

To: James Pitman, P.E.  
District 2 Design Engineer

Date: Oct. 30, 2009

Subject: DESIGN VARIATION; [Reduced minimum crest vertical curve lengths]

Financial Project ID: 209294-1-56-01, 209293-2-52-01, 209294-1-52-01 New Const. (X) RRR ( )  
Federal Aid Number: Yes  
Project Name: SR 9B from SR 5/US 1 (Philips Hwy) to SR 9A.  
State Road Number: SR 9B Co./Sec./Sub. 72002  
Begin Project MP: 2.451 End Project MP: 5.476  
Full Federal Oversight: Yes (X) No ( )  
Request for Design Exception ( ), Design Variation (X)

Requested for the following element(s):

( ) Design Speed ( ) Lane Widths ( ) Shoulder Widths ( ) Bridge Widths  
( ) Structural Capacity ( ) Vertical Clearance ( ) Grades ( ) Cross Slope  
( ) Superelevation ( ) Horizontal Alignment (X) Vertical Alignment ( ) Stopping Sight Distance  
( ) Horizontal Clearance ( ) Other \_\_\_\_\_

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Project Overview:

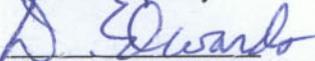
The SR 9B project in Duval County consists of the construction of 3.025 miles of a divided 70 mph four-lane roadway. This roadway begins with a proposed half-diamond interchange connection at SR 5/ US 1, southeast of Jacksonville, heads north, and ends with a new systems interchange at SR 9A. The 9B highway will have 400' of LAROW and an 88' median. Interstate criteria are being used. It has a proposed FIHS classification. The existing SR 9A median was widened when built, with the expectation to receive this project's systems connection with SR 9B. In the ultimate future it is expected that SR 9B will be eight lanes.

Proposed Variation Overview:

This variation recommends allowing two existing SR 9A 1000' crest Vertical Curve Lengths to remain within the new interchange, even though they would be less than the 1800' crest minimum lengths required per PPM I-2.8.2. A Variation was not needed before, as the SR 9A / SR 9B interchange didn't exist. However, the construction of the new SR 9A / SR 9B interchange will include the existing SR 9A 1000' vertical curves within its limits. Stopping sight distances and "K" values would still be maintained. Per AASHTO, once the "K" values are met, the minimum curve length is only an aesthetic requirement. Construction time and Maintenance of Traffic would be improved by granting this variation.

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Recommended by:

  
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Approvals:

  
James Pitman, P. E.  
Date 11-20-09  
District 2 Design Engineer  
Florida Dept. of Transportation

## DESIGN VARIATION

### Project Description:

The SR 9B project in Duval County consists of the construction of 3.025 miles of a divided 70 mph four-lane roadway. This roadway begins with a proposed half-diamond interchange connection at SR 5/ US 1, southeast of Jacksonville, heads north, and ends with a new systems interchange at SR 9A. The 9B highway will have 400' of LAROW and an 88' median. Interstate criteria are being used. It has a proposed FHHS classification. The existing SR 9A median was widened when constructed, with the expectation to receive this project's systems connection with SR 9B. The existing SR 9A project at the proposed interchange is in a 7% superelevation. In the ultimate future it is expected that SR 9A will be six lanes and SR 9B will be eight lanes.

### Design Criteria:

Current FDOT design criteria for Interstates requires a minimum crest vertical curve length of 1000' for open highways and an 1800' vertical curve length within interchanges [per 2009 PPM, Vol. I, page 2-47, Table 2.8.5]. This table also goes on to state that for a 70 mph Arterial, the minimum crest curve length would be 500'. Lastly it states for "All Facilities" "The lengths of crest vertical curves are not to be less than 3 times the design speed (mph) expressed in feet." It is the 1800' interchange minimum vertical curve length that would not be met.

