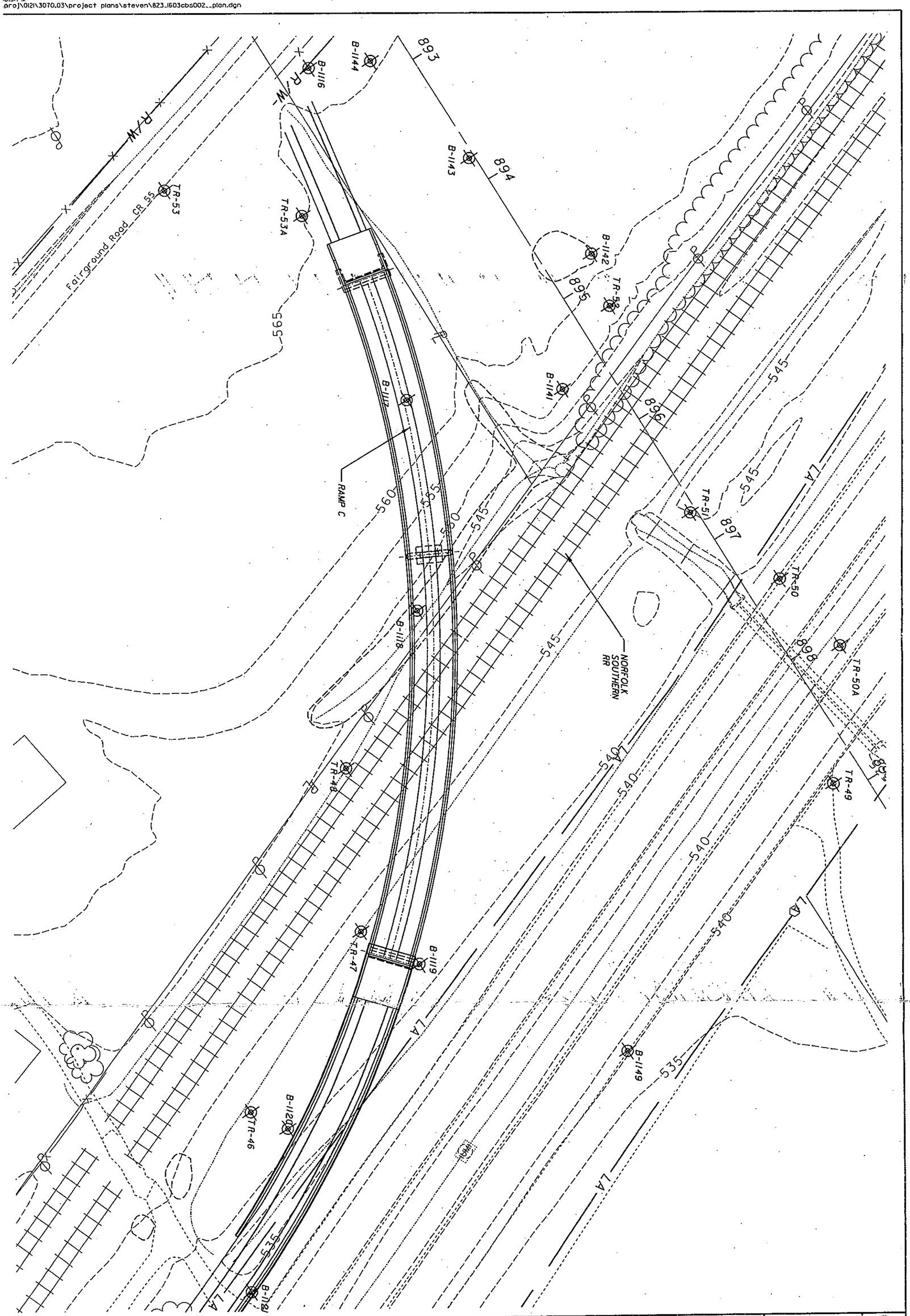

SCI-823-10.13
PID 79977

BORING PLAN
RAMP C - ALTERNATIVE 2

HORIZONTAL SCALE IN FEET
0 30
15 60

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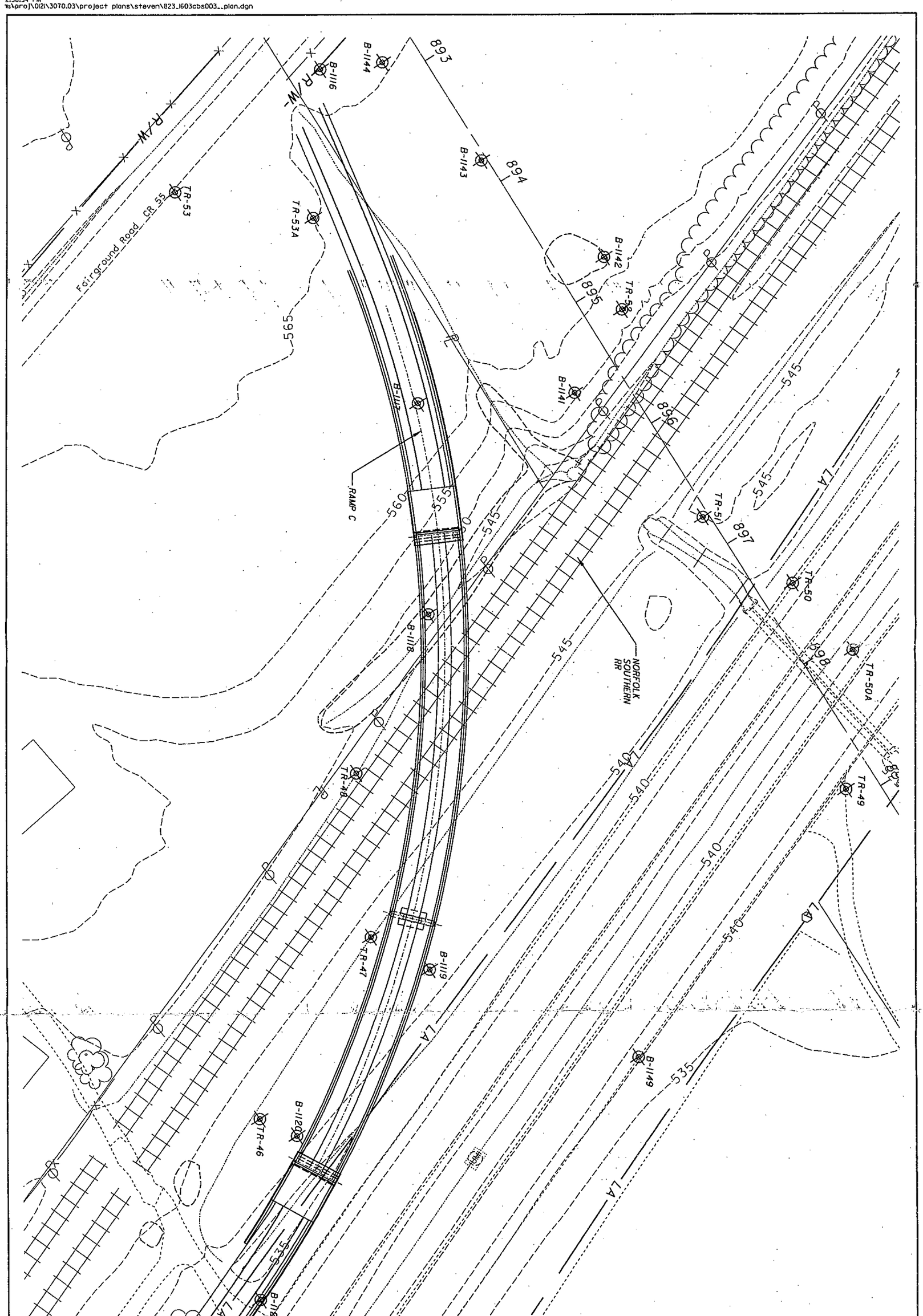

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PID 79977

BORING PLAN
RAMP C - ALTERNATIVE 3

0 30
15 60
HORIZONTAL SCALE IN FEET

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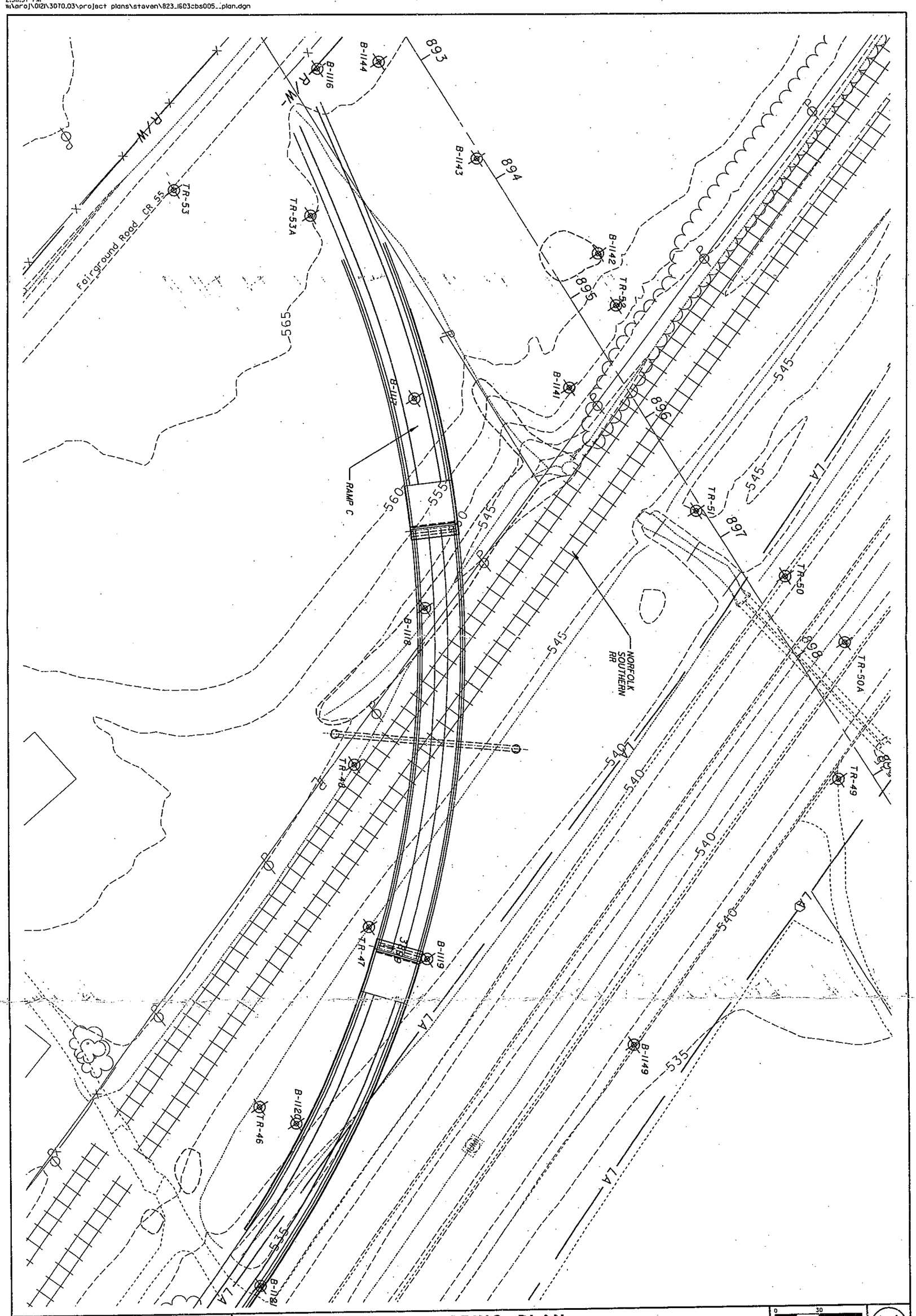


SCI-823-10.13
PID 79977

BORING PLAN
RAMP C - ALTERNATIVE 5

0 30
15 60
HORIZONTAL SCALE IN FEET

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 B-1117 | Location: Ramp C N:325458.045, E:1826571.466 | Date Drilled: 9/19/05 to 9/20/05

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 23.0' (prior to coring)
20.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	562.6												
0.7	561.9	3 6 6	6	1			Topsoil = 8" POSSIBLE FILL: Loose to medium dense brown and gray SANDY SILT (A-4a), little coarse gravel, trace clay; damp. @ 0.7'-2.5', contains roots.						
5		3 4 5	6	2									
5.5	557.1	4 2 3	3	3			POSSIBLE FILL: Medium stiff gray SILTY CLAY (A-6b), little gravel; contains organic material and sandstone fragments; moist.						
		2 2 2	2	4									
10		2 2 4	4	5									
		2 4 9	5	6									
15													
15.5	547.1	5 6 5	12	7		3.0	Very stiff brown SILT (A-4b), little clay, little fine to coarse sand; contains coarse sand seams; wet.	0	2	--	13	70	15
18.0	544.6	5 6 7	12	8			Loose to medium dense brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay; moist to wet.	53	13	--	9	15	10
20		3 2 2	8	9									
		2 2 2	12	10									
25													
25.5	537.1	1 WOH WOH	12	11			Very loose brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6); wet.	32	33	--	9	17	9
		6 8 9	6	12			@ 28.5'-30.0', medium dense.	53	12	--	9	15	11
30													

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

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1117 | Location: Ramp C N:325458.045, E:1826571.466 | Date Drilled: 9/19/05 to 9/20/05

WATER OBSERVATIONS: Water seepage at: 26.0'
Water level at completion: 23.0' (prior to coring)
20.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
	532.6													Natural Moisture Content, % - ● PL ⊢—⊣ LL Blows per foot - ○ 10 20 30 40
30.0	532.6	4 5 7	6	13		0.5	Medium stiff gray SILT (A-4b), little fine to coarse sand, trace to little clay; wet.							
33.0	529.6	50/4	4	14			Severely weathered black SHALE, carbonaceous.							50+
35		50/3	3	15										50+
		50/3	2	16										50+
40														
43.0	519.6	Core 60"	Rec 60"	RQD 28%	R1		Soft black SHALE; moderately weathered, carbonaceous, laminated, moderately fractured. @ 43.0'-44.0', broken zone. @ 44.9'-45.0', decomposed.							
45														
48.0	514.6						Bottom of Boring - 48.0'							
50														
55														
60														

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1118 | Location: Ramp C N:325533.09, E:1826443.997 | Date Drilled: 10/18/05

WATER OBSERVATIONS: Water seepage at: 11.8'-20.5'
Water level at completion: 12.7' (prior to coring)
15.6' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	546.2												
		1 2 2	18	1		0.75	No topsoil Medium stiff to stiff brown SILT AND CLAY (A-6a), trace fine to coarse sand, trace gravel; moist.						
		1 2 3	18	2		1.5		1	2	--	5	62	30
5													
5.5	540.7						Very stiff brown CLAY (A-7-6), some silt, trace fine sand; moist.						
		5 6 9	18	3		2.5		0	0	--	2	31	67
		6 7 8	18	4		2.0	@ 11.0'-11.8', very soft to soft.						
10													
11.8	534.4	4 5 9	18	5A 5B		0.25	Loose to medium dense brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay; wet.	41	16	--	9	24	10
		4 5 4	3	6									
15													
15.5	530.7						Medium dense to dense brown GRAVEL WITH SAND (A-1-b), little silt, trace clay; wet.						
		4 7 11	13	7				55	12	--	10	18	5
		7 14 18	13	8									
20													
20.5	525.7						Severely weathered black SHALE.						
		17 41 28	10	9									
		50/3	3	10									
25.0	521.2						Medium hard black SHALE; moderately weathered, carbonaceous, laminated, slightly to moderately fractured.						
		Core 120"	Rec 120"	RQD 78%	R1		@ 28.9'-29.1', broken zone.						
30													

GRADATION

STANDARD PENETRATION (N)
Natural Moisture Content, % - ●
PL ⊢——⊣ LL
Blows per foot - ○
10 20 30 40
53
69
50+

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1118 | Location: Ramp C N:325533.09, E:1826443.997 | Date Drilled: 10/18/05

WATER OBSERVATIONS: Water seepage at: 11.8'-20.5'
Water level at completion: 12.7' (prior to coring)
15.6' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION
30	516.2						
30.6	515.6						Medium hard black SHALE; moderately weathered, carbonaceous, laminated, slightly to moderately fractured.
							Hard gray SANDSTONE; very fine to fine grained, slightly to moderately weathered, micaceous, thickly bedded, slightly fractured. @ 30.8', 33.6', 33.7', 34.8', low angle clay filled fractures. @ 30.8'-33.8', calcareous.
35.0	511.2						Bottom of Boring - 35.0'
40							
45							
50							
55							
60							

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

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

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1119 | Location: Ramp C N:325668.639, E:1826236.989 | Date Drilled: 7/18/05

WATER OBSERVATIONS: Water seepage at: 10.0'-25.0'
Water level at completion: 12.0' (prior to coring)
5.0' (inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) / Natural Moisture Content, % - ● / PL — LL / Blows per foot - ○
0	542.0													
0.3	541.7	6 6 5	7	1		3.0	Topsoil - 4" Very stiff brown SANDY SILT (A-4a), little clay, trace gravel; possible organic; damp.							
3.0	539.0	4 5 7	12	2		4.5+	Hard brown CLAY (A-7-6), trace fine to coarse sand, trace gravel; damp.							
5.5	536.5	4 4 5	12	3		2.0	Stiff to very stiff brown SILTY CLAY (A-6b), "and" fine to coarse sand, trace gravel; moist.	9	11	--	32	22	26	
8.0	534.0	3 3 3	10	4			Very loose to loose brown GRAVEL WITH SAND AND SILT (A-2-4), trace clay; wet.	46	18	--	9	18	9	
		1 1 1	8	5										
13.0	529.0	1 1 2	14	6			Very loose to loose brown COARSE AND FINE SAND (A-3a), little gravel, trace clay; trace silt; wet.							
		2 4 3	12	7				12	47	--	22	19		Non-Plastic
18.0	524.0	5 8 9	13	8			Medium dense brown GRAVEL WITH SAND AND SILT (A-2-4), little clay; contains sandstone fragments; wet.	36	22	--	11	18	13	Non-Plastic
20.5	521.5	4 5 17	12	9			Medium dense to dense brown COARSE AND FINE SAND (A-3a), little silt, little clay; contains sandstone fragments; moist.	14	6	--	48	20	12	Non-Plastic
		7 17 19	14	10										
25.0	517.0	Core 60"	Rec 59"	RQD 30%	R-1		Very hard gray SANDSTONE; very fine to fine grained, moderately to highly weathered, argillaceous, micaceous, thinly bedded to medium bedded, highly fractured, iron-staining @ 28.7'-28.9', high angle fractures.							
30.0	512.0						Bottom of Boring - 30.0'							

GRADATION

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1120 | *Location:* Ramp C N:325809.232, E:1826192.665 | *Date Drilled:* 7/18/05

WATER OBSERVATIONS: Water seepage at: 11.0'-19.0'
Water level at completion: 11.0' (prior to coring)
5.0' (inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	542.7												
0.4	542.3						Topsoil - 5"						
		3 5 7	9	1		4.5+	Very stiff to hard brown CLAY (A-7-6), "and" silt, trace fine to coarse sand; damp.	0	1	--	2	44	53
		3 6 7	15	2		3.25		0	0	--	2	49	49
5													
5.5	537.2												
		2 5 4	12	3			Loose brown GRAVEL WITH SAND, SILT AND CLAY (A-2-6); moist to wet.	16	30	--	20	14	20
		1 2 4	8	4									
10													
10.5	532.2												
		3 3 2	6	5			Loose brown GRAVEL WITH SAND (A-1-b), some clay; wet.						
		1 1 1	8	6									
15													
		8 7 6	7	7									
		7 29 10	6	8			@ 18.5'-22.5', dense.						
20													
		14 22 18	6	9									
23.0	519.7												
		10 12 9	14	10			Medium dense brown GRAVEL WITH SAND, SILT, AND CLAY (A-2-6); contains sandstone fragments; moist.						
25													
26.0	516.7	50/5	6	11			Severely weathered brown SANDSTONE.						
28.5	514.2						Hard gray SANDSTONE; very fine to fine grained.						
30													

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

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring B-1120 | Location: Ramp C N:325809.232, E:1826192.665 | Date Drilled: 7/18/05

WATER OBSERVATIONS: Water seepage at: 11.0'-19.0'
Water level at completion: 11.0' (prior to coring)
5.0' (inside hollowstem augers)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
30	512.7	Core 60"	Rec 54"	RQD 17%	R-1		Hard gray SANDSTONE; very fine to fine grained, moderately weathered, micaceous, argillaceous, laminated to medium bedded, moderately to highly fractured. @ 32.8'-33.1', broken.						
33.5	509.2						Bottom of Boring - 33.5'						
35													
40													
45													
50													
55													
60													

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

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring TR-46 | Location: US 23 Ramp C N:325824.223, E:1826216.977 | Date Drilled: 03/17/05

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	% Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0.1	543.1 543.0						Topsoil - 1"						
		2 1 1	2	1			FILL: Very loose brown and black GRAVEL WITH SAND (A-1-b), some silty clay; contains roots; damp. @ 1.0'-2.5', organic odor.						
5		2 2 2	4	2				44	19	--	13	16	8
5.5	537.6						Stiff to very stiff brown SILT AND CLAY (A-6a), little fine to coarse gravel, trace fine to coarse sand; damp to moist.						
		3 3 3	18	3		2.0							
8.5	534.6						Medium dense brown and gray GRAVEL WITH SAND (A-1-b), little silty clay; moist.						
		2 6 6	12	4									
10		2 11 7	11	5				56	15	--	9	16	4
13.5	529.6						Loose brown GRAVEL WITH SAND (A-1-b), some silt, trace clay; wet.						
		3 4 3	8	6									
15		5 4 4	12	7			@ 18.0', heaving sand.	33	31	--	13	20	3
19.0	524.1						Dense light brown GRAVEL WITH SAND AND SILT (A-2-4), trace to little clay; moist to wet.						
		16 15 20	14	8									
20		14 19 20	8	9									
		5 5 12	14	10			@ 23.0', gray.	30	11	--	24	25	10
25													
25.5	517.6	50/3	3	11			Severely weathered gray SANDSTONE, argillaceous, micaceous.						
27.0	516.1						Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, thickly bedded to massive, slightly fractured.						
30													

WATER OBSERVATIONS: Water seepage at: 13.5'-19.0'
Water level at completion: 16.0' (prior to coring)
5.0' (includes drilling water)

GRADATION

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

Non-Plastic
Non-Plastic
50+

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring TR-46 | Location: US 23 Ramp C N:325824.223, E:1826216.977 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.5'-19.0'
Water level at completion: 16.0' (prior to coring)
5.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No: Drive	Sample No: Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION: % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) / Natural Moisture Content, % - ● / PL — LL / Blows per foot - ○
30	513.1	Core 120"	Rec 118"	RQD 83%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, thickly bedded to massive, slightly fractured. @ 29.4',31.4',35.9', very thin clay seams. @ 29.8',30.8', thin clay seams. @ 31.6'-32.0', broken zone with clay and rock fragments. @ 33.4'-33.7', clay seam. @ 33.7'-34.2', cross bedded.							10 20 30 40
37.0	506.1						Bottom of Boring - 37.0'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring TR-47 | Location: US 23 Ramp C N:325689.987, E:1826278.864 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (prior to coring)
9.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N)
0.0	543.1						Ground Surface							
0.1	543.0						Topsoil - 1"							
		1 2 4	10	1		1.5	Stiff to very stiff brown and gray CLAY (A-7-6), trace fine sand; damp to moist. @ 1.0'-2.5', slightly organic.							
		2 4 5	13	2		2.5								
5														
		4 6 10	15	3		4.5	@ 6.0'-7.5', hard.	0	0	--	2	48	50	
8.0	535.1						Medium stiff brown SANDY SILT (A-4a), trace gravel, trace clay; moist to wet.							
		1 3 2	10	4		0.5								
10														
		2 2 2	7	5		--								
13.0	530.1						Very loose brown COARSE AND FINE SAND (A-3a), little silty clay; wet.							
		W O H	18	6				0	2	--	83	15		Non-Plastic
15														
		WOH WOH 1	18	7										
18.0	525.1						Stiff brown GRAVEL WITH SAND AND SILT (A-2-4), little clay; moist.							
		11 14 12	10	8		1.5		30	11	--	24	22	13	
20														
21.0	522.1						Very stiff to hard dark gray SANDY SILT (A-4a), little clay, little gravel; damp to moist.							
		42 34 17	12	9		--		15	9	--	35	26	15	51
23.0	520.1						Severely weathered black SHALE, carbonaceous.							
		4 10 21	11	10				29	23	--	31	12	5	Non-Plastic
25														
26.5	516.6	50/4	4	11			Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, massive, slightly fractured. @ 26.7'-28.4', healed vertical fracture.							50+
30														

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

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring TR-47 | Location: US 23 Ramp C N:325689.987, E:1826278.864 | Date Drilled: 03/17/05

WATER OBSERVATIONS: Water seepage at: 13.0'-18.0'
Water level at completion: 18.0' (prior to coring)
9.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay	STANDARD PENETRATION (N) / Natural Moisture Content, % / PL — LL / Blows per foot
30	513.1	Core 120"	Rec 120"	RQD 74%	R1		Hard gray SANDSTONE; very fine to fine grained, slightly weathered, argillaceous, micaceous, massive, slightly fractured. @ 30.0'-30.2', healed vertical fracture. @ 30.2'-32.4', 34.7'-35.4', high angle bedding. @ 31.8'-32.4, broken zone with thin clay seam. @ 33.1'-33.6', low angle healed fracture. @ 33.1'-33.6', high angle healed fracture. @ 33.7', highly weathered fracture. @ 33.7'-34.0', very argillaceous.							10 20 30 40
36.5	506.6						Bottom of Boring - 36.5'							
40														
45														
50														
55														
60														

FILE: 0121-3070-03 [5/23/2007 6:15 PM]

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

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

LOG OF: Boring TR-48 | Location: US 23 Ramp C N:325635.827, E:1826379.383 | Date Drilled: 3/21/05

WATER OBSERVATIONS: Water seepage at: 16.0'-18.0'
Water level at completion: 8.0' (includes drilling water)

Depth (ft)	Elev. (ft)	Blows per 6"	Recovery (in)	Sample No. Drive	Sample No. Press / Core	Hand Penetrometer (tsf) / * Point-Load Strength (psi)	DESCRIPTION	GRADATION % Aggregate	% C. Sand	% M. Sand	% F. Sand	% Silt	% Clay
0	546.3						No Topsoil						
		2 2 3	14	1			FILL: Loose black GRAVEL WITH SAND (A-1-b); contains mostly coal fragments and cinders; damp.						
3.0	543.3												
5		W O H	1	2			FILL: Very loose gray and black SILT AND CLAY (A-6a), little fine to coarse sand; contains roots, coal and cinder fragments; damp.						
5.5	540.8												
		WOH 2 3	16	3		2.5	Very stiff brown SILT (A-4b), some clay, trace fine sand; moist.						
8.0	538.3												
		2 5 7	17	4		3.5	Very stiff brown and gray CLAY (A-7-6), trace fine sand; damp to moist.	0	0	--	2	43	55
10													
		2 5 6	15	5		3.5							
13.0	533.3												
		1 2 2	5	6			Very loose brown GRAVEL WITH SAND (A-1-b), little silt, trace clay; moist to wet.						
15													
		1 1 1	8	7				37	27	--	17	19	
		6 6 7	10	8			@ 18.5', medium dense; moist.	52	14	--	15	12	7
20													
		2 7 30	15	9			@ 21.0', dense, trace gravel, trace clay.						
23.5	522.8												
		20 15 50	12	10			Severely weathered black SHALE.						
25.0	521.3						Soft to medium hard black SHALE; carbonaceous, slightly weathered, very thinly bedded, highly fractured.						
							@ 25.3'-25.6', 26.0'-26.4', broken.						
							@ 27.1'-27.2', sandstone seam.						
30		Core 120"	Rec 120"	RQD 97%	R1								

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

Non-Plastic
Non-Plastic
65

FILE: 0121-3070-03 [5/25/2007 8:42 AM]

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.00 ft	0.00 Kips	13.30 Kips	13.30 Kips
9.01 ft	16.88 Kips	13.30 Kips	30.18 Kips
11.99 ft	29.42 Kips	13.30 Kips	42.72 Kips
12.01 ft	29.48 Kips	32.52 Kips	62.00 Kips
20.49 ft	49.95 Kips	32.52 Kips	82.47 Kips

DLZ
ENGINEERS • ARCHITECTS • SCIENTISTS
PLANNERS • SURVEYORS

CLIENT CH2M Hill / ODOT D-9
PROJECT SCI-823 Portsmouth Bypass
SUBJECT Allowable uplift in piles
Ramp C Structure

PROJECT NO. 0121-3070.03
SHEET NO. 1 OF 1
COMP. BY SJK DATE 5-23-07
CHECKED BY DAA DATE 5-25-07

Ramp C Structure - US 23 Interchange

Based upon boring B-1118 * Assumes HP 12×53 piles

Ultimate skin friction on piles = 50 kips

Allowable Uplift Resistance = $\frac{50\text{ k}}{3.0}$ = 16.7 kips per pile

APPENDIX F

Meeting Agenda:
Structures - Outstanding Issues at Norfolk Southern RR Portsmouth Bypass Project

Attendees: ODOT OSE, Norfolk Southern, TranSystems, CH2M HILL, DLZ

FROM: Shawn Thompson – CH2M HILL

DATE May 2, 2007

ODOT Office of Structural Engineering (OSE), Norfolk Southern, TranSystems, CH2M HILL, and DLZ are scheduled to meet on Wednesday, May 2, 2007 to discuss outstanding Structures and Geotechnical issues on the Portsmouth Bypass Project, particularly the proposed structures adjacent to the Norfolk Southern Railway. The agenda is to include, but is not limited to, the following:

1. *Bridge Issues:*

   CH2M HILL to discuss the 3 bridges over the Norfolk Southern RR, and what elements are driving the geometry.

Goals: 1.) Norfolk Southern concurrence on clear zone requirements (NS was generally in concurrence with our clear zone requirements provided)

2.) Norfolk Southern concurrence on potential ditch relocation to reduce Ramp C spans (NS was okay with the potential relocation of the ditch to reduce the Ramp C bridge spans, as long as the existing drainage capacity was not affected)

3.) Discuss boring a new pipe under the tracks (NS was okay with the idea of jacking and boring a new pipe under the existing tracks, as long as railway service was not interrupted)

4.) Discuss temporary work (falsework bent) between two existing tracks (NS stated that all temporary falsework would need to be at a minimum 10'-0" from the centerline of existing track)

2. *Geotechnical Issues:*

   DLZ and ODOT OSE to discuss existing track settlement with Norfolk Southern RR, due to the construction of MSE wall abutments adjacent to the tracks.

Goals: 1.) Reach agreement on what amount of calculated settlement is acceptable (NS was okay with the calculated 0.25" of settlement if an MSE wall is constructed approximately 40'-0" from the existing tracks)

3. *Other Outstanding Issues?* (NS confirmed that a permanent pier could not be placed between two existing tracks, and that 10'-0" of horizontal lateral clearance needed to provided during construction)

Thompson, Shawn/COL

From: Thompson, Shawn/COL
Sent: Friday, April 13, 2007 4:01 PM
To: Wyatt, Dave
Cc: Jirschele, Steve/COL; jrcox@transystems.com; mdweeks@transystems.com; Miller, Robert/CLE; Richard Behrendt
Subject: RR Minimum Clearances - Portsmouth Bypass Project, OH

Attachments: Document.pdf

Document.pdf (185 KB)

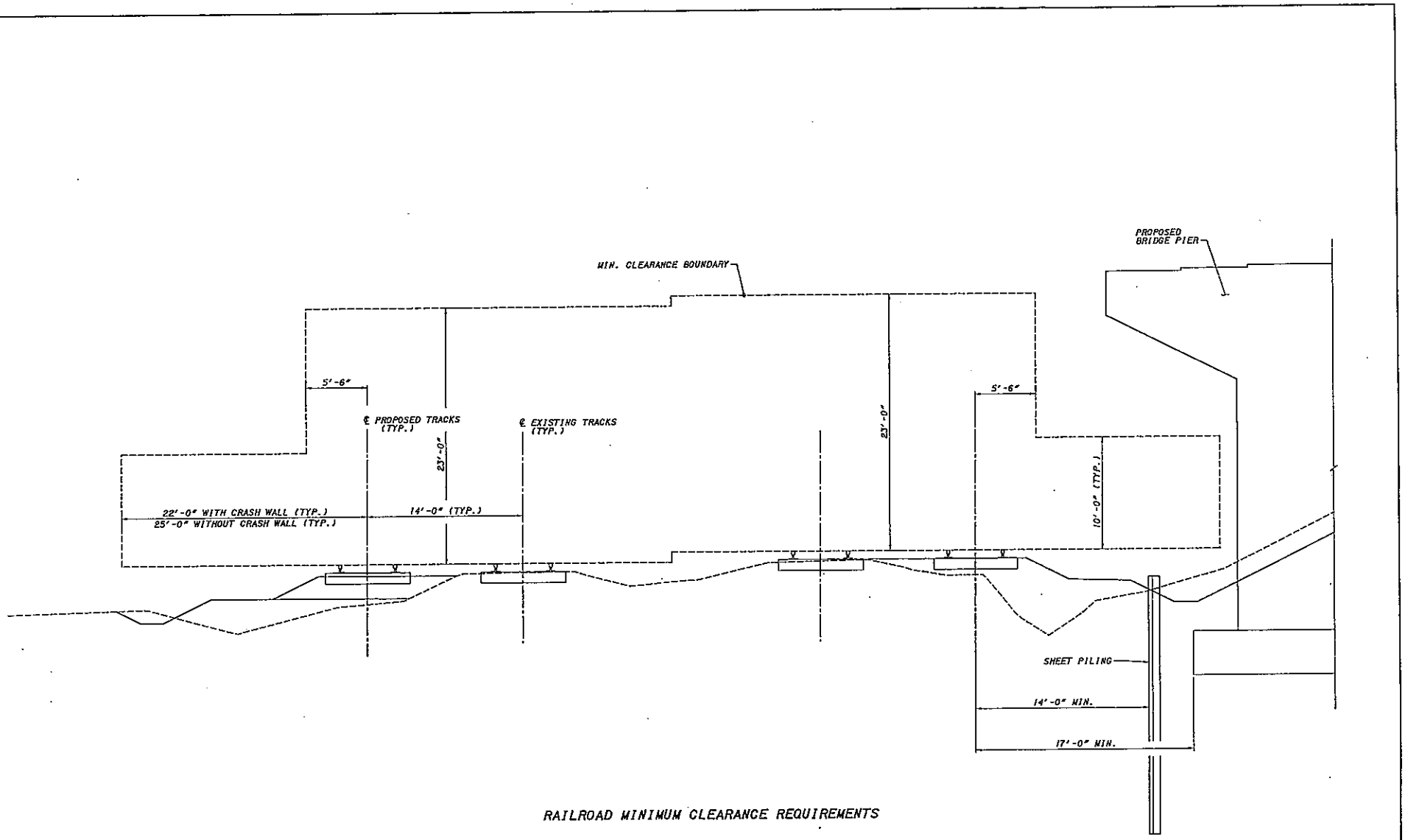
David,

Good afternoon. I hope you are doing well. Attached is a .pdf drawing showing our interpretation of your criteria for clearances at the US-23/SR-823 Interchange, as we understand them. Both Norfolk Southern and ODOT have clearance requirements. We will use the most conservative requirement, in the event of conflicts or differences between the two agencies.

One thing of note is the location of the T-type pier. Our understanding is that as long as the pier stem is a minimum of 22'-0" from the centerline of the track and 10'-0" high, the pier cap can extend inside of the 22'-0" clearance envelope. Again, due to the two new tracks and the curvature of the ramps, our goal is to shorten the span lengths as much as possible.

At your earliest convenience, please provide a response re: acceptance of our clearance understanding.

Thanks David. Have a great weekend.
Shawn



RAILROAD MINIMUM CLEARANCE REQUIREMENTS

FOR NORFOLK SOUTHERN CORP. APPROVAL

CH2M HILL, APRIL 13, 2007

SCI-823-0.00 PID 19415

Thompson, Shawn/COL

From: Wyatt, Dave [dave.wyatt@nscorp.com]
Sent: Wednesday, April 04, 2007 8:12 AM
To: Thompson, Shawn/COL
Cc: Richard Behrendt; ramoore1@nscorp.com; Jirschele, Steve/COL
Subject: FW: Norfolk Southern technical questions - Portsmouth Bypass ProjectinOhio
Attachments: Portsmouth_Bypass.pdf; 04032007_Phone_Conv.doc

Shawn:

Thanks for the layout view. I have added my comments in red to the attached Phone conversation Word Document.

Thanks

David Wyatt
System Engineer Public Improvements
Norfolk Southern Corporation
1200 Peachtree Street, N.E.
Atlanta, Georgia 30309

telephone: 404/529-1641
cell phone: 404/245-2596
fax: 404/527-2769

From: Shawn.Thompson@CH2M.com [mailto:Shawn.Thompson@CH2M.com]
Sent: Wednesday, April 04, 2007 7:12 AM
To: Wyatt, Dave
Cc: Richard.Behrendt@dot.state.oh.us; ramoore1@nscorp.com; Steve.Jirschele@CH2M.com
Subject: RE: Norfolk Southern technical questions - Portsmouth Bypass Projectin Ohio

David,
Good morning. I hope things are going well for you. I tried calling you yesterday, but I understand that you are on vacation this week and will return next Monday - I hope you had a great vacation.

I would like to thank you for your responses to my questions regarding the Portsmouth Bypass project in Ohio for ODOT. Per your request to Question #2 below, I have attached a .pdf file that contains the overall plan view of the project, as well as a zoomed-in plan view of the Ramp C bridge over Norfolk Southern RR (please note the yellow in the zoomed-in plan view indicates existing communication poles). As you can see from the curvature of Ramp C, coupled with the additional two future railway tracks, the challenge will be to shorten our bridge span lengths as much as possible from a constructability standpoint.

In any case, I have attached a Word file of some additional questions we were planning on asking you yesterday via phone. Your responses will continue to assist us in developing the most economical bridge structure at this location, while satisfying Norfolk Southern requirements and minimizing/eliminating RR impacts.

At your earliest convenience, we could either discuss over the phone our additional questions, or you may simply type out your responses and e-mail them back - whatever's easiest for you.

Thanks again for all your assistance on this project. Have a good day.

Shawn
614-734-7144 ext. 17

From: Wyatt, Dave [mailto:dave.wyatt@nscorp.com]
Sent: Thu 3/22/2007 6:48 PM
To: Thompson, Shawn/COL
Cc: Richard Behrendt; ramoore1@nscorp.com
Subject: FW: Norfolk Southern technical questions - Portsmouth Bypass Projectin Ohio

Shawn:

1.) Although we heard that the two new tracks are to be 14'-0" from the centerline of the existing tracks, could you confirm this 14'-0" offset? The future tracks will be located 14'-0" form center line of existing tracks – one future track each side.

2.) As you can see from the plan views, our pier locations accommodate the 20'-0" minimum distance from centerline of track to allow a roadbed profile with open ditches, but the pier stems/caps are cantilevered towards the tracks. We currently show a minimum distance of 13'-0" from the centerline of track to these cantilevered pier stems/caps. Is this acceptable, or do you have an acceptable minimum horizontal clear distance for this case? We did not get a plan view of the bridge layout, we only received a profile view. I am not sure of the skew of the cap relative to the track – please provide a plan view of the bent layouts relative to the centerline of tracks.

3.) In order to keep the span lengths as small as possible, we are not allowing for a maintenance roadway. Is this acceptable to both ODOT and Norfolk Southern? If you provide a minimum of 26'-0" from the centerline of future track to face of pier we can get a roadway in in conjunction with a standard 2'-0" flat bottom ditch; however, the picture that you attached indicates an existing ditch that exceed the 2'-0" flat bottom –your design should accommodate the exsitng drainage ditch..

4.) We are assuming that the 23'-0" vertical clearance is acceptable to Norfolk Southern to accommodate double-stacking. (you mentioned yesterday that this 23'-0" dimension is measured from a spot 5'-6" perpendicular from the top/rail) The 23'0" min. vertical clearance ATR is measured at a point 5'-6" each side form from center line of trac.k

5.) We are assuming that pier footings located no closer than 11'-0" from the centerline of the track is adequate in order to provide enough room for temporary shoring? Your assumption is correct.

6.) Per ODOT bridge design guidelines and NS guidelines, we are following the standard that all piers and MSE retaining walls located 25'-0" from the centerline of the tracks do not require crashwall protection. Correct – However, you previously mentions a severe skew, how does this impact the crash zone?

David Wyatt
System Engineer Public Improvements
Norfolk Southern Corporation
1200 Peachtree Street, N.E.
Atlanta, Georgia 30309

telephone: 404/529-1641
cell phone: 404/245-2596
fax: 404/527-2769

From: Shawn.Thompson@CH2M.com [mailto:Shawn.Thompson@CH2M.com]
Sent: Thursday, March 08, 2007 10:12 AM
To: tdwyatt@nscorp.com
Cc: Richard.Behrendt@dot.state.oh.us; jrcox@transystems.com; robert.miller@ch2m.com; steve.jirschele@ch2m.com

Subject: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio
Importance: High

David,
Good morning. I hope you are doing well. If you recall, I sent you some questions a few weeks ago concerning our bridge structures on the Portsmouth Bypass project in Ohio for ODOT. Please see the original e-mail below. I was curious if you'd had a chance to review my questions? Unfortunately, my work is starting to get onto the critical path, and your responses would greatly assist me in starting to lay out these structures in conformance to Norfolk Southern standards. Would you happen to know when I can expect to receive a response regarding this?

In addition, please read the below e-mail from Steve Jirschele, another structural engineer with my company. Apparently, there are communication line poles that run parallel to the existing tracks on the east side. See attached picture and profile of the proposed mainline bridge that shows this existing line (on the left side of the attached profile, this communication line is labeled "centerline Utilities). With the future tracks, this line may need to be relocated. My question regarding this communication line is as followed:

- What is the standard distance from centerline track to the communication line and the preferred distance from centerline pole to face of pier or MSE wall?

Also, could we get track plans or utility plans from Norfolk Southern? I just want to make sure that as we lay out these structures, we don't run into any other utilities that we're not aware of.

Thanks David. Have a great day.

Shawn

From: Jirschele, Steve/COL
Sent: Friday, February 23, 2007 12:01 PM
To: Thompson, Shawn/COL
Subject: RE: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio

Shawn,

As you recall there is the communication line (poles) that runs parallel to the tracks. Does the communication line have to be moved for the future track? When you talk to David - ask him the standard distance from centerline track to the communication line and the preferred distance from centerline pole to face of pier or MSE wall.

Did we ever get tracks plans or utility plans from the NS. For instance is there buried fiber optic cable or anything else that we should know about.

Steve Jirschele

From: Thompson, Shawn/COL
Sent: Friday, February 23, 2007 11:53 AM
To: tdwyatt@nscorp.com
Cc: richard.behrendt@dot.state.oh.us
Subject: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio

David,
Good morning. It was nice talking to you yesterday in regards to our Portsmouth Bypass project in southern Ohio. Again, Richard Behrendt, ODOT State Rail Coordinator, recommended that I contact you about several issues. I have attached two .pdf documents for your use in kindly assisting us. First, you will find plan views of our proposed interchange configuration, as well as detailed plan views of two horizontally curved ramp bridges (Ramp B and Ramp C) that need to span over the existing two tracks AND the proposed two new tracks. For

these ramp bridges, I looked at single span and 3-span alternatives from a constructability perspective. Second, I have attached a narrative that outlines the bridge impacts from adding the two new tracks.

A quick history of the project is that our original preliminary bridge designs in 2005 only accommodated the existing two tracks. We received notification from Norfolk Southern in early 2006 that two new tracks at 14' centers were to be added in the future. Therefore, this changes our bridge layouts. Because of the heavy geometric curvatures of Ramps B&C, we need to shorten our span lengths over the RR as much as possible, which hence leads to my technical questions/assumptions for you and Norfolk Southern:

1.) Although we heard that the two new tracks are to be 14'-0" from the centerline of the existing tracks, could you confirm this 14'-0" offset?

2.) As you can see from the plan views, our pier locations accommodate the 20'-0" minimum distance from centerline of track to allow a roadbed profile with open ditches, but the pier stems/caps are cantilevered towards the tracks. We currently show a minimum distance of 13'-0" from the centerline of track to these cantilevered pier stems/caps. Is this acceptable, or do you have an acceptable minimum horizontal clear distance for this case?

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4.) We are assuming that the 23'-0" vertical clearance is acceptable to Norfolk Southern to accommodate double-stacking. (you mentioned yesterday that this 23'-0" dimension is measured from a spot 5'-6" perpendicular from the top/rail)

5.) We are assuming that pier footings located no closer than 11'-0" from the centerline of the track is adequate in order to provide enough room for temporary shoring?

6.) Per ODOT bridge design guidelines and NS guidelines, we are following the standard that all piers and MSE retaining walls located 25'-0" from the centerline of the tracks do not require crashwall protection.

Again, thank you David for your time in assisting us on this challenging, yet exciting project. If you could provide me with your written responses at your earliest convenience, I would greatly appreciate it. Please do not hesitate to contact me should you have any questions to what was written above.

Thanks. Have a great weekend.

Shawn

Shawn K. Thompson, P.E.
CH2M HILL
Bridge Engineer
Operations Leader
5775 Perimeter Drive
Suite 190
Dublin, OH 43017
614-734-7144 ext. 17
shawn.thompson@ch2m.com

CH2MHILL TELEPHONE CONVERSATION RECORD

Call To: Norfolk Southern Corp.

Phone No.: **Date:** April 03, 2007

Call From: Steve Jirschele, Shawn Thompson **Time:**

Message Taken By: Steve Jirschele

Subject: Portsmouth Bypass - Railroad Design Criteria

1. What is the minimum horizontal clearance that we're allowed? (I'm thinking about a drilled shaft that wouldn't have a footing.) **Minimum horizontal clearances are indicated in our Design Criteria see www.nscorp.com from the eight options across the top select "Doing Business" from the drop down options select "Publications" from the drop down options select "Design of Grade Separation Structures". 22'-0**

2. The clearance between the existing tracks is ±26.6'. Can we build a drilled shaft pier between the tracks? **NO**

3. Discuss the concept of an integral pier cap with the RR since it may require less than 22' of clearance during construction for formwork. **From the layout the pier is to located a minimum of 25'-0" from the future track; therefore, unless the future track is installed prior to your construction, I do not see a conflict. However, to elimiantethis potential conflict, I suggest that you consider locating the piers (that are adjacent to the railroad) parallel to the railroad, this will eliminate the need to consider crash wall protection for the piers.**

4. Is any additional clearance required for the communication lines? **All railroad comminucations lines will be relocated via the force account agreement prior to construction.**

5. Are there any buried RR utilities on site? If so and if they are in conflict with the construction they will be relocated via the force account agreement prior to construction. Upon receipt of the TSL plans we will distribute to all our involved departments (Signal & Electrical, Communications, T-Cubed (fiber optics)) to determine if their facilities will be impacted and, if so, request an estmate for relocating.

6. What is the allowable settlement or heave of the tracks due to construction? (DLZ says that the track could settle 0.3" if we build an MSE wall 20' from the tracks. Is that acceptable to the RR?) 0.00"

Thompson, Shawn/COL

From: Wyatt, Dave [dave.wyatt@nscorp.com]
Sent: Thursday, March 22, 2007 8:49 PM
To: Thompson, Shawn/COL
Cc: Richard Behrendt; ramoore1@nscorp.com
Subject: FW: Norfolk Southern technical questions - Portsmouth Bypass Projectin Ohio
Importance: High
Attachments: 16-riprap from CMP culvert.JPG; Document.pdf

Shawn:

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David Wyatt
System Engineer Public Improvements
Norfolk Southern Corporation
1200 Peachtree Street, N.E.
Atlanta, Georgia 30309

telephone: 404/529-1641
cell phone: 404/245-2596
fax: 404/527-2769

From: Shawn.Thompson@CH2M.com [mailto:Shawn.Thompson@CH2M.com]

Sent: Thursday, March 08, 2007 10:12 AM
To: tdwyatt@nscorp.com
Cc: Richard.Behrendt@dot.state.oh.us; jrcox@transystems.com; robert.miller@ch2m.com; steve.jirschele@ch2m.com
Subject: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio
Importance: High

David,
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From: Jirschele, Steve/COL
Sent: Friday, February 23, 2007 12:01 PM
To: Thompson, Shawn/COL
Subject: RE: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio

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To: tdwyatt@nscorp.com
Cc: richard.behrendt@dot.state.oh.us
Subject: Norfolk Southern technical questions - Portsmouth Bypass Project in Ohio

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Again, thank you David for your time in assisting us on this challenging, yet exciting project. If you could provide me with your written responses at your earliest convenience, I would greatly appreciate it. Please do not hesitate to contact me should you have any questions to what was written above.

Thanks. Have a great weekend.

Shawn

Shawn K. Thompson, P.E.
CH2M HILL
Bridge Engineer
Operations Leader
5775 Perimeter Drive
Suite 190
Dublin, OH 43017
614-734-7144 ext. 17
shawn.thompson@ch2m.com

Thompson, Shawn/COL

From: mdweeks@transystems.com
Sent: Friday, May 05, 2006 9:56 AM
To: Miller, Robert/COL; Thompson, Shawn/COL
Cc: jrcox@transystems.com; jgbrown@transystems.com; rnunna@transystems.com
Subject: FW: SCI-823 NS RR involvement (3)

Rob and Shawn,

District 9 has given the go ahead to proceed with the Bridge Type Study based on your recent analysis (see below). Let me know if you need anything.

Thanks,
Mike

From: David.Norris@dot.state.oh.us [mailto:David.Norris@dot.state.oh.us]
Sent: Friday, May 05, 2006 9:39 AM
To: CO-Michael Weeks
Subject: RE: SCI-823 NS RR involvement (3)

Mike,

I haven't heard anything from OSE. Please proceed with the bridge type studies.

--
David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061

<mdweeks@transystems.com>

05/05/2006 09:37 AM

To <David.Norris@dot.state.oh.us>
cc
Subject RE: SCI-823 NS RR involvement (3)

Dave,

Has OSE indicated anything regarding? Please let me know if we can proceed with the resubmission of the Bridge Type Study.

Thanks,
Mike

From: David.Norris@dot.state.oh.us [mailto:David.Norris@dot.state.oh.us]
Sent: Thursday, April 27, 2006 1:37 PM
To: CO-Michael Weeks
Subject: RE: SCI-823 NS RR involvement (3)

Mike,

I forwarded your info to Tim Keller, Ananda Dharma & Rich Behrendt.
Tim is out of the office til May 5, and haven't heard from Ananda (he reviewed the first submission).

I talked to Rich, and he feels pretty good about the 3-span bridge option, from the RR view.
I also talked to Larry Wills, in our office, and he thinks your proposal will work. There will be several details to work out, like crash walls, temporary supports, etc.

Unless I hear from OSE in the next couple of days, I think that you should go ahead with the Type Study submission.

David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061
<mdweeks@transystems.com>

04/26/2006 04:31 PM

To <David.Norris@dot.state.oh.us>
cc
Subject RE: SCI-823 NS RR involvement (3)

Dave,

As we discussed, I have attached CH2M's Railroad Impact Analysis for your consideration. The intent of the analysis was to confirm that the existing geometric configuration of the interchange can accommodate the two additional RR tracks. A two-span option (as well as other alternatives) may also work – this will be addressed in the resubmission of the bridge type studies.

Let me know if you think we need to meet with OSE and others to discuss before we finalize the bridge type studies.

Mike

From: David.Norris@dot.state.oh.us [mailto:David.Norris@dot.state.oh.us]
Sent: Wednesday, April 26, 2006 2:57 PM
To: CO-Michael Weeks
Subject: Fw: SCI-823 NS RR involvement (3)

Mike,

I just left a message on your phone.

I mentioned at today's J&P meeting that you were trying to schedule a meeting with OSE, ORES and Rich Behrendt to discuss the NS RR bridges.
Please let me know when you get one scheduled.

Thanks,
--
David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061

---- Forwarded by David Norris/Administration/D09/ODOT on 04/26/2006 02:53 PM ----

Richard Behrendt/RealEstate/CEN/ODOT

04/26/2006 02:43 PM

To David Norris/Administration/D09/ODOT@ODOT

cc Gary Cochenour/Production/D09/ODOT@ODOT, Jim Viau/RealEstate/CEN/ODOT@ODOT, Ray Lorello/RealEstate/CEN/ODOT@ODOT, Cash Misel/Director/CEN/ODOT@ODOT, Tim McDonald/ProductionMgmt/CEN/ODOT@ODOT

Subject Re: SCI-823 NS RR involvement (3) Link

Dave,
J.Viau noted to me that this project was discussed at today's J&P meeting, and was advised that a possible meeting is being attempted to be scheduled w/NS - Please ensure that I am included on the invitation list for this meeting.

Searching through my emails, I see that I did not provide a followup to your request that I discuss this project w/Chris Bennett - I did in fact talk w/him about this when he was in Columbus a couple of weeks ago, and his position is that NS will require accomodation of two (2) additional future tracks in addition to the two (2) existing tracks already in place as a requirement to execution of an Agreement.

This rail corridor is the subject of an intense study by NS to determine the cost to do clearance work in West Virginia & Ohio in order to provide for the movement of double-stack intermodal traffic over this route. When complete, this will provide a fast inland route from the Mid-Atlantic seaports in Virginia to Chicago and points west, and is anticipated to become a premier high-speed corridor for NS in the years to come.

As I stated in my email below from 3/13, the plans should be adjusted to account for NS current and future tracks...

Rich Behrendt
Program Mgr./State Rail Coordinator
Ohio Department of Transportation
1980 West Broad St.
Columbus, Ohio 43223
Phone: 614-387-3097
FAX: 614-466-0158
email: richard.behrendt@dot.state.oh.us

Richard Behrendt/RealEstate/CEN/ODOT

03/13/2006 11:29 AM

To David Norris/Administration/D09/ODOT
cc Ray Lorello/RealEstate/CEN/ODOT@ODOT, Jim Viau/RealEstate/CEN/ODOT@ODOT, Gary Cochenour/Production/D09/ODOT@ODOT
Subject Re: SCI-823 NS RR involvement Link

Dave,

Looking at the plan (and assuming the PL indication is NS's ROW line) , NS obviously has a wide ROW along US23 at the SR 823 area, and regardless of the other infrastructure/civil/physical issues that NS would need to amend if/when future tracks are constructed, putting new piers on their ROW w/o accomodating future tracks and dimensionally restricting them to the current layout to 2 tracks with the current design will invariably delay this project if we attempt to challenge this request.

Additionally, some of the new piers on Ramp B & C , as well as the bridge piers carrying SR 823 overhead look to be closer than 25' from centerline of existing track, which NS mandates should be accomodated w/crashwalls if less than 25' as per the NS design criteria: www.nscorp.com/nscorphtml/engineering/pdf/SEC1_OHB3.pdf

I'll talk w/Chris, but if he has already indicated that the design needs to accomodate 2 additional future tracks, the design should have accomodated that request - When was this info. conveyed this to Chris?

I realize that, depending upon how far along design is, to alter the design will increase cost; but in my opinion, it is highly unlikely that NS will approve of the design (or signing off on a RR Agreembased) based on the current layout if this is not corrected...

Rich Behrendt
Program Mgr./State Rail Coordinator
Ohio Department of Transportation
1980 West Broad St.
Columbus, Ohio 43223
Phone: 614-387-3097
FAX: 614-466-0158
email: richard.behrendt@dot.state.oh.us

David Norris/Administration/D09/ODOT

03/13/2006 09:56 AM

To Richard Behrendt/RealEstate/CEN/ODOT@ODOT
cc
Subject SCI-823 NS RR involvement

Rich,

Attached are 8 scanned files of pertinent sheets of the July 2005 PAVR submittal from TranSystems
These plan sheets were sent to NS previously, and in their response, they indicated that they would probably

request clearance for 2 additional tracks(one on each side) in the Lucasville/US 23 area.
I feel that this would cause considerable impact on the design & cost of our 3 proposed bridges, particularly the 2 curved ramp bridges.

I would appreciate you checking with Mr. Chris Bennett to see how serious they are about this.

Thanks,
--
David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061 [attachment "RR_Impacts_Vert. Clr..pdf" deleted by David Norris/Administration/D09/ODOT] [attachment "RR_Impacts_Ramps B&C Calcs.pdf" deleted by David Norris/Administration/D09/ODOT] [attachment "RR_Impacts_Ramps B&C Plan Views.pdf" deleted by David Norris/Administration/D09/ODOT] [attachment "RR_Impacts_Report & Tele. Conversation.pdf" deleted by David Norris/Administration/D09/ODOT]

Thompson, Shawn/COL

From: Jirschele, Steve/COL
Sent: Tuesday, April 11, 2006 12:20 PM
To: Miller, Robert/COL; Thompson, Shawn/COL
Subject: Conversation Record with Norfolk Southern
Attachments: 04112006_Bennett_Phone_Conv.doc

CH2MHILL TELEPHONE CONVERSATION RECORD

Call To: Chris Bennett

Phone No.: 404-529-1256 **Date:** April 11, 2006

Call From: Steve Jirschele **Time:** 08:27 AM

Message Taken By: Steve Jirschele

Subject: Portsmouth Bypass

Copies: Shawn Thompson, Rob Miller

I called Chirs Bennett to discuss the Norfolk Southerns requirements in regard to adding two more tracks to their existing trackage. We discussed:

1. The new track centerline will be 14' off the centerline of the existing track.

2. For design purposes we can assume that the profile of the new tracks will match the profile of the existing tracks.

3. The two existing tracks at the site are on ±26' centers. I asked if they would be realigned to 14' centers when the new tracks were built. He was surprised that they were that far apart, but he offered the following observations:

    a. If the tracks are that far apart, there has to be a physical reason for it. Before a commitment could be made to move the tracks closer, they would have to know why they're that far apart now.

    b. ODOT would have to pay all realignment costs.

    c. Chris said that, based upon his past experience, ODOT cannot (or will not) comitt to funding a future realignment project that may or may not occur. He said without a funding commitment, the railroad will not comit to realigning the track.

    d. The other possibility is that ODOT fund the realignment now. However, that would still require an investigation as to why the tracks are ±26' apart now. If the tracks are that far apart, there is probably a good reason for it so the possibility of realigning the tracks to be closer together is probably slim.

Chris suggested that we assume the existing tracks cannot be realigned and proceed with preliminary design on that basis. If that results in a conclusion that it is impossible to build the bridges then ODOT, Norfolk Southern, and us (with TranSystems) could have a meeting to discuss other alternatives.

Thompson, Shawn/COL

From: Jirschele, Steve/COL
Sent: Tuesday, March 21, 2006 5:35 PM
To: jrcox@transystems.com; Thompson, Shawn/COL
Cc: mdweeks@transystems.com; Miller, Robert/COL; Wolpert, Andy/COL
Subject: RE: Norfolk Southern RR Coordination

Thanks Jon. I called Chris Bennett at NS. He said ODOT has been forwarded all the information on their requirements for the Portsmouth location and said we need to get the information from them. He did say that the required clearances will be per the information on their website. 23' vertical clearance is sufficient for their double stack operations. Based upon previous e-mails, it is our understanding that one new track will be added on each side of the existing tracks. The only information we don't have is profile and centerline information for the new track. Below is the design criteria that we currently have or are asking you (or ODOT) to provide so the Bridge Type Studies can be revised:

1. Clearance to conform to requirements on the NS website: http://www.nscorp.com/nscorp/application?pageid=Legacy&page=http%3A//www.nscorp.com/nscorphtml/engineering/structure_design.html

2. Two new tracks to be added. One to the east and one to the west of the existing tracks. ODOT/TranSystems to provide the distance from the new track centerline to the existing track centerline.

3. ODOT/TranSystems to provide guidance on the profile of the new track since the new track will likely be the point of minimum vertical clearance. Should we match the existing rail profile or make an allowance for the new rail to be slightly higher than the existing?

Thanks for your help Jon, but now I think its up to ODOT to get us some more information.

Steve Jirschele

From: jrcox@transystems.com [mailto:jrcox@transystems.com]
Sent: Tuesday, March 21, 2006 12:24 PM
To: Jirschele, Steve/COL; Thompson, Shawn/COL
Cc: mdweeks@transystems.com
Subject: Norfolk Southern RR Coordination

Gentlemen,

As Steve and I discussed earlier, the contact person at Norfolk Southern is Chris Bennett, Engineer of Public Works, at 404-529-1256 about the minimum vertical clearance for double stacking.

Jon R. Cox
National Bridge Leader
TranSystems Corporation
720 E. Pete Rose Way
Suite 360
Cincinnati, OH 45202

Office: (513) 621-1981
Cell: (513) 226-3765
Fax: (513) 621-2901

Thompson, Shawn/COL

From: mdweeks@transystems.com
Sent: Tuesday, March 14, 2006 7:14 PM
To: Miller, Robert/COL
Cc: Thompson, Shawn/COL; Jirschele, Steve/COL; jrcox@transystems.com
Subject: FW: SCI-823 NS RR involvement (2)

Guys,

See below for ongoing coordination with D-9 and Central Office regarding the Norfolk Southern future rails. Your team needs to assess the impacts to the designs and verify clearances with NS RR if needed.

Mike

From: Richard Behrendt [mailto:Richard.Behrendt@dot.state.oh.us]
Sent: Monday, March 13, 2006 2:07 PM
To: David Norris
Cc: Gary Cochenour; jcox@transystems.com; Jim Viau; CO-Michael Weeks; Ray Lorello
Subject: Re: SCI-823 NS RR involvement (2)

Dave,
Thanks for the added info.

I don't believe this is just a random comment on NS's part...As you may know, this rail corridor is currently a major route from the midwest down to the deep-water ports in Virginia and to the southeast part of the country, as well as being a major coal-hauling route from WV to the Great Lakes ports in the midwest and northeast. This line is currently under serious expansion review by NS as part of the 'Hearland Corridor' project, which will look at existing structures/clearances to determine costs for undercutting tunnels and removing other obstructions that will then permit operation of double-stack container/intermodal service and will no doubt run in the hundreds of millions of dollars. Together w/the new intermodal facility being constructed at Rickenbacker Airport here in Columbus, this line is projected to increase tonnage substantially, which is probably why NS is requesting added track potential on this route as existing capacity will soon be max'ed out if traffic develops as anticipated....

Rich Behrendt
Program Mgr./State Rail Coordinator
Ohio Department of Transportation
1980 West Broad St.
Columbus, Ohio 43223
Phone: 614-387-3097
FAX: 614-466-0158
email: richard.behrendt@dot.state.oh.us

David Norris/Administration/D09/ODOT

03/13/2006 01:16 PM

To Richard Behrendt/RealEstate/CEN/ODOT@ODOT

cc Gary Cochenour/Production/D09/ODOT@ODOT, Jim Viau/RealEstate/CEN/ODOT@ODOT, Ray Lorello/RealEstate/CEN/ODOT@ODOT, mdweeks@transystems.com, jcox@transystems.com

Subject Re: SCI-823 NS RR involvement Link

Rich,

The preliminary plans were sent to NS RR on 7/29/05. I received the email from Mr. Bennett on 01/13/06.

Part of the PAVR submission was the bridge type studies for all 21 bridges.
I don't have the bridge type studies in electronic format, that's why I sent the plan view sheets. If you would like to see the studies, Jawdat Siddiqi should have them in the Office of Structural Engineering.

The mainline bridge over NS had 8 alternatives proposed (3, 4, 5, 6 spans for steel beam & concrete beam).
Ramps B & C had 2 alternatives proposed (1, 2 span steel curved girder) each.
No selection has been made yet, as the consultant is incorporating review comments, and will resubmit. I asked Mr. Weeks to proceed with evaluating what NS RR requested, to see how it will affect our bridges.

I'm not saying that we should challenge their request, I'd just like more confidence that their expansion will really occur, instead of perhaps being a pipe dream.
This could cause us to reconfigure the whole interchange.

Thanks,
—
David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061

Richard Behrendt/RealEstate/CEN/ODOT

03/13/2006 11:29 AM

To David Norris/Administration/D09/ODOT@ODOT
cc Ray Lorello/RealEstate/CEN/ODOT@ODOT, Jim Viau/RealEstate/CEN/ODOT@ODOT, Gary Cochenour/Production/D09/ODOT@ODOT
Subject Re: SCI-823 NS RR involvement Link

Dave,

Looking at the plan (and assuming the PL indication is NS's ROW line) , NS obviously has a wide ROW along US23 at the SR 823 area, and regardless of the other infrastructure/civil/physical issues that NS would need to amend if/when future tracks are constructed, putting new piers on their ROW w/o accomodating future tracks and dimensionally restricting them to the current layout to 2 tracks with the current design will invariably delay this project if we attempt to challenge this request.

Additionally, some of the new piers on Ramp B & C , as well as the bridge piers carrying SR 823 overhead look to be closer than 25' from centerline of existing track, which NS mandates should be accomodated w/crashwalls if less than 25' as per the NS design criteria: www.nscorp.com/nscorphtml/engineering/pdf/SEC1_OHB3.pdf

I'll talk w/Chris, but if he has already indicated that the design needs to accomodate 2 additional future tracks, the design should have accomodated that request - When was this info. conveyed this to Chris?

I realize that, depending upon how far along design is, to alter the design will increase cost; but in my opinion, it is

highly unlikely that NS will approve of the design (or signing off on a RR Agreement) based on the current layout if this is not corrected...

Rich Behrendt
Program Mgr./State Rail Coordinator
Ohio Department of Transportation
1980 West Broad St.
Columbus, Ohio 43223
Phone: 614-387-3097
FAX: 614-466-0158
email: richard.behrendt@dot.state.oh.us

David Norris/Administration/D09/ODOT

03/13/2006 09:56 AM

To Richard Behrendt/RealEstate/CEN/ODOT@ODOT

cc

Subject SCI-823 NS RR Involvement

Rich,

Attached are 8 scanned files of pertinent sheets of the July 2005 PAVR submittal from TranSystems
These plan sheets were sent to NS previously, and in their response, they indicated that they would probably request clearance for 2 additional tracks(one on each side) in the Lucasville/US 23 area.
I feel that this would cause considerable impact on the design & cost of our 3 proposed bridges, particularly the 2 curved ramp bridges.

I would appreciate you checking with Mr. Chris Bennett to see how serious they are about this.

[attachment "339.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "253.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "331.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "252.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "325.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "018.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "002.tif" deleted by David Norris/Administration/D09/ODOT] [attachment "001.tif" deleted by David Norris/Administration/D09/ODOT]

Thanks,
--
David A. Norris, PE
ODOT District 9 DDD Engineering Assistant
PO Box 467 Chillicothe, OH 45601
Toll Free: (888) 819-8501
Direct Phone: (740)-774-9061

APPENDIX G

inter-office communication

to: Harry A. Fry, District 9 Deputy Director **date:** Oct. 14, 2005

from: Timothy J. Keller, Administrator, Office of Structural Engineering **by:** Ananda Dharma, P.E.

subject: SCI-823-0.00; PID 19415; Bridge No. SCI-823-XXXX; Ramp C over Norfolk Southern Railroad; Structure Type Study Review

Attn.: Thomas M. Barnitz, District 9 Production Administrator

We have briefly reviewed Structure Type Study submission from CH2MHill for the proposed bridge along Ramp C over Norfolk Southern Railroad. Our comments are shown below.

General Comments

1. The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure Type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office. The determination of utilizing a spread footing abutment placed directly on the reinforced soil mass can only be made after the above mentioned analysis have been performed as a minimum. Please refer to Section 204.6 of the 2004 Ohio Bridge Design Manual for additional design guidelines on MSE walls and L&D Manual, Volume 3, Section 1403.5.3 for submittal requirements.

2. The Structure Type Study stated that the Design Consultant should use compatible structure types and arrangements for the three bridges due to their close proximities. Does the District Office agree with this statement? We feel that the aesthetics should not be a determining factor in deciding the correct structure type at this particular site.

3. The cost of structural steel and prestressed concrete beams have fluctuated and the following costs are the most recent available. The Design Consultant should look over their cost calculations and revise as appropriate to reflect the following costs:

Structural Steel: Grade 50 Rolled Beams: $0.90 - $1.00 per pound
Grade 50 Plate Girders: $1.00 - $1.15 per pound (Level 4)
$1.15 - $1.30 per pound (Level 5)
For Grade 70, add $0.10 - $0.15 per pound

Prestressed Concrete I-Beams: AASHTO Type 2: $150 - $170/LF
AASHTO Type 3: $175 - $200/LF
AASHTO Type 4 (54"): $215 - $225/LF
AASHTO Type 4 (60"): $240 - $255/LF
AASHTO Type 4 (66"): $265 - $280/LF
AASHTO Type 4 (72"): $295 - $310/LF

Paint: $12/SF

MSE Walls: $45 - $50/SF

4. Due to the Department's long term experience and information that we have received concerning weathering steel, we have modified our anticipated long-term maintenance of weathering steel. Initial painting of the beams is not required. However, the paint cycle should be initiated when required by the inspection process. For the purpose of calculating Life Cycle Maintenance Cost for Structural Steel Painting, the beams will need to be painted every 25-30 years. The Design Consultant can assume that the beams will be painted twice. (Number of Maintenance Cycles: 2)

5. We cannot determine the best structure type at this point in time. We would like the Design Consultant to investigate the use of trapezoidal twin steel box girders for the one span alternate. Please provide the cost analysis for this analysis. The guideline of choosing the most economical structure as the best alternate might not apply in this location and that's why we are requesting the Design Consultant to investigate other structure types.

6. Please note that a large skew angle as shown in Alternative 2 can cause several construction problems. Also, the MSE walls cannot be utilized at the acute angles of the structure. There is a skew limitation for the design of MSE walls.

Site Plan - Sheet 1 of 3

7. In the Profile view, a stream is being shown to the north of the proposed pier in Alternate 1. Please show the edge limit of the stream in the Plan view and the direction of the flow. How much flow is in the stream? Please provide additional information.

8. Show the vertical clearances for both railroad tracks. Profile view only showed the vertical clearance for one of the railroad tracks.

9. Verify all vertical clearances. Norfolk Southern Railroad requires that the 23'-0" minimum vertical clearance is measured from top of high rail to the lowest point of the structure in the horizontal clearance area.

10. Please investigate the use of straight or 45 degree turnback wingwalls instead of turnback wingwalls.

11. Please justify the limit of the MSE walls on both sides of Ramp C. Along Ramp C, a 2:1 slope shall be utilized whenever possible to minimize the length of the walls.

12. Provide Project Identification Number (**PID**) below the County-Route-Section in the Title Block as per Section 102.5 of the 2004 Ohio Bridge Design Manual (BDM).

13. Include the Structure File Number in the Title block. Structure File Number can be obtained by contacting Ms. Kathy J. Keller, Office of Structural Engineering, Bridge Inventory section (Phone: 614-752-9973) prior to Stage 1 (Preliminary Design) submission.

Please provide our office with the disposition of comments in writing and a revised Site Plan prior to Preliminary Design submission.

Nothing in these comments is to be construed as authorizing extra work for which additional compensation may be claimed. If you have reason to believe that these comments require work outside the limits of your Scope of Services, please contact this office before proceeding.

Should you have any questions concerning our review comments for the above referenced project, please contact our office.

TJK:JS:ad

c: David A. Norris, ODOT District 9
Douglas A. Buskirk, ODOT District 9
Lawrence A. Wills, ODOT District 9
Timothy J. Keller, Office of Structural Engineering
Jawdat Siddiqi, Office of Structural Engineering
file

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: DGS/SKT DATE: 6/12/2007

Bridge SCI-823-1603: Ramp C over Norfolk

Southern Tracks

PROJECT: SCI-823-10.13: Portsmouth Bypass PROJ. NO: 319861.08.06

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

Reference Page/Sheet No.	Review Comment	Designer Response
	ODOT Comments	
General	1. The Design Consultant shall first determine that MSE wall supported abutments can be utilized at the proposed location prior to making any MSE wall recommendations during the Structure Type Study. Subsurface soil conditions are to be evaluated for expected settlements, differential settlements, allowable bearing capacities and global stability of the proposed MSE walls prior to submitting Structure Type Study to our office. The determination of utilizing a spread footing abutment placed directly on the reinforced soil mass can only be made after the above mentioned analysis have been performed as a minimum. Please refer to Section 204.6 of the 2004 Ohio Bridge Design Manual for additional design guidelines on MSE walls and L&D Manual, Volume 3, Section 1403.5.3 for submittal requirements.	On October 4, 2006, DLZ submitted an updated "Subsurface Exploration and MSE Wall and Embankment Evaluations for Proposed US 23 / SR 823 Interchange" report, in response to ODOT concerns with the existing subsurface soil conditions at the site. Per the ODOT Review of MSE Wall and Embankment Evaluation Report IOC from Peter Narsavage, dated April 23, 2007, *"From the report, we understand that undrained bearing capacity and differential settlement of the ramp MSE walls are of concern. The other stability checks, such as global stability, sliding, and drained bearing capacity result in acceptable safety factors. We believe that MSE walls could be built in two stages, without any surcharging or ground improvement. Wick drains could be considered to decrease the amount of time required for consolidation of the foundation soil. Where the height of the MSE wall was high enough to cause concern about differential settlement, slip joints can be provided at regular intervals. The top row of facing panels would not be fabricated until after settlement was substantially complete."*

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: DGS/SKT DATE: 6/12/2007

Bridge SCI-823-1603: Ramp C over Norfolk

Southern Tracks

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ. NO: 319861.08.06

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

General	2. The Structure Type Study stated that the Design Consultant should use compatible structure types and arrangements for the three bridges due to their close proximities. Does the District Office agree with this statement? We feel that the aesthetics should not be a determining factor in deciding the correct structure type at this particular site.	Will comply.
General	3. The cost of structural steel and prestressed concrete beams have fluctuated and the following costs are the most recent available. The Consultant should look over their cost calculations and revise the cost comparison as appropriate utilizing the following costs: Structural Steel: Grade 50 Rolled Beams: $0.90 - $1.00 per pound; Grade 50 Plate Girders: $1.00 - $1.15 per pound (Level 4) and $1.15 - $1.30 per pound (Level 5); For Grade 70, add $0.10 - $0.15 per pound Prestressed Concrete I-Beams: AASHTO Type 2: $150-$170/LF AASHTO Type 3: $175-$200/LF AASHTO Type 4 (54"): $215-$225/LF AASHTO Type 4 (60"): $240-$255/LF AASHTO Type 4 (66"): $265-$280/LF AASHTO Type 4 (72"): $295-$310/LF Paint: $12/SF MSE Walls: $45-$50/SF	Will comply. In September 2006, we contacted the ODOT Office of Estimating regarding another ODOT Project for pricing information. We received new pricing information for several structural items in 2006 dollars, which will be used on this Structure Type Study re-submittal.

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: DGS/SKT DATE: 6/12/2007

Bridge SCI-823-1603: Ramp C over Norfolk

Southern Tracks

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ. NO: 319861.08.06

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

General	4. Due to the Department's long term experience and information that we have received concerning weathering steel, we have modified our anticipated long-term maintenance of weathering steel. Initial painting of the beams is not required. However, the paint cycle should be initiated when required by the inspection process. For the purpose of calculating Life Cycle Maintenance Cost for Structural Steel Painting, the beams will need to be painted every 25-30 years. The Design Consultant can assume that the beams will be painted twice. (Number of Maintenance Cycles: 2)	Will comply.
General	5. We cannot determine the best structure type at this point in time. We would like the Design Consultant to investigate the use of trapezoidal twin steel box girders for the one span alternate. Please provide the cost analysis for this analysis. The guideline of choosing the most economical structure as the best alternate might not apply in this location and that's why we are requesting the Design Consultant to investigate other structure types.	The revised Structure Type Study consists of 5 new span arrangements in order to accommodate two future railroad tracks. The increased span lengths required to carry traffic over the railroad tracks have eliminated the potential for a single span bridge alternative. All 5 new span arrangements consist of Steel Plate I-Girder superstructures; however, to comply with the comment, a Steel Tub Girder alternative was also investigated for the span arrangement of Alternative 3 (this is presented as Alternative 3b).
General	6. Please note that a large skew angle as shown in Alternative 2 can cause several construction problems. Also, the MSE walls cannot be utilized at the acute angles of the structure. There is a skew limitation for the design of MSE walls.	Will comply. Large skew angles and MSE wall alignments with acute angles will be avoided for all alternatives presented in the revised Structure Type Study.

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: DGS/SKT DATE: 6/12/2007

Bridge SCI-823-1603: Ramp C over Norfolk

Southern Tracks

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ. NO: 319861.08.06

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

Site Plan (1/3)	7. In the Profile view, a stream is being shown to the north of the proposed pier in Alternate 1. Please show the edge limit of the stream in the Plan view and the direction of the flow. How much flow is in the stream? Please provide additional information.	CH2M HILL will attempt to maintain the existing drainage, grading, and location of the ditch, not stream, in this area for this project. However, the existing crushed aggregate open channel ditch is located in close proximity to the potential future track. Futhermore, realigning the ditch to accommodate substructure units closer to the RR at the clear zone distance will permit shorter span lengths. At the May 2, 2007 meeting with Norfolk Southern representatives at ODOT Central Office, Norfolk Southern concluded that redirecting this open channel to allow shorter span lengths would be permitted. As a result, CH2M HILL will investigate various alternatives with substructure units located both inside and outside of the existing ditch. Existing and proposed flow arrows for this ditch will be provided in the plans.
Site Plan (1/3)	8. Show the vertical clearances for both railroad tracks. Profile view only showed the vertical clearance for one of the railroad tracks.	Will comply.
Site Plan (1/3)	9. Verify all vertical clearances. Norfolk Southern Railroad requires that the 23'-0" minimum vertical clearance is measured from top of high rail to the lowest point of the structure in the horizontal clearance area.	Will comply.

CH2MHILL

DESIGNER RESPONSE TO REVIEW COMMENTS

BY: DGS/SKT DATE: 6/12/2007

Bridge SCI-823-1603: Ramp C over Norfolk

Southern Tracks

PROJECT: **SCI-823-10.13: Portsmouth Bypass** PROJ. NO: 319861.08.06

REVIEWER: ODOT OSE – Ananda Dharma, P.E. PHASE: Type Study

Site Plan (1/3)	10. Please investigate the use of straight or 45 degree turnback wingwalls instead of turnback wingwalls.	Will comply. 45 degree turnback wingwalls will be used where applicable.
Site Plan (1/3)	11. Please justify the limit of the MSE walls on both sides of Ramp C. Along Ramp C, a 2:1 slope shall be utilized whenever possible to minimize the length of the walls.	Will comply. MSE walls will be terminated as quickly as possible.
Site Plan (1/3)	12. Provide Project Identification Number (**PID**) below the County-Route-Section in the Title Block as per Section 102.5 of the 2004 Ohio Bridge Design Manual (BDM).	Will comply. CH2M HILL has been notified that the PID number for this project is **79977**.
Site Plan (1/3)	13. Include the Structure File Number in the Title block. Structure File Number can be obtained by contacting Ms. Kathy J. Keller, Office of Structural Engineering, Bridge Inventory section (Phone: 614-752-9973) prior to Stage 1 (Preliminary Design) submission.	Will comply. CH2M HILL has been notified that the Structure File Number for this bridge is **7306814**.