WEKIVA PARKWAY (SR 429)/SR 46 REALIGNMENT PD&E STUDY

TECHNICAL MEMORANDUM:

IDENTIFICATION OF WEKIVA RIVER BRIDGES STUDY CONCEPTS

Prepared for:

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and

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This Technical Memorandum documents the process that was utilized to identify suitable alternative bridge concepts for the proposed Wekiva River crossing. The river is a Federally-designated Wild & Scenic River.

The scope of this bridge study was qualitative in nature and developed to provide information in support of the PD&E Study process, and more specifically in support of the Programmatic Section 4(f) Evaluation for the Federal Highway Administration and the Section 7 Determination for the National Park Service which requires a feasible bridge concept for evaluation of potential impacts to the Outstandingly Remarkable Values of this Wild & Scenic River. More detailed information on the PD&E Study scope and process is available in other documents. In the event that any of the bridge concepts identified in this memorandum are considered for project final design and construction, additional engineering will be required to confirm the basic assumptions and conclusions of this study.

1.0 Summary of Bridge Study Process

The bridge concept study was conducted in conjunction with roadway alignment and profile studies, and utilized information contained in previous engineering studies of the Wekiva River crossing location. Physical constraints, such as floodplain limits and right-of- way limits, were also obtained from the project roadway preliminary design team. Design drawings of the existing SR 46 bridge over the Wekiva River were also examined to define pertinent information related to site geotechnical conditions and utilities. A site visit was conducted on March 3, 2011 to confirm available data and identify additional conditions that may influence bridge concepts. The above information was used for defining site constraints and design criteria, and in the brainstorming of potential bridge concepts.

Following identification of potential bridge type concepts, a subsequent process of identifying and screening bridge types relative to engineering and construction considerations was conducted, and a shortlist of initial bridge types was identified for further study. A charette workshop was conducted on March 2 and 3, 2011 to define stakeholder requirements and concerns related to the proposed SR 429 mainline and service road bridges crossing the Wekiva River.

A constructability screening was also conducted by the engineering team. Simulations of these five bridge concepts were developed to examine the visual compatibility of the bridge schemes with the crossing location and environment. The overall objective of the screening process was to identify five bridge types that were most compatible with stakeholder requirements, while also meeting basic engineering and construction requirements. This memorandum documents the alternatives screening and development process, and their subsequent further development into bridge layout concepts.

Another step in the overall process, which focused on identifying the most appropriate bridge alternatives for further consideration, was conducted following the second charette workshop on April 20, 2011. It is briefly addressed in Section 5.0 of this document. That process will be further documented in a subsequent technical memorandum.

2.0 Design Requirements and Criteria

Basic criteria related to the bridge design and construction necessary for development of concept level designs were identified, as were stakeholder preferences and concerns. These criteria were used to develop and evaluate bridge concepts.

2.1 Bridge Engineering Design Requirements

The new crossing must accommodate three roadways. The eastbound and westbound expressway roadways will each consist of three lanes and two (inside and outside) 12 foot wide shoulders for an inside to inside of barrier dimension of 60 feet. An adjacent service road will consist of one lane of traffic in each direction along with 10 foot wide shoulders and a 10 foot wide pedestrian/bicycle trail for an inside to inside of barrier dimension of 56.33 feet.

The following requirements apply to the bridge design.

1. The FDOT Structures Manual, January 2011 Edition and AASHTO LRFD Bridge Design Code 4th Edition are assumed to be the relevant bridge design codes.
2. Extreme loadings, such as vessel impact and seismic, will not apply to this project. While wind loads defined in the FDOT Structures Manual, Volume 1, Section 2.4.1 may represent a major final design consideration, they would not control the design of the bridges.
3. The main span over the Wekiva River will not have any piers located in the river (estimated river width was determined by mean high water elevation). This resulted in a minimum span length (defined as center to center of pier) over the Wekiva River on the order of 270 to 300 feet. It was decided to use a 300 foot span length for purposes of the study, and it was assumed that some adjustment in this dimension may be required during subsequent project development stages.
4. It was assumed that no haul roads, embankments or causeways could be constructed within the Wekiva River shoreline to shoreline limits for purposes of constructing new bridges or demolishing the existing bridge.
5. 1994 boring logs and other information for the existing SR 46 bridge suggest that limestone underlies the site at a depth of approximately 20 to 30 feet below grade, and it would be a reasonable to assume that this material could support a bridge foundation required by study alternatives. Geotechnical studies must be conducted during the

design stage to confirm actual site geotechnical conditions at pier locations based on the selected bridge design scheme and reactions transmitted to the foundation.

6. Subsurface high pressure gas pipelines are located within the existing right-of-way. Avoidance of these utilities would be desirable if possible, but it is assumed they may have to be relocated.

2.2 Stakeholder Design Criteria

At the first Conceptual Design Charette on March 3, 2011 a Vision Statement was developed to guide the study along with related criteria statements, as follows.

1. "Enhance wildlife habitat/connectivity"
    a. Keep bridge lengths consistent with previously identified bridge lengths.
    b. Separate the roadways onto three individual bridges with a minimum 10 foot wide physical separation between the faces of all three adjacent bridges to provide light entry into areas beneath the bridges.
    c. Criteria #2, minimize noise, #5, minimize impact to adjacent vegetation and #7, minimize shadow effects also contribute to this goal.
2. "Minimize noise impacts"
    a. Select bridge type and materials of construction which minimize noise.
    b. Consider the inclusion of noise barriers on the bridge.
3. "Minimize visual (impact) of the bridge"
    a. Keep the roadway profile as low as possible to avoid intruding above the tree line.
    b. Set the profile grade of all three bridges at approximately the same elevation within the immediate vicinity of the Wekiva River.
    c. Minimize girder depths.
    d. Keep structural components hidden from view as much as possible through use of existing vegetation for screening.
    e. Use color and texture to blend with the surrounding forest vegetation.
4. "Promote knowledge of the river to Parkway users"
    a. Design railings/barriers to provide river views from bridge.
    b. Consider signs or gateway features at the ends of the bridge.
5. "Minimize impact to adjacent habitat/tree buffer/island"
    a. Place the three bridges as far south within the ROW corridor as possible to minimize the bridge footprint on the island to the north of the existing bridge crossing.
    b. Minimize impact on vegetation during construction.
6. "Enhance the aesthetic quality of the bridge"
    a. Select bridge design that is visually interesting to both river and Parkway users.
    b. Consider the use of non-conventional bridge structural systems.
7. "Minimize shadow effect of bridge"
    a. Consider "light scoops" or other methods of increasing the light under the bridge.
8. "Enhance river flows"
    a. Clear span the river, allowing no piers within the river.

   b. Use methods of construction that do not interfere with river flows.

9. "Incorporate constructability"
10. "Consider ease and impact of maintenance"
11. "Provide an economical solution"

3.0 Identification of Bridge Alternatives

Alternative bridge concepts were identified and evaluated for their ability to meet design criteria and address site constraints. This was a two stage process. In the first stage, bridge schemes that did not meet basic technical criteria stated in Section 2.1 or did not conform to stakeholder criteria stated in Section 2.2 were identified and discarded. The second stage of the process included a more focused examination of five bridge alternatives to identify technical and visual characteristics, and was followed by a constructability screening of the five alternatives for potential fatal flaws.

3.1 Bridge Type Alternatives Dismissed from Further Consideration

A number of bridge types were eliminated from further consideration following an evaluation of their basic features relative to technical and stakeholder criteria. These alternatives are briefly discussed in this section.

3.1.1 Steel Plate Girder and Spliced Precast Concrete Girder Bridges

These bridge types are technically feasible and economical for constructing spans of 300 feet, and have been used in similar applications within the State of Florida. However, their multi-girder cross section does not result in an acceptable visual character of the bridge when viewed from beneath by recreational waterway users. In addition, secondary structural members such as cross frames or diaphragms required for multi-girder structures would also not be visually compatible with this site.

3.1.2 Cable Stayed Bridges

These structure types are typically more cost competitive for spans that are considerably greater than 300 feet. In addition, the upper portions of these bridges would project approximately 50 to 60 feet above the top of deck, resulting in their visibility by river users at distant viewpoints along the waterway.

3.1.3 Through-Arch Bridges

Through-arch bridges are often used for locations where it is desirable that the bridge make a strong visual statement, often in marked contrast to the surrounding natural environment. That overall approach is not compatible with the stakeholder preference that the bridge be as visually unobtrusive as possible. Through-arch bridges are also complex assemblies of bridge components that also project above the top of deck surface, and this high degree of visual complexity was not considered to be compatible with the desire to minimize the visual impact of the bridge on the surrounding site.

3.1.4 Suspension Bridges

Unlike cable stayed or arch bridges, suspension bridge towers, which are the uppermost structural components above the deck surface, would need to project only 25 to 30 feet above the top of deck. However, similar to cable stayed bridges, suspension bridges are typically economical for spans considerably in excess of 300 feet. In addition, a classical suspension bridge typically requires an anchorage for the main cables which results in a massive structure when viewed from beneath the bridge deck by recreational waterway users. The requirement for an anchorage can be eliminated by use of a self anchored deck design which uses the deck system as a strut to resist the cable horizontal thrust component. However, this bridge type results in complex and expensive construction, including the use of temporary piers to support the superstructure during bridge erection.

3.2 Bridge Type Alternatives Identified for Further Consideration

Bridge type concepts that were initially identified as being compatible with project constraints and requirements during the screening process included the following:

3.2.1 Scheme 1: Segmental Concrete Box Girder

Segmental concrete bridges have been utilized on Florida bridge projects for over twenty-five years, and have a long history of successful utilization throughout the U.S. Precast segmental spans of up to 500 feet have been achieved in the U.S.[1] while cast in place construction has been used for far longer spans[2]. A span of 300 feet for a deck width of approximately 63 feet is well within the range of feasibility for precast construction and would be a variable depth girder for purposes of economy and to minimize the visual depth of structure at midspan. The approximate structure depth at the piers for a 300 foot span would be on the order of 16 feet, while the depth at midspan would be on the order of half that depth.

From a visual standpoint, this bridge type has a number of attractive features. The soffit is a series of smooth planes with the inclined outside web face and wide deck overhangs creating a set of deep shadow patterns. The highly inclined exterior web face also creates an illusion of thinness, even for a relatively deep structure. The east-west bridge orientation and height of the girder above the water result in reflected light reaching areas far from the south face. The narrow soffit width at the piers results in relatively narrow pier shapes, resulting in a more transparent structure when viewed from the river. Finally, repetitive use of a constant box girder section results in a unity between all three bridges when viewed from beneath.

The 1,500-foot long segmental scheme shown on drawings in ***Appendix A*** (***Figures 1 and 1A***) has a main span unit arrangement of 180 feet - 300 feet - 180 feet, flanked by three 140 foot approach spans at each end of the bridge. An 8 foot structure depth is shown for the approach spans, and the main span unit depth varies between 8 and 16 feet. The two cell box girder cross section has a variable width soffit with a minimum dimension at the main piers, and a maximum dimension at the approach spans and middle of the main span. Twin column piers support integral cap beams at all piers, and the pier faces are tapered in both the longitudinal and transverse directions. The same cross section and support geometry is used for both expressway bridges and the service road bridge on the south side of the corridor.

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[1] I-35 W Bridge in Minneapolis

[2] The Raftsundet Bridge in Norway has a main span of approximately 1,000 feet

3.2.2 Scheme 2: Strutted Segmental Concrete Box Girder

A strutted box girder is similar in many respects to the two cell segmental box girder, except that the concrete box girder section is significantly reduced in cross section (and weight) and external struts are used to support the longer slab overhangs. While some wide, single cell segmental box girder bridges have been constructed with internal struts[3], few bridges in the U.S. have been constructed with external struts. This bridge type has been more commonly constructed in Europe, primarily on steel bridges at sites where the superstructure is located high above the ground. It is envisioned that the main span would have similar dimensions as the precast segmental box girder, with a structure depth at the piers on the order of 15 feet, while the depth at midspan would be on the order of half that depth.

While there do not appear to be any apparent fundamental barriers to the application of this technology to this project, additional study would be required to confirm that this structure type could span 300 feet with a 63 foot wide deck.

From a visual standpoint, this bridge type has similar features to the segmental box girder bridge. However, there are some significant differences. The narrow girder soffit would be viewed as a "spine beam" with the primary structure element being the soffit of the deck slab. The linear struts would appear very slender when viewed from directly beneath, but on portions of the bridge that are more distant for the river, the struts would be perceived as a surface composed of an inclined series of linear elements. The narrowness of the spine beam would result in the thinnest substructure of all bridge alternatives and the greatest transparency of the bridge when viewed along the alignment. Finally, as with the segmental box girder, the repetitive use of a constant box girder section results in a unity between all three bridges when viewed from beneath.

The 1,500-foot long strutted box girder scheme shown on drawings in ***Appendix A*** (***Figures 2 and 2A***) has the same span arrangement as shown for Scheme 1. The single cell box girder cross section has a constant width soffit. Single column piers support the girder at all piers, and the pier faces are tapered in both the longitudinal and transverse directions. The same cross section and support geometry is used for both expressway bridges and the service road bridge on the south side of the corridor.

3.2.3 Scheme 3: Concrete Through-Girder

The final concrete bridge scheme is a through-girder type structure. Unlike the previously discussed segmental box girder alternatives, the through-girder bridge system has the deck surface supporting traffic in the lower portion the cross section, and major structural members that support the span at the outer edges of the cross section. Through-girder sections have been widely used for steel plate girder railway bridges for over a century to provide minimal structure depths.

Through-girder type structures are relatively uncommon in contemporary concrete bridges, with the noteworthy exception of through-girder construction in precast concrete segmental channel bridges. This structure type was developed to allow for application of segmental construction methods for bridge replacement projects where there were major limitations on structure depth introduced by existing roadway geometry. The maximum bridge deck

[3] Sunshine Skyway Bridge in Tampa; Baldwin Bridge over the Connecticut River

width is limited by the deck slab span between edge girders, and the span length is limited by the girder dimension, which is the combination of the soffit slab thickness and the barrier height. Application of this structure type to a 60 foot maximum slab span would require an integral floorbeam system to increase the deck slab capacity.

Unlike most channel bridges, there are no under-clearance limitations on this project and the use of a downward projection of the edge girder is feasible. Applying these modifications to the basic bridge scheme appears to be feasible in increasing spans to approximately 130 feet or more, and deck widths to 60 feet. **However, additional study would be required to confirm that this structure type could span 300 feet with a 63 foot wide deck.**

A recently developed application of segmental bridge construction is required to extend the span length to 300 feet for the river crossing main span. Extradosed girder bridges are a hybrid between cable stayed and girder type bridges. As with girder bridges, they depend on a relatively rigid girder section to resist bending and shear forces. However, when spans increase beyond the capacity of the girders, they utilize a secondary load support system consisting of post-tensioning tendons that extend above the deck surface. The tower heights are approximately half that of a cable stayed bridge of the same span since the deck is far more rigid and carries a substantial percentage of the total loading. While many extradosed bridges have been constructed in Europe, as well as Japan and other Asian countries, Mexico and Canada over the past two decades, it is a relatively new bridge type for the U.S. One notable exception is an early extradosed "finback" bridge in Austin, Texas[4] which was constructed in 1986. It is also one of the few externally strutted concrete girder bridges in the country.

It is envisioned that a combination of the through-girder bridge type and extradosed bridge type for the longer main span would result in a bridge that would have a slender structure depth at the middle of the main span, the shallowest structure depth at the piers when viewed from beneath the deck, and the lowest upward projection of any through bridge type resulting in minimal visual impacts on the surrounding viewshed. It is envisioned that the tendons that extend above the deck level would be encased within a concrete fin wall at the outer edges of the bridge deck, which would provide a visual reference point to motorists in defining the river crossing. Another interesting visual feature of this bridge type is the repetitious coffered ceiling pattern resulting from the segments with integral floorbeams.

The 1,500-foot long segmental through-girder scheme shown on drawings in ***Appendix A*** (***Figures 3 and 3A***) has the same span arrangement as the Scheme 1 segmental box girder arrangement. An 8 foot structure depth is shown for the approach spans, and the main span unit depth varies between 8 and 16 feet. The cross section has a constant width soffit and is supported by twin columns at all piers, with stays at the main piers. The pier faces are tapered in both the longitudinal and transverse directions. The same cross section and support geometry is used for both expressway bridges and the service road bridge on the south side of the corridor.

[4] Barton Creek Bridge, Travis County, Texas

A slight alignment shift to the north is required for the three bridges due to the supporting members for the spans being located outside of the barrier line, resulting in a wider overall deck width than deck type bridges. As with the other alternatives, a 10 foot horizontal separation between all bridges is required to accommodate construction and to provide for daylight to reach areas under the bridge deck. The combination of the 10 foot clearance between bridge and the wider deck widths results in the need to shift the centerline of the expressway slightly to the north.

3.2.4 Scheme 4: Steel Box "Tub" Girders

Tub girder sections have been utilized for many curved and long span steel bridges, and also for bridges where aesthetics is an important design consideration. As previously noted, while steel plate girders would be an economical scheme to address the required main span length, the highly articulated soffit and necessity to use cross frames between the girders for stability are not acceptable from the standpoint of aesthetics. Tub girder spans of 300 feet and deck widths in excess of 63 feet have been successfully constructed in the U.S. within the past decade, and should not present any unique design or construction issues. As with segmental concrete box girder bridges, longer span steel box girder bridges would use a variable depth girder to reduce dead weight and provide for a thin girder section at midspan.

The approximate structure depth at the piers would be on the order of 11 feet, while the depth at midspan would be on the order of 8 feet. While the cross section could consist of a single cell girder, a section consisting of multiple lines of adjacent tub girders has advantages in terms of redundancy and reduced weight of field sections during handling, transport, and erection.

From a visual standpoint, steel box girder bridges have features in common with segmental box girders. The highly inclined exterior web face also creates an illusion of thinness, even for a relatively deep structure. Three bridges located in close proximity would result in a patterned ceiling consisting of light, smooth and continuous soffit surfaces and shadowed inclined web faces. However, piers supporting multiple girder lines are typically wider and more articulated than those supporting segmental box girder bridges.

The 1,500-foot long steel box girder scheme shown on drawings in ***Appendix A*** (***Figures 4 and 4A***) has a main span unit arrangement of 225 feet - 300 feet - 225 feet, flanked by two 187.5 foot approach spans at each end of the bridge. An 8 foot structure depth is shown for the approach spans, and the main span unit depth varies between 8 and 11 feet. The three box girder cross section has a variable width soffit with a minimum dimension at the main piers, and a maximum dimension at the approach spans and middle of the main span. A single column supports each girder line at each pier, and the pier faces are tapered in both the longitudinal and transverse directions. The same cross section and support geometry is used for both expressway bridges and the service road bridge on the south side of the corridor.

3.2.5 Scheme 5: Composite Steel Truss Bridge

The other steel alternative that was considered was a deck truss bridge. While this structure type was once preferred in the U.S. for highway bridge spans of 300 feet or more, the development of plate and box girder bridges has resulted in fewer applications of this bridge type. The only exception is a limited number of longer span bridges where vertical under-clearance is a major design consideration. Recent developments in truss bridges have occurred in Europe, and include the development of highly efficient composite steel and concrete structures. These contemporary truss bridges have a high degree of visual transparency which makes them suitable for consideration on this project.

The approximate structure depth at the piers would be on the order of 32 feet, while the depth at midspan would be on the order of 15 feet, making this the deepest of all of the bridge alternatives. The cross section configuration of each of the three parallel bridges could consist of a single triangular or box section, or could be a series of multiple truss sections. As with tub girder construction, the reinforced concrete top slab acts compositely with the truss sections to resist bending stresses.

Engineering issues related to this bridge type that would need to be addressed include structural redundancy and connection details. Redundancy is a characteristic of structures that relates to their ability to function after sustaining damage to an individual member. Trusses can be designed to exhibit redundant behavior by providing alternative load paths and insuring adequate stability of individual members. The post-tensioned deck on this scheme would potentially provide for a high degree of redundancy. Another design detail related to redundancy which has visual implications is the connections of truss members at joints. Contemporary U.S. practice has been the use of gusset plates and bolted connections at truss joints. Alternative details may be suitable for consideration and would need to be examined prior to application.

From a visual standpoint, the primary characteristic of this bridge type is the relative transparency of the structure. Trusses are highly efficient networks of individual linear members that are combined to transmit loads to supports. A narrow truss bridge viewed from beneath may be perceived as containing space with a minimal mass, while a wider truss bridge may be far more opaque and visually complex. When viewed from a distance, a contemporary steel truss could be painted to potentially blend into its surroundings more effectively than a relatively deep girder type bridge.

The 1,500-foot long truss scheme shown on drawings in ***Appendix A*** (***Figures 5 and 5A***) has a main span unit arrangement of 150 feet - 300 feet - 150 feet, flanked by three 150 foot approach spans at each end of the bridge. The main span unit truss depth varies between 8 and 16 feet, with constant depth prestressed concrete girders at the approach spans. Two column piers support the truss spans with drop cap beams at all approach piers. Pier faces are tapered in both the longitudinal and transverse directions. The same cross section and support geometry is used for both expressway bridges and the service road bridge on the south side of the corridor.

4.0 Constructability Considerations

A preliminary screening of the five bridge alternatives was conducted to identify issues that could potentially be fatal flaws which would eliminate a bridge scheme from further consideration.

4.1 Wekiva River Access

Only approximately 250 to 270 feet of the 1,500 foot long bridges would be located directly over the Wekiva River. However, restrictions on accessing the waterway may influence feasible bridge options and the selection of appropriate construction methods and equipment.

The water depth is relatively shallow and would not accommodate construction barge drafts. If it is assumed that dredging would not be acceptable to environmental resource agencies, use of marine based construction equipment would not be feasible for constructing this project.

Recreational boat traffic uses the waterway, and it is not known if this portion of the river will be open to boaters during superstructure construction or if a temporary closure of the river to boaters will be required as a safety precaution.

It is assumed that temporary structures for contractor access or equipment working platforms can be constructed over the waterway, and that the supports for these temporary structures would be aligned with the existing bridge piers. Similarly, it was assumed that pile supports for temporary structures may be located within the river. It is recommended that these assumptions related to temporary structures within the river be confirmed through discussions with environmental resource agencies. If these assumptions related to temporary structures are not correct, special equipment such as overhead launching trusses or ground based cranes that can pick large loads at a long radius may be required for superstructure construction.

4.2 Construction Staging

It is assumed that SR 46 vehicular traffic in the vicinity of the Wekiva River must be maintained within the existing corridor at all times during expressway construction, which will require staging of new highway and bridge construction. A major feature of the existing highway is an existing 11 span, 561 foot long precast concrete girder bridge which crosses the Wekiva River and adjacent floodplains, and lies within the new bridge footprint.

One approach to construction staging is illustrated in ***Appendix A*** (***Figure 6***) and discussed below. It is understood that alternative staging schemes are possible, and may have benefits that may be more attractive for implementation:

- Stage 1 – Construct the new service road and bridge adjacent to the south ROW line. This would also include the placement of embankments and retaining walls at the roadway approaches to accommodate the new service road profile. This will probably require the construction of a temporary work bridge over the Wekiva River between the service road bridge and the existing bridge to accommodate cranes and other construction equipment necessary to build the service road bridge.
- Stage 2 – Detour traffic from the existing highway onto the new service road. Construct the westbound SR 429 mainline bridge using the existing bridge for crane access. Following completion of the westbound expressway bridge, demolish the existing bridge.

- Stage 3 – Construct the eastbound SR 429 mainline bridge using the work bridge for crane access. Following completion of the eastbound expressway bridge, demolish the work bridge and open the mainline bridges to traffic.

Based on this preliminary evaluation, it appears that a staged approach to construction could be applied to any of the five bridge alternatives.

4.3 Bridge Erection Schemes

While it is assumed that most bridges can be constructed by a multiple number of erection schemes and methods, it is important to examine potential construction schemes during this stage of project development to provide assurance that there is no apparent fatal flaw related to construction. It is assumed that the substructures of all three bridges would be reinforced concrete columns and caps supported by driven pile foundations, and that there would not be any fatal flaws related to utilization of this commonly used Florida bridge substructure type on this project.

The first three bridge alternatives are concrete bridges. It is assumed that, for purposes of economy, the entire 1,500 foot length of each of these three bridge alternatives would be constructed with precast segments and that all three bridges would be fabricated in the same casting yard. The combined deck area of the three bridges is on the order of 275,000 square feet which is well within the feasible range for this type of construction, since the re-use of customized forms and any special erection equipment would justify a large initial investment by the contactor.

Scheme 1: Segmental Concrete Box Girder

Cantilever erection of the 300 foot main span over the Wekiva River from the piers flanking the river banks would be the most likely method of main span construction. The 150 foot cantilevers would likely not require temporary supports within the waterway.

Erection of the approach spans could use either balanced cantilever or span by span construction methods. Span by span methods are suitable for multiple spans made continuous, and require a temporary underslung or overhead erection truss to support each span prior to installing and stressing longitudinal post-tensioning tendons. Cantilever erection does not require a temporary erection truss, since each erected segment is supported by the previously erected segments. Cantilever erection can be performed by ground based cranes, such as crawler cranes or rubber tire cranes, or by an overhead erection truss.

It is assumed that delivery of the segments would be by a special high capacity transporter vehicle to the location where a crawler crane could pick and place the segment. For locations over the river, a crawler crane may need to be placed on a working platform to place segments at the leading edge of the cantilever. This problem is eliminated by using an overhead erection truss since the truss is aligned with the bridge centerline.

Scheme 2: Strutted Segmental Concrete Box Girder

Overall, this scheme is very similar to Scheme 1. From an erection perspective, the strutted box sections may preclude use of an under-slung erection truss, but either overhead equipment or cantilever erection with crawler cranes appear to be feasible alternatives for segment erection.

Scheme 3: Concrete Through-Girder

Span-by-span construction of the precast girder segments for 140 foot approach spans is assumed to use an underslung erection gantry supported on the piers. It is assumed that the same equipment would be used to erect the 180 foot long side spans for the main span unit. Similar to Schemes 1 and 2, it is assumed that segments would be delivered by transporter to a location where a crawler crane could pick and place the segment on the erection gantry. An overhead erection gantry could also be used to erect the approach and side spans, provided that the segments were delivered to directly beneath the span and lifted upward into position on temporary hangers.

Erection of the main span is assumed to be in cantilever outward from the main piers, with stays added to the cantilever to control dead load moments. Similar to Schemes 1 and 2, it is assumed that for locations over the river, a crawler crane on a working platform may be needed to place segments at the leading edge of the cantilever.

Scheme 4: Steel Box "Tub" Girders

Steel tub girders are commonly shipped in field sections that are erected with crawler (or similar) cranes. Since the Wekiva River bridges will not be constructed over a navigable waterway, it is assumed that trucks will be used to transport the steel girder sections from the fabrication shop to the site, and that shipping weigh and dimensional limitations will dictate box girder shipping lengths.

Field sections are typically connected to previously erected sections using high strength bolts and splice plates. Depending on the erection scheme, field sections can be preassembled into long pieces prior to lifting and may be supported prior to splicing by temporary shoring towers or a supplemental crane. Erection of the 300 foot main span over the river may require the use of temporary shoring towers due to stability considerations. Alternatively, a scheme using shoring towers to erect the side spans, and cantilever the main span field sections without the use of towers, may deserve consideration. Cross frames between girder lines are often utilized to provide for stability of the erected steel prior to placement of deck concrete.

A reinforced concrete top slab is an integral component of the structural cross section and acts compositely with the steel tub sections to resist bending stresses. Composite behavior is achieved with use of field welded shear studs, and the deck slab concrete is subsequently cast in place.

Scheme 5: Composite Steel Truss Bridge

It is envisioned that the variable depth side spans of the main span unit would be erected on shoring towers which could support a portion or all of the span steel weight. It is also envisioned that the variable depth main span would be erected in cantilever either concurrently with the side span erection or subsequent to completion of the side spans. Erection of a 300 foot truss span is well within the feasible range of established bridge construction technology.

Erection of the individual tubular truss sections could be done with crawler cranes and members connected together by field welded joints. It may be appropriate to consider the use of cast steel nodes at the member joints to simplify tubular member erection. Bolted splices would be used at the top chord connections. Bracing frames between truss lines and bottom chord lateral bracing would be erected in conjunction with chord, diagonal and strut members to provide for stability of truss assembly.

4.4 Conclusion

While challenges to construction of individual bridges were identified, none appeared to be fatal flaws. It is recommended that issues related to environmental resource agencies be addressed during subsequent project development stages.

5.0 Initial Bridge Types Eliminated from Further Consideration

At the second charette meeting with stakeholders on April 20, 2011, renderings of and information on the five bridges types identified in Section 3.2 of this memorandum were presented. As a result, two of the initial bridge types (through-girder and steel box girder) were eliminated from further consideration as noted below.

Concrete Through-Girder

The stakeholders indicated the height of this bridge type would be visually disruptive, especially if a higher profile over the river is the selected option. Also, a representative of the National Park Service stated the through-girder concept was a “no-go” from a scenic standpoint on a recent Wild & Scenic River bridge project.

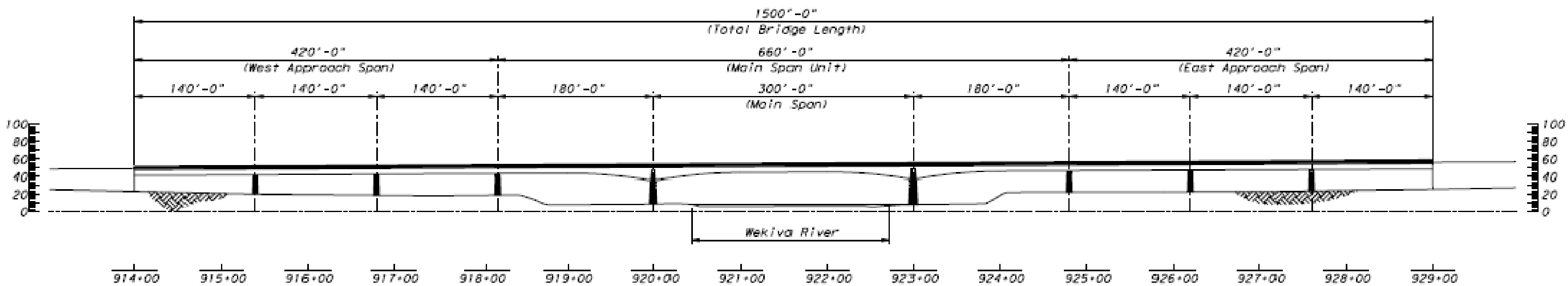
Steel Box “Tub” Girder

None of the stakeholders expressed support for this bridge type.

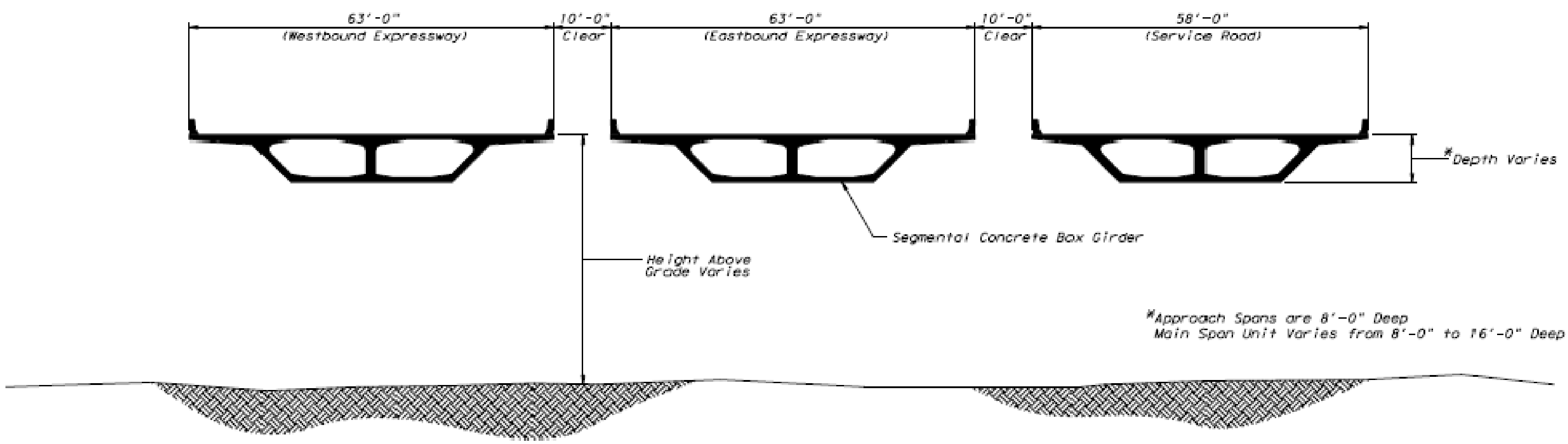
The renderings of the five bridges types that were presented at the second charette are shown in ***Appendix B (Exhibits 1 – 5)***.

Appendix A

Drawings



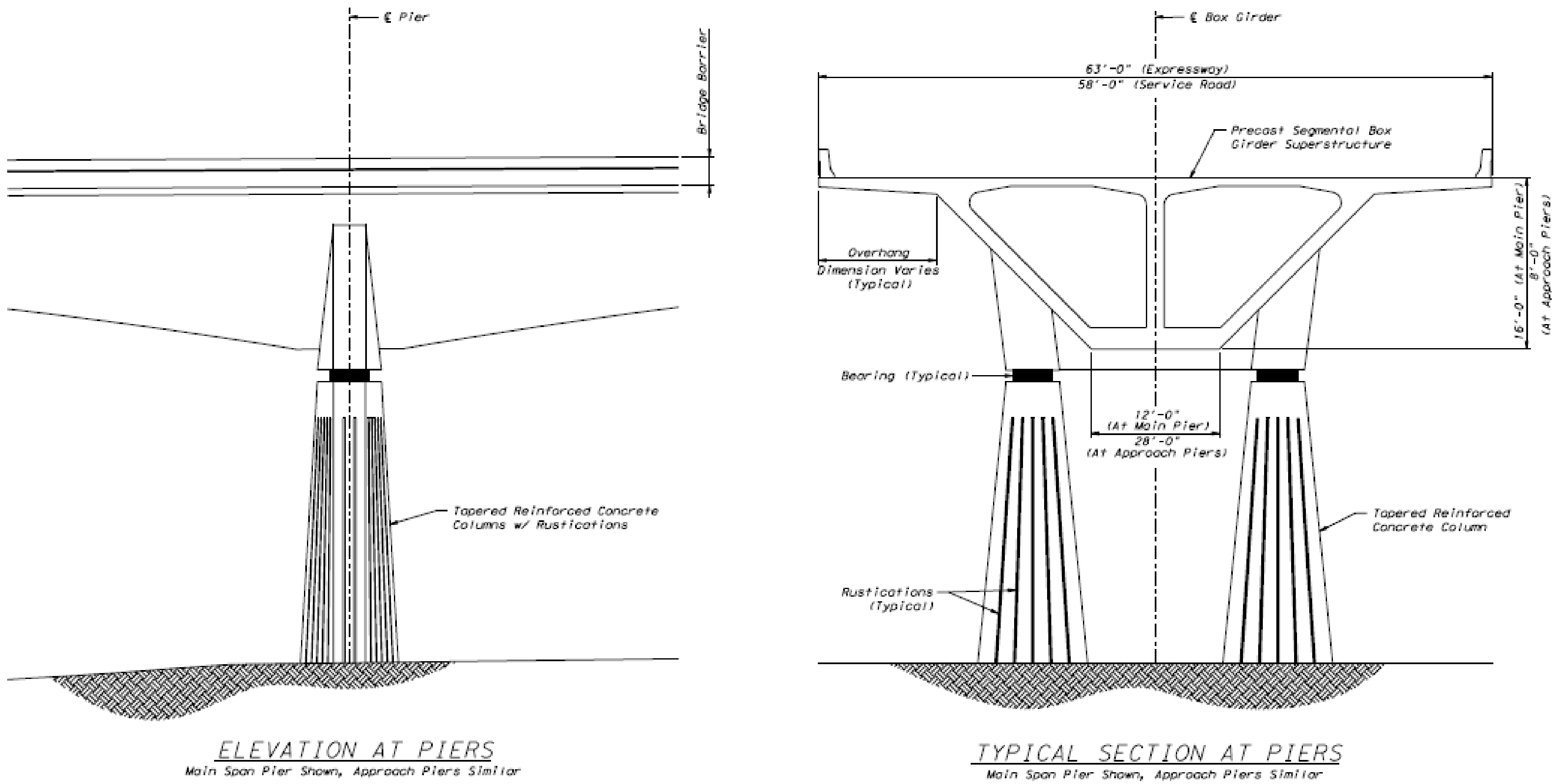
ELEVATION AND SPAN LAYOUT



TYPICAL SECTION

FIGURE 1 SEGMENTAL CONCRETE BOX GIRDER
BRIDGE SCHEME 1 - ELEVATION & TYPICAL SECTION

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



ELEVATION AT PIERS
Main Span Pier Shown, Approach Piers Similar

TYPICAL SECTION AT PIERS
Main Span Pier Shown, Approach Piers Similar

FIGURE 1A SEGMENTAL CONCRETE BOX GIRDER BRIDGE SCHEME 1 - PIER DETAIL

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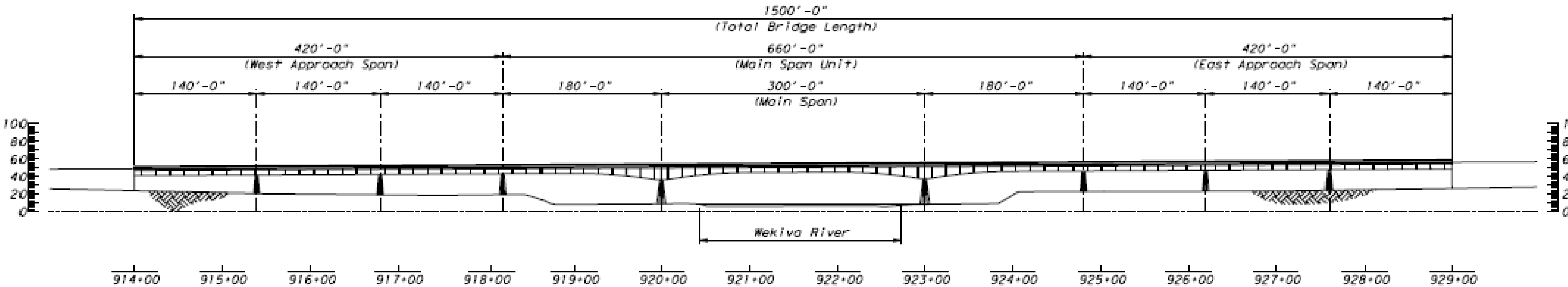
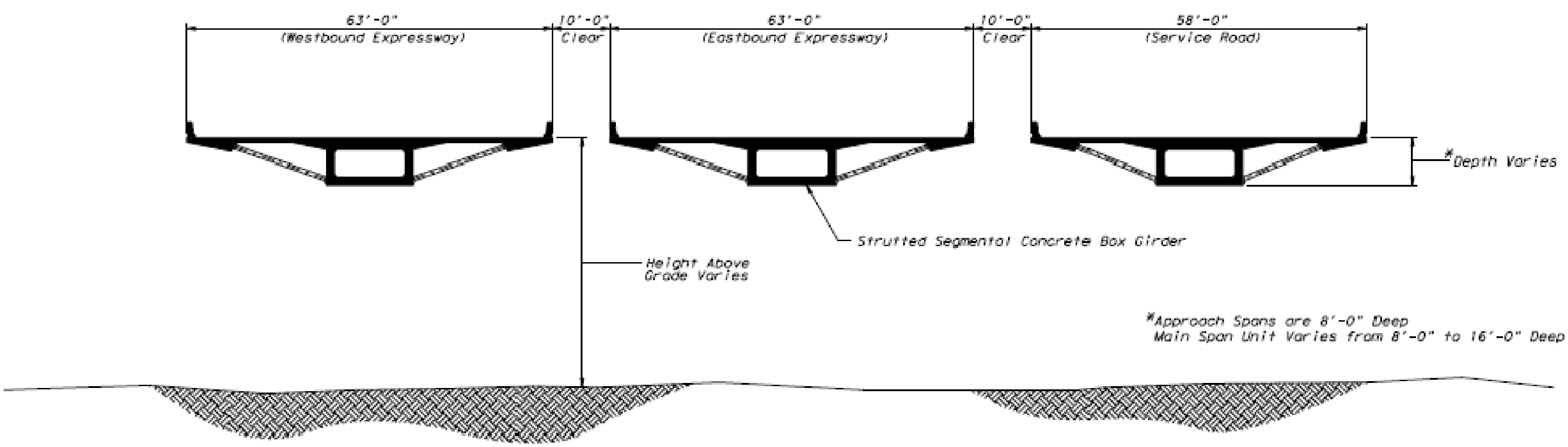


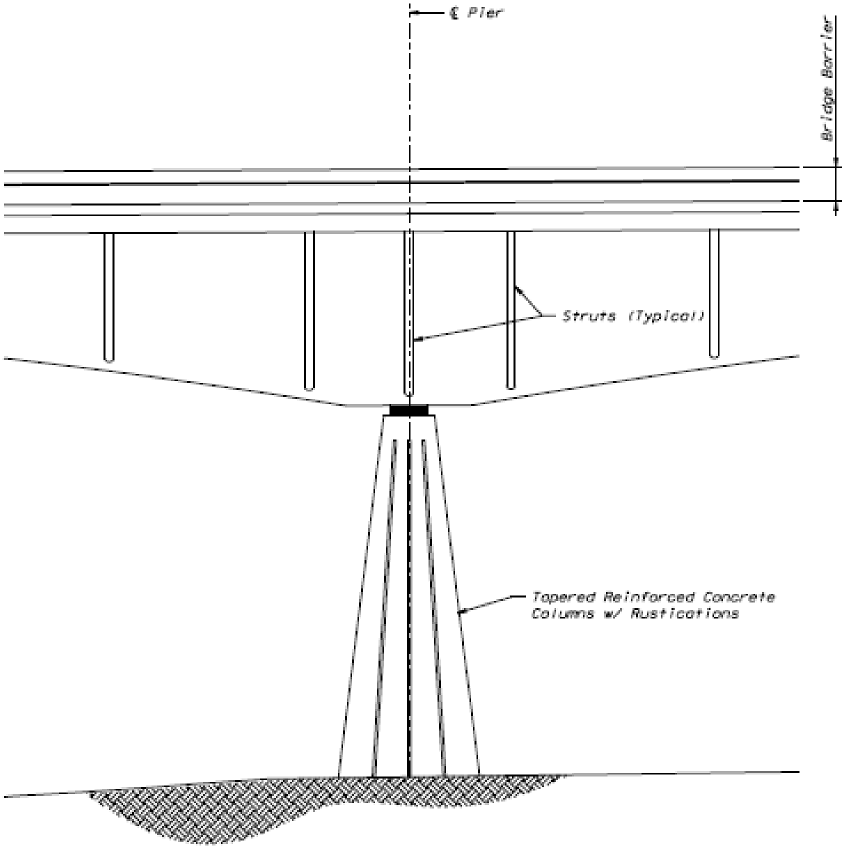
ELEVATION AND SPAN LAYOUT



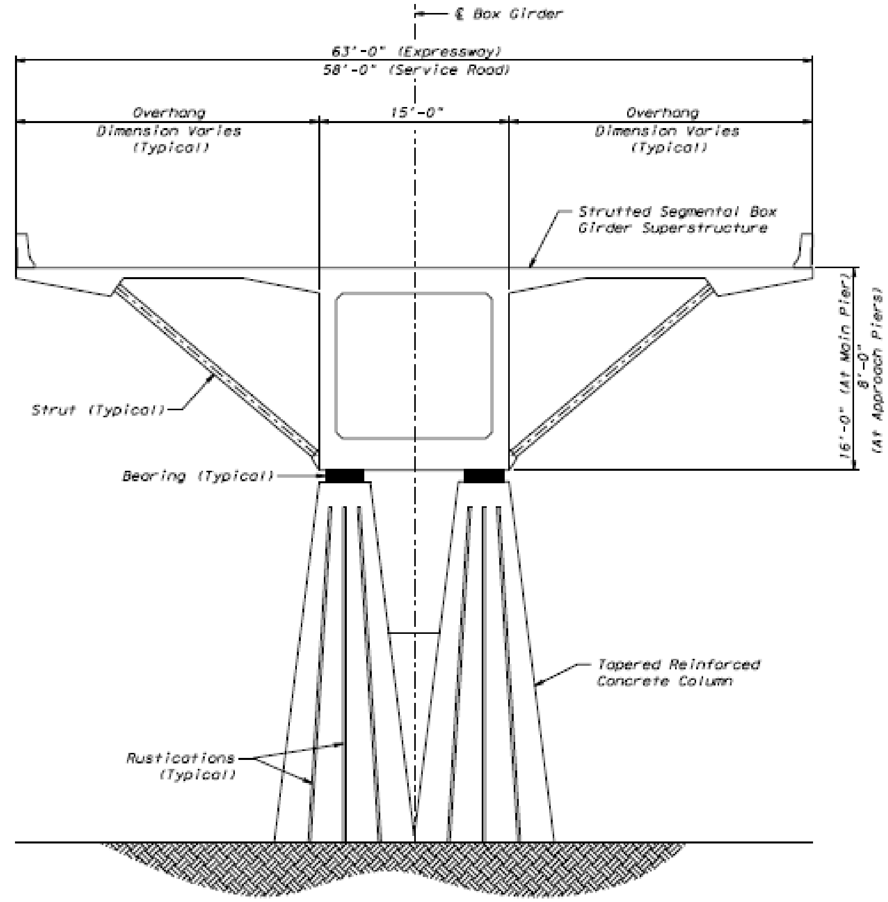
TYPICAL SECTION

FIGURE 2 STRUTTED SEGMENTAL CONCRETE BOX GIRDER
BRIDGE SCHEME 2 - ELEVATION & TYPICAL SECTION

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



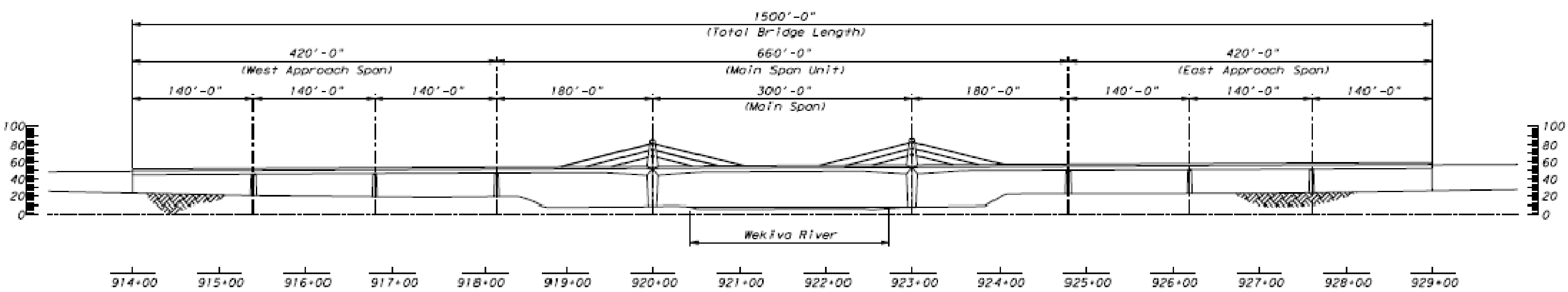
ELEVATION AT PIERS
Main Span Pier Shown, Approach Piers Similar



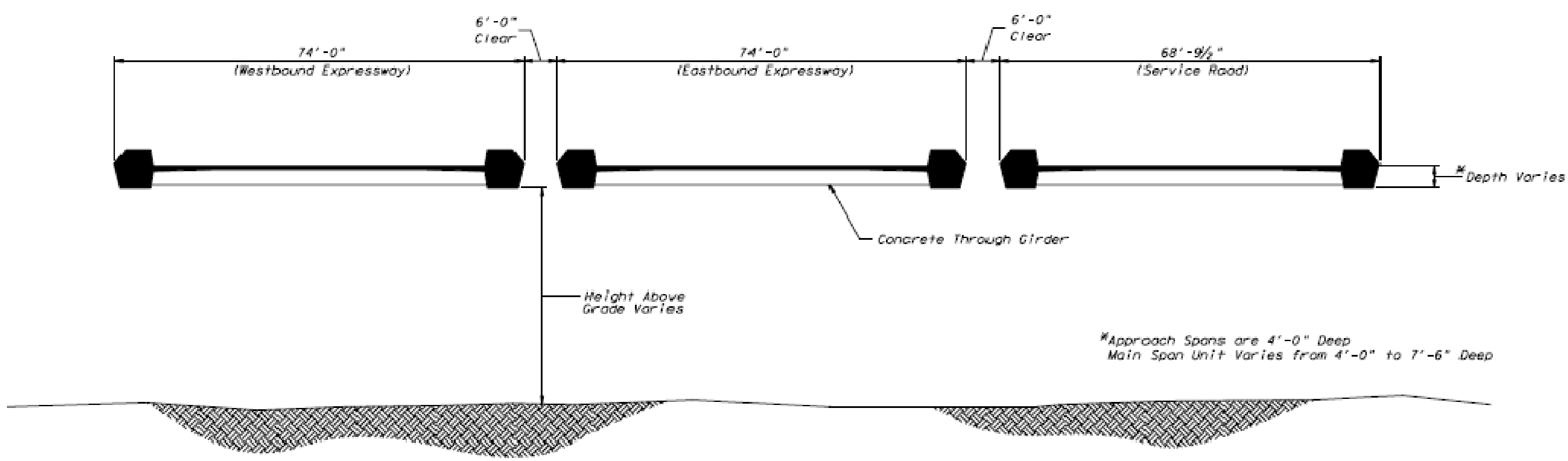
TYPICAL SECTION AT PIERS
Main Span Pier Shown, Approach Piers Similar

FIGURE 2A STRUTTED SEGMENTAL CONCRETE BOX GIRDER
BRIDGE SCHEME 2 - PIER DETAIL

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



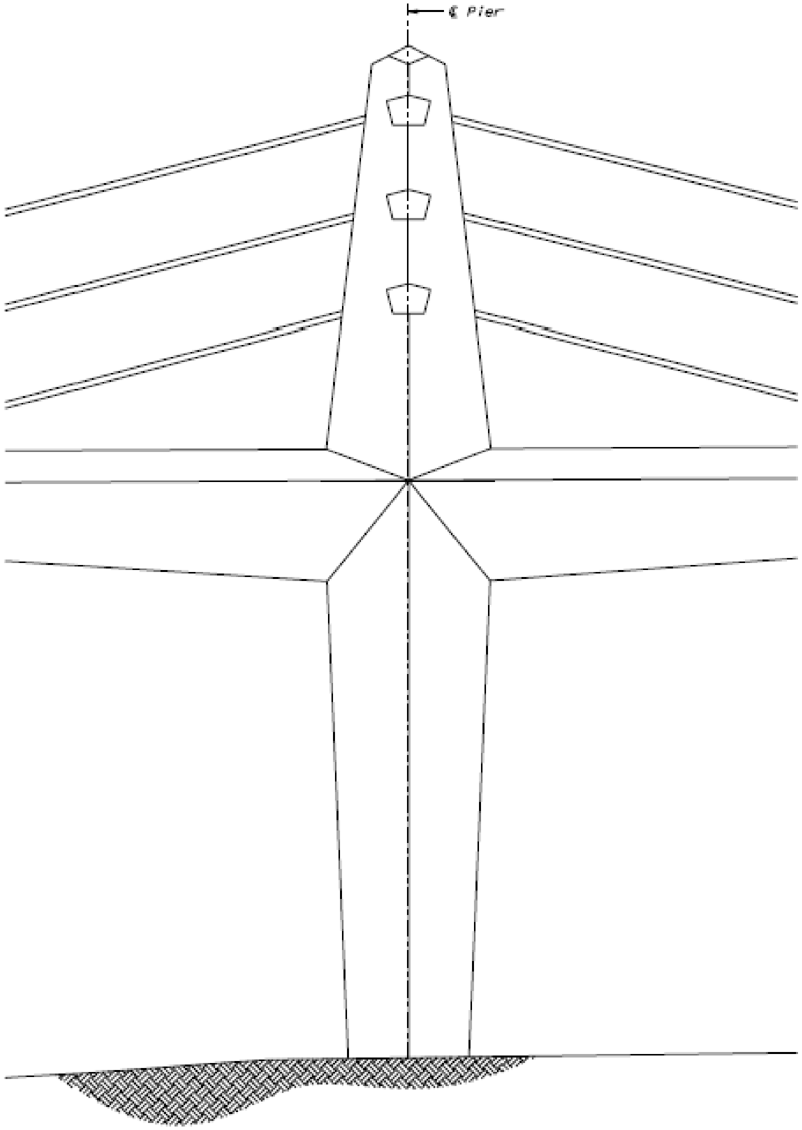
ELEVATION AND SPAN LAYOUT



TYPICAL SECTION

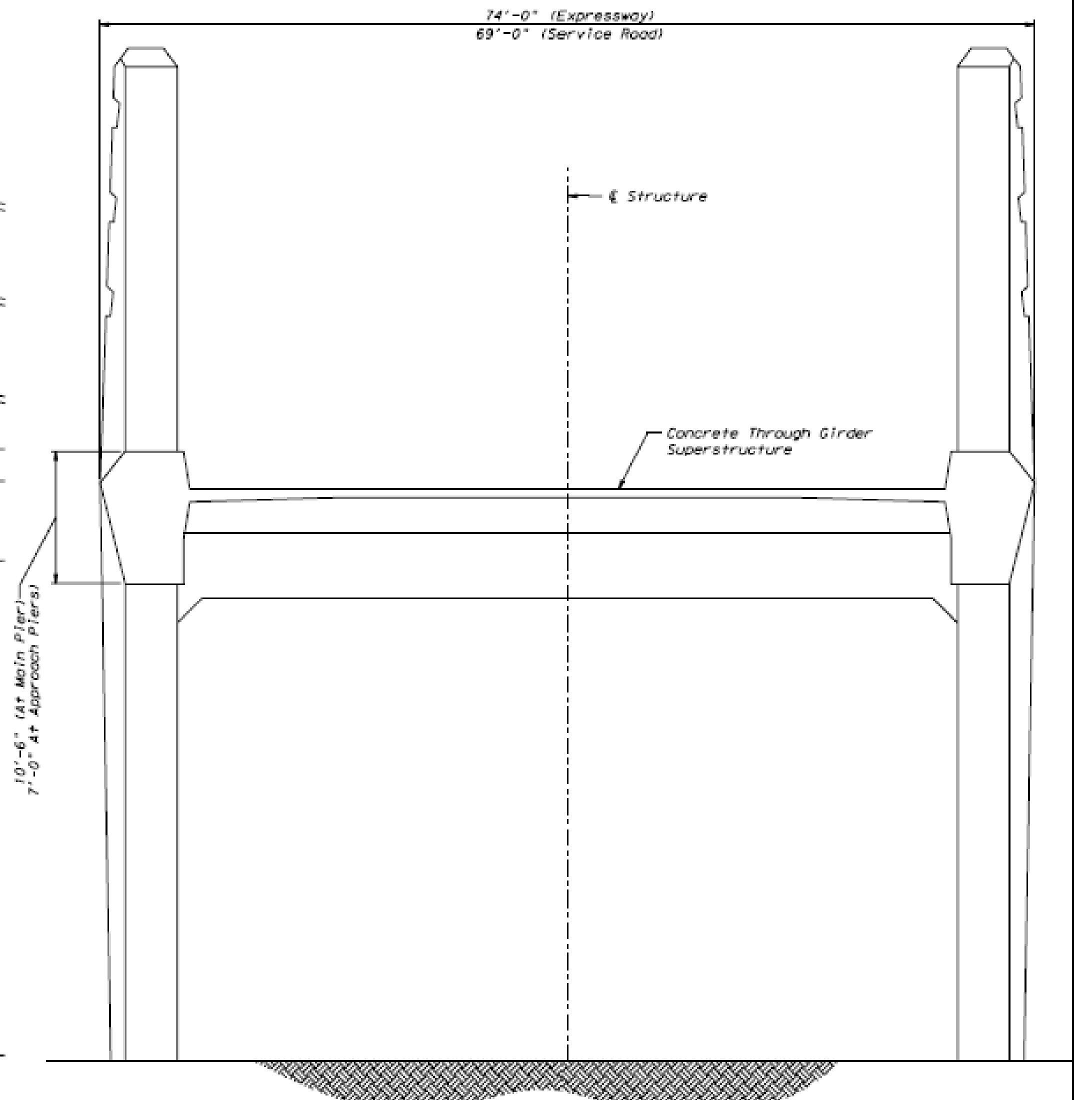
FIGURE 3 CONCRETE THROUGH-GIRDER
BRIDGE SCHEME 3 - ELEVATION & TYPICAL SECTION

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



ELEVATION AT PIERS

Main Span Pier Shown, Approach Piers Similar

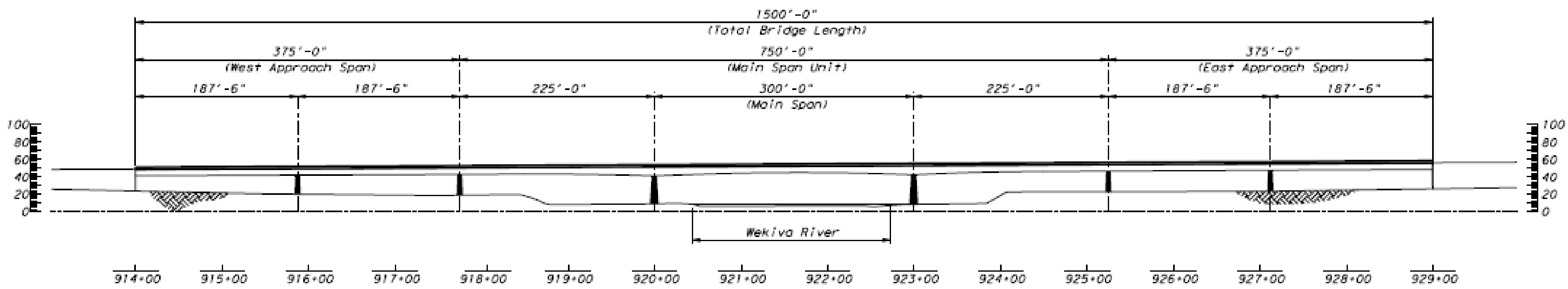


TYPICAL SECTION AT PIERS

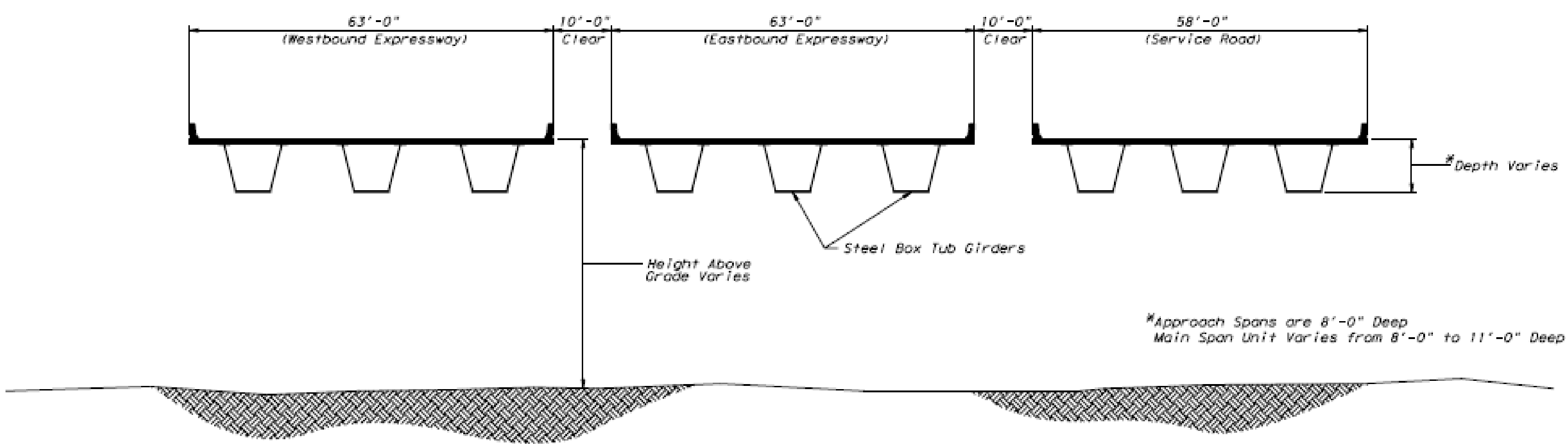
Main Span Pier Shown, Approach Piers Similar

FIGURE 3A CONCRETE THROUGH-GIRDER
BRIDGE SCHEME 3 - PIER DETAIL

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



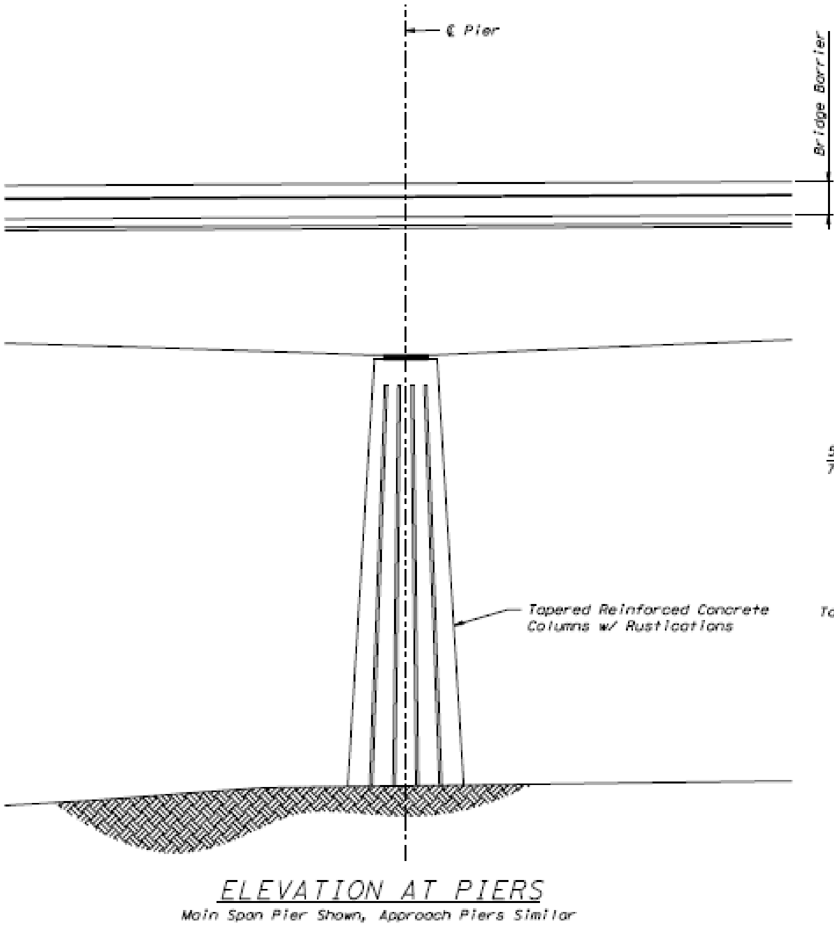
ELEVATION AND SPAN LAYOUT



TYPICAL SECTION

FIGURE 4 STEEL BOX "TUB" GIRDERS
BRIDGE SCHEME 4 - ELEVATION & TYPICAL SECTION

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



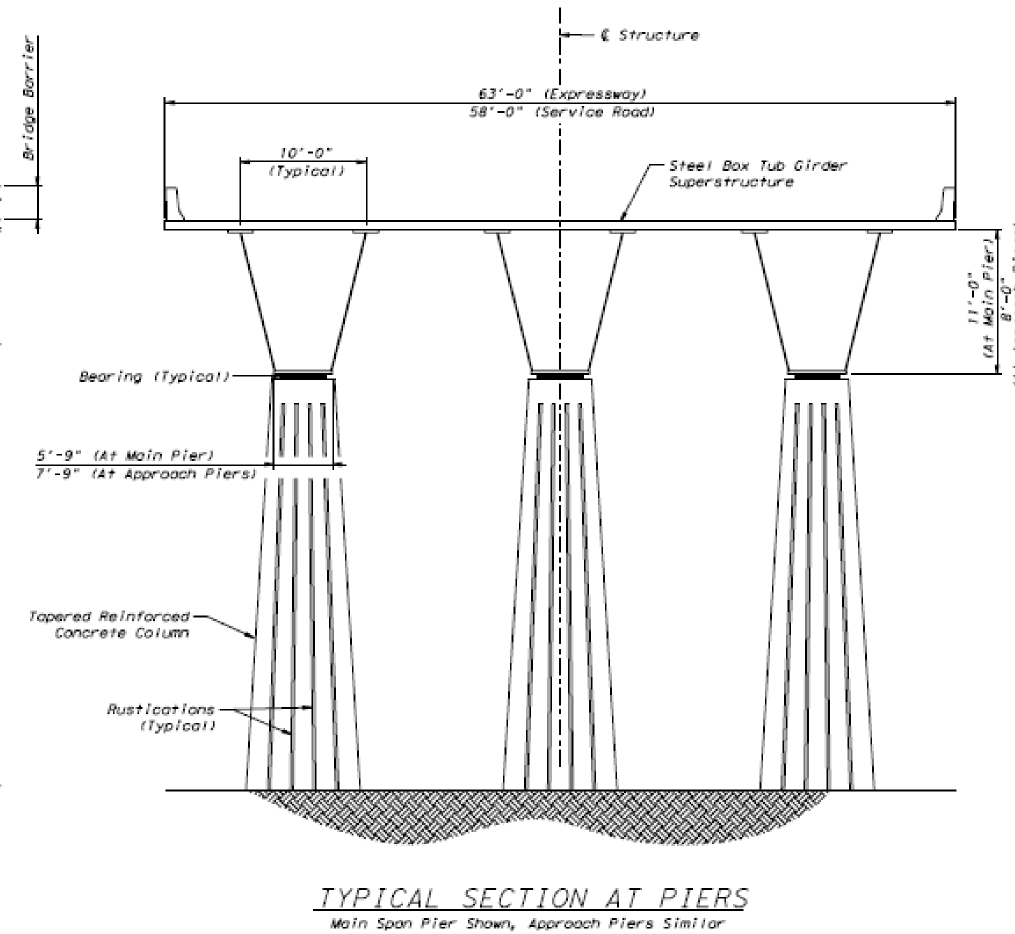


FIGURE 4A STEEL BOX "TUB" GIRDERS
BRIDGE SCHEME 4 - PIER DETAIL

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY

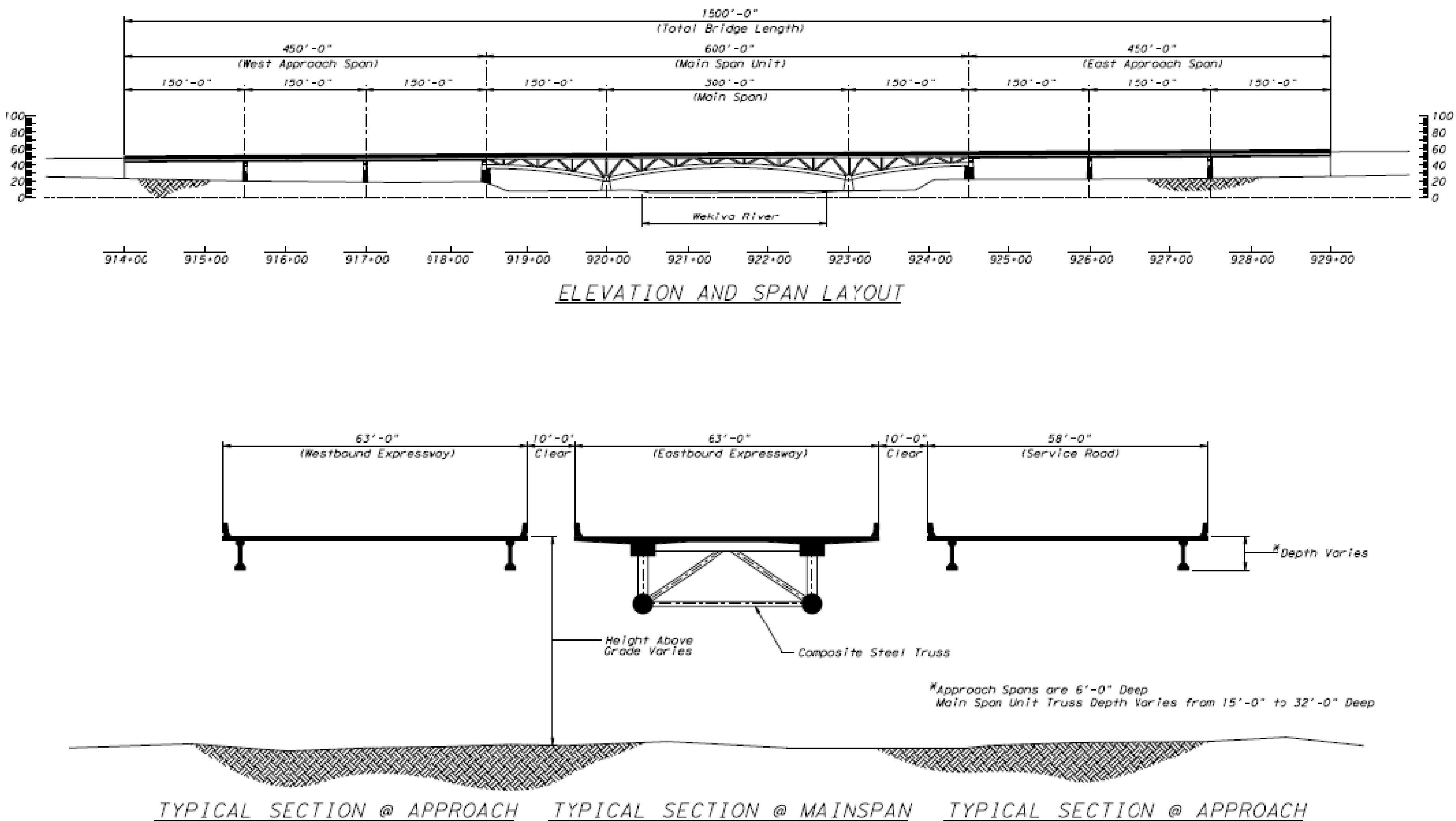
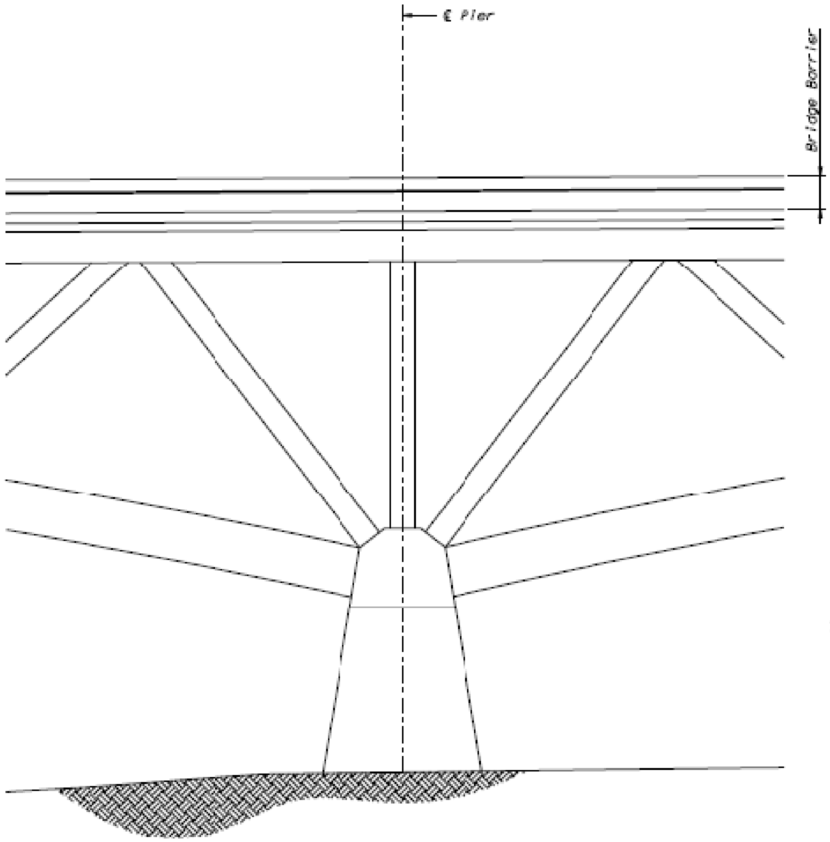
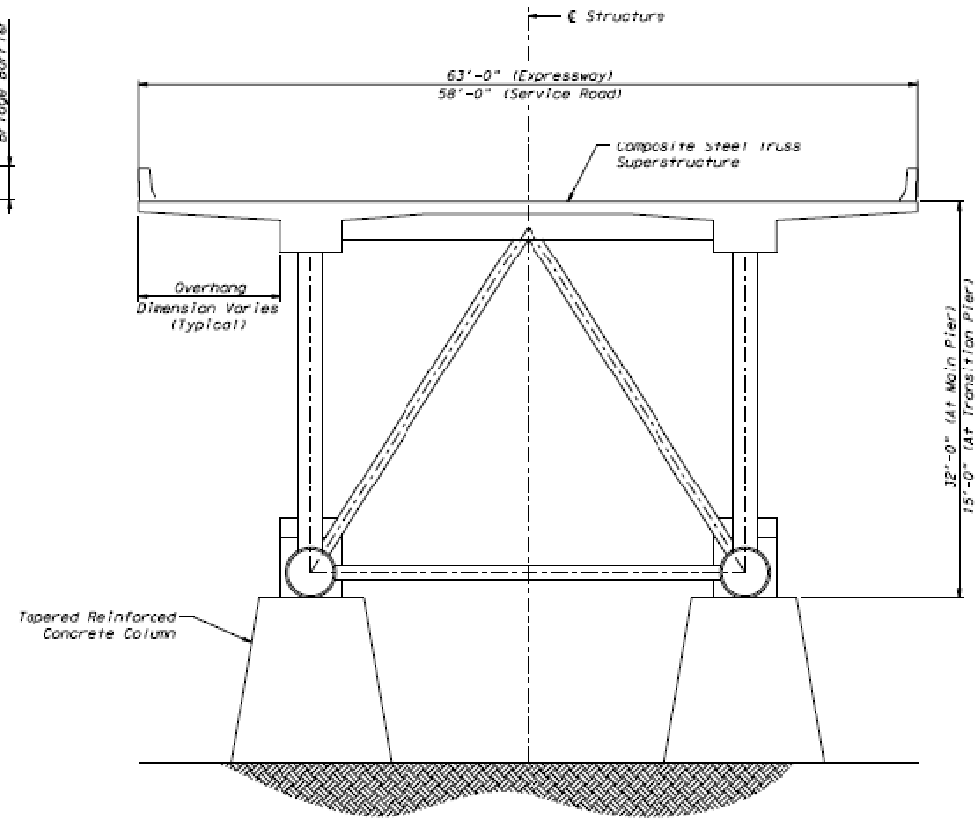


FIGURE 5 COMPOSITE STEEL TRUSS
BRIDGE SCHEME 5 - ELEVATION & TYPICAL SECTION

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



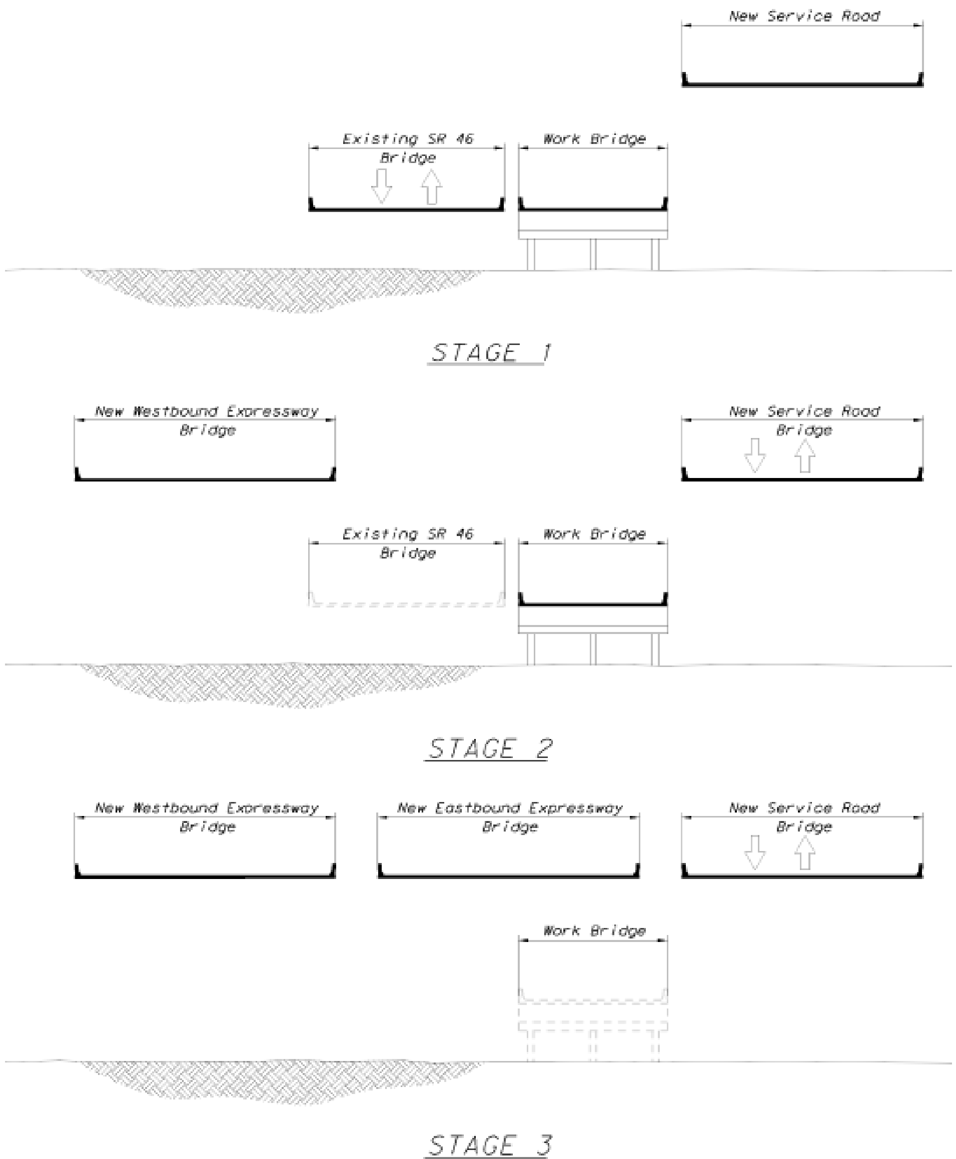
ELEVATION AT PIERS
Main Span Pier Shown, Approach Piers Similar



TYPICAL SECTION AT PIERS
Main Span Pier Shown, Approach Piers Similar

FIGURE 5A COMPOSITE STEEL TRUSS
BRIDGE SCHEME 5 - PIER DETAIL

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY



STAGE 1

- Construct Work Bridge South of Existing SR 46 Bridge.
- Construct New Service Road Bridge.

STAGE 2

- Move SR 46 Traffic onto Service Road and Bridge.
- Construct New Westbound Expressway Bridge.
- Remove Existing SR 46 Bridge.

STAGE 3

- Construct New Eastbound Expressway Bridge while removing Work Bridge.
- Open New Bridges and Roadway to Traffic.

FIGURE 6
CONSTRUCTION PHASING

APRIL 15, 2011
WEKIVA RIVER BRIDGE STUDY

Appendix B

Renderings

Exhibit 1…… Segmental Concrete Box Girder

Exhibit 2…… Strutted Segmental Concrete Box Girder

Exhibit 3…… Concrete Through-Girder

Exhibit 4…… Steel Box "Tub" Girders

Exhibit 5…… Composite Steel Truss

Exhibit 1 – Segmental Concrete Box Girder

Exhibit 2 – Strutted Segmental Concrete Box Girder


Exhibit 3 – Concrete Through-Girder


Exhibit 4 – Steel Box “Tub” Girders


Exhibit 5 – Composite Steel Truss