### Proposed Criteria:

This variation proposes to keep the existing SR 9A vertical curve geometry for the two 1000' crest vertical curve lengths. The existing "K" values of these curves are as follows; NE bound, from sta 128+00 @ +0.303% to 138+00 @ - 0.000% for a "K" of 3,300; and SW bound, 337+00 @ +0.496% to 347+00 @ -1.165% for a "K" of 602. Both of these "K" values are greater than the 70 mph Interstate crest "K" value of 506 required in PPM I-2.8.2, Table 2.8.5.

### Reason for the design variation:

- A) The 2004 AASHTO, pg 265, recommends that vertical curves "...be designed to provide at least the stopping sight distances shown in Exhibit 3-1", pg 112. [This distance would be provided by meeting the standard "K" values.] It also notes that the curves be "...safe and comfortable, pleasing in appearance and adequate for drainage".
- B) On pg 276 AASHTO notes "...special attention to drainage should be exercised where values of "K" in excess of 167 are used." The concern here is that high "K" values arise from longer curves and flatter profiles. Flattening the grades by going from 1000' to an 1800' crest vertical curve could cause drainage problems, i.e. silt or sand deposition, and ponding in the shoulder gutter due to variations or inaccuracy in constructing such nearly flat longitudinal slopes.
- C) On the bottom of page 274, AASHTO goes on to state "On high-type highways, longer curves are appropriate to improve appearance." This confirms that these longer curves are aesthetic in nature and not safety related.
- D) If 8 lanes are expected on SR 9A & SR 9B in the future, then the median will likely have median barrier and the outside have retaining walls with shoulder barriers. This means that there will be more paved drainage areas that will convey water longitudinally along a barrier rather than mostly laterally to a 1:6 slope or gutter. Proposing longer, flatter curves may not have much of a negative drainage impact now, but it will have a more detrimental drainage affect for the future.
- E) Revising the profile to provide for 1800' vertical curves would require lowering [reconstructing] the existing crests and/or overbuilding the approaches. This would increase construction time and add additional Maintenance of Traffic impacts.

### Recommendation:

Based on the above rationale, it is recommended to allow the two existing SR 9A 1000' Vertical Curve Lengths to remain within the new interchange. Stopping sight distances and "K" values would still be maintained. Per AASHTO, once the "K" values are met, the minimum curve length is only an aesthetic requirement. Construction time would be reduced and Maintenance of Traffic would be improved by granting this variation. This Design Variation will not reduce the roadway's capacity nor adversely affect driver safety.

To: James Pitman, P.E.  
District 2 Design Engineer

Date: Dec. 01, 2009

Subject: DESIGN VARIATION; [Reduced Border Widths]

Financial Project ID: 209294-1-56-01, 209293-2-52-01, 209294-1-52-01 New Const. (X) RRR ( )  
Federal Aid Number: Yes  
Project Name: SR 9B from SR 5/US 1 (Philips Hwy) to SR 9A.  
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Begin Project MP: 2.451 End Project MP: 5.476  
Full Federal Oversight: Yes (X) No ( )  
Request for Design Exception ( ), Design Variation (X)

Requested for the following element(s):

- ( ) Design Speed
- ( ) Lane Widths
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- ( ) Bridge Widths
- ( ) Structural Capacity
- ( ) Vertical Clearance
- ( ) Grades
- ( ) Cross Slope
- ( ) Superelevation
- (X) Horizontal Alignment
- ( ) Vertical Alignment
- ( ) Stopping Sight Distance
- ( ) Horizontal Clearance
- ( ) Other \_\_\_\_\_

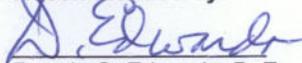
Project Overview:

The SR 9B project in Duval County consists of the construction of 3.025 miles of a divided 70 mph four-lane roadway. This roadway begins with a proposed half-diamond interchange connection at SR 5 / US 1, southeast of Jacksonville, heads north, and ends with a new systems interchange at SR 9A. The 9B highway will have 400' of LAROW and an 88' median. Interstate criteria are being used. It has a proposed FIHS classification. The ROW for the SR 9B project has already been purchased based on prior plans. In the ultimate condition it is expected that SR 9B will be eight lanes in each direction and SR 9A will be 6 lanes in each direction.

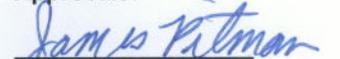
Proposed Variation Overview:

This variation recommends allowing the SR 9B Border Width [ the distance from the outside travel lane to the LAROW line.] to be reduced below the 94' required per PPM I-2.5.1. The alternative is to acquire additional ROW from the adjacent property owners. These property owners were impacted previously when FDOT acquired ROW to accommodate the design from the previous 90% plans. The border width near Ramp B1, exiting southwest from SR 9B to SR 5/ US 1 would be reduced to 50'. The border width on the southeast side of the 9A/9B interchange would be reduced to 50' and on the southwest side of the 9A/9B interchange it would be reduced to around 50'. Along the existing pond on the northwest side of the interchange, it would be reduced to 82'. No negative impacts to Highway Maintenance or roadside Drainage are expected from granting this variation.

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**Approvals:**

  
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Date 12-2-09  
District 2 Design Engineer  
Florida Dept. of Transportation

## DESIGN VARIATION

### Project Description:

The SR 9B project in Duval County consists of the construction of 3.025 miles of a divided 70 mph four-lane roadway. This roadway begins with a proposed half-diamond interchange connection at SR 5/ US 1, southeast of Jacksonville, heads north, and ends with a new systems interchange at SR 9A. The highway will have 400' of LAROW and an 88' median. Interstate criteria are being used. The existing SR 9A median was widened when built, with the expectation to receive this project's systems connection with SR 9B. The existing 9A project at the proposed interchange is in 7% superelevation. In the ultimate condition it is expected that SR 9A will be six lanes and SR 9B will be eight lanes.

### Design Criteria:

Current FDOT design criteria for Limited Access Facilities in PPM I-2.5.1, requires the Border Width, (the distance from the outside travel lane to the LAROW line) to be 94' wide. The 2004 AASHTO, pg 508 states "The typical range in widths of outer separations is 25 to 45 m [80' to 150'], but much narrower widths may be used in urban areas if retaining wall are employed." The old standard LAROW width for Interstates was 300' which came from a 64' median, two 24' roadways and 94' border widths to the LAROW.

### Proposed Design:

Based on the current ROW available and the latest interchange concept from District 2 there are four locations where the border width would be less than 94'.

- A) The border width near Ramp B1, exiting SW from SR 9B to SR 5/ US 1 would be reduced to 67'+/-. The station limits for the reduction are 581+90.00 to 590+64.00. The border reduction is proposed due to the fact that the ROW for this project is already acquired and the B1 off-ramp terminal laneage was increased to dual lefts, a through and a right. This turn lane widening could not be made to the inside of the interchange because of the proposed loop ramp in that NW quadrant. To allow for possible shifts in final design, a request is made for a border width of 50' at this location.
- B) The border width on the southeast side of SR 9B approaching the 9A/9B interchange would be reduced to 65.30'. The station limits for the reduction are 2376+06.00 to 2403+05.00 right. To allow for possible shifts in final design a request is made for a border width here of 50'.
- C) The border width on the southwest side of SR 9B approaching the 9A/9B interchange would be reduced to 52.30'. The station limits for the reduction are 1392+29.00 to 1394+71.00. To allow for possible shifts in final design a request is made for a border width here of 50'.
- D) The border width on the northwest side of SR 9A approaching the 9A/9B interchange, alongside of the existing 9A pond, would be reduced to 82.0'. The station limits for the reduction are from BL Constr 9A sta 325+00 to 339+51.59-Back & 4339+51.59-Ahead to 4345+00 BL Constr SR 9A Left. To avoid impacting the pond, the roadway should not move further outward than the calculated 82' minimum border width.

### Reason for the design variation:

- A) One alternative is to acquire more ROW from the adjacent property owners again to achieve the 94' desired width. This has some obvious drawbacks, including time delays. This project is part of the ARRA funding and has strict guidelines for project completion which could be jeopardized should this project require going through the ROW acquisition process again. Cost is another drawback. Considering that this project is funded through ARRA, should ROW be required, these additional costs would need to be encumbered, thus reducing the scope of work that can be constructed.
- B) No negative impacts to Highway Maintenance or roadside Drainage are expected from granting this variation.

### Recommendation:

Based on the above rationale, it is recommended that the reduced Border Width be allowed to avoid another impact to the adjacent property owners. This Design Variation will not reduce the roadway's capacity nor adversely affect Maintenance or driver safety.

To: James Pitman, P.E.  
District 2 Design Engineer

Date: Nov. 19, 2009

Subject: DESIGN VARIATION; [Compound Curve Ratio]

Financial Project ID: 209294-1-56-01, 209293-2-52-01, 209294-1-52-01      New Const. (X) RRR ( )  
Federal Aid Number: Yes  
Project Name: SR 9B from SR 5/US 1 (Philips Hwy) to SR 9A.  
State Road Number: SR 9B      Co./Sec./Sub. 72002  
Begin Project MP: 2.451      End Project MP: 5.476  
Full Federal Oversight: Yes (X) No ( )  
Request for Design Exception ( ), Design Variation (X)

Requested for the following element(s):

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- ( ) Structural Capacity      ( ) Vertical Clearance      ( ) Grades      ( ) Cross Slope
- ( ) Superelevation      (X) Horizontal Alignment      ( ) Vertical Alignment      ( ) Stopping Sight Distance
- ( ) Horizontal Clearance      ( ) Other \_\_\_\_\_

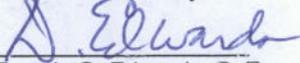
Project Overview:

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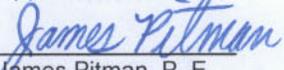
Proposed Variation Overview:

This variation recommends allowing the SR 9B southbound off-ramp to US 1 to have a compound horizontal curve at the exit gore that exceeds the maximum 1.5:1 compound curve radius ratio as noted in PPM I-2.8.1.1, pg 2-42. This variation would be temporary until such time as the SR 9B mainline continues over US 1. No negative impacts to traffic operations or safety are expected from granting this variation.

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**Approvals:**

  
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Date 12-2-09  
District 2 Design Engineer  
Florida Dept. of Transportation

## DESIGN VARIATION

### Project Description:

The SR 9B project in Duval County consists of the construction of 3.025 miles of a divided 70 mph four-lane roadway. This roadway begins with a proposed half-diamond interchange connection at SR 5/ US 1, southeast of Jacksonville, heads north, and ends with a new systems interchange at SR 9A. The highway will have 400' of LAROW and an 88' median. Interstate criteria are being used. The existing SR 9A median was widened when built, with the expectation to receive this project's systems connection with SR 9B. The existing 9A project at the proposed interchange is in 7% superelevation. In the ultimate condition it is expected that SR 9A will be six lanes and SR 9B will be eight lanes.

### Design Criteria:

Current FDOT design criteria for the use of compound curves is found in the 2009 PPM I-2.8.1.1, pg 2-42. It says "The use of compound curves in horizontal alignment should be avoided where simple curves can be used. When compound curves are necessary on open highways, the ratio of the flatter radius to the sharper radius should not exceed 1.5:1. For turning roadways and intersections a ratio of 2:1 (where the flatter radius precedes the sharper radius in the direction of travel) is acceptable." It also says, "The length of compound curves for turning roadways when followed by a curve of one-half radius or preceded by a curve of double radius, should be as shown in Table 2.8.2b", pg 2-44. Table 2.8.2b, "The arc length in feet of Compound Curves-----Turning Roadways", uses radii of 100', 150', 200', 250', 300', 400' and  $\geq 500'$ .

In 2004 AASHTO, pg 164 it states "When the design speed of the turning roadway is 45 mph or less, compound curvature can be used to form the entire alignment of the turning roadway. When the design speed exceeds 45 mph, the exclusive use of compound curves is often impractical, as it tends to need a large amount of ROW. Thus, high-speed turning roadways follow the interchange ramp design guidelines in Chapter 10 and include a mix of tangents and curves. By this approach, the design can be more sensitive to ROW impacts as well as to driver comfort and safety."

From the AASHTO quote it seems that the 1.5:1 curve ratio is intended to apply only to roadways with design speeds of 45 mph or less. PPM Table 2.8.2b seems only intended for curve radii less than 800' or 1000'. It could be that the compound curve ratio limit is not applicable for this higher speed, larger radii case.

### Proposed Design:

Based on the current ROW available and the latest interchange concept there are two phases for the design of the SB off-ramp to US 1.

- A) The initial phase is when SR 9B starts and ends at US 1 as a half-diamond interchange. At that time, both of the SB mainline lanes will be directed to the two lanes of the SB off-ramp using striping and a large 6171.00' radius curve from a PT at 598+60.81 to a PCC [Point of Compound Curve] at 590+64.00 which is near the ramp's, 19' wide, physical gore area. There will be an "All Traffic Must Exit" sign in advance of this curve. At the PCC point, traffic follows a smaller 1432.00' radius curve to a PC of 581+20.01. There the two lanes split into dual left, a through and right storage lanes before ending at the crossroad, US 1. The ratio of these two curves is 6171'/1432' or 4.31:1 which exceeds the 1.5:1 ratio allowed.
- B) In a later, final phase, SR 9B will be built to continue southward over US 1 and the SB exit ramp will stay a two lane exit ramp. The exit ramp will consist of a parallel auxiliary lane and the outside through lane on SR 9A will be an option lane. The outside through lane, auxiliary lane and exit ramp will have a 3% cross slope. The exit ramp or aux lane will have a 4 +/- degree deflection angle near 594+61.65, as required in Index 525. It will tie into the initial ramp tangent to the 1432' radius curve near 591+23.96. To minimize the chance of any exit ramp queues backing up onto the mainline, the exit ramp was extended some 1400' northward ending at SR 9B station 210+95.00, which is the south end of a 750' mainline bridge. This phase does not propose to use compound curves at the exit so no variation is needed for the permanent final phase, only for the initial phase.

However, the initial exit ramp construction will follow the outside alignment of the wider, future single aux lane exit with the 4 degree deflection angle. Building the wider paved area now will avoid constructing narrow widening concrete pavement strips in the later phase. This wider future-use aux lane pavement and taper will be striped out initially.

### Reason for the design variation:

- A) One alternative to the proposed variation in the initial phase would be to not use the 6171' radius exit curve at all but to use the standard 4 degree exit angle proposed for use in the final phase but keep two exit lanes. Both SB mainline lanes of traffic could be shifted over 12' using a 70:1 taper in advance of the exit. This would close the inside SB lane and put the outside lane on the future aux lane. However, while one could argue that a 4 degree deflection is too large without using a curve, this is the standard design angle used for all off-ramps. The "All Traffic Must Exit" sign plus a SB speed reduction to 40 or 45 mph ahead of the 4 degree "gore" should alert all drivers that

they will be using an off-ramp. This does not work because this is not a typical exit but rather a continuation of the mainline (posted speed 70 mph) and reduction of speed to 50 mph for the first curve ( $R=6171'$  where  $e=0.03$  ft/ft). This speed reduction to 50 mph allows the cross slope of the mainlines and auxiliary lane, to be constructed at 0.03 ft/ft which matches the normal cross slope for SR 9B and the future expansion over SR 5 (US1). The pavement design for this project calls for concrete pavement; therefore, it is important to design this temporary exit such that the reconstruction of the mainline is avoided/minimized in the area of the exit.

- B) Another alternative to the proposed variation would again be to not use the larger 6171' curve but a radius of near 2084'. This would have an acceptable curve ratio of 1.455 : 1. This could start near the 24' outside mainline EOP at sta 195+60 SB [or 594+50 on the ramp stationing] and form a PCC with the 1432' curve near 589+00. This doesn't work because the outside through lane and auxiliary lane need to be constructed at 0.03 ft/ft cross slope to accommodate the future expansion of SR 9B over SR 5 (US1). The use of a 2084' radius would require a 0.05 ft/ft cross slope requiring reconstruction of SR 9B mainline for the future expansion over SR 5. This becomes increasingly difficult and costly for the future expansion because the pavement is concrete.
- C) Since no other alternative seems viable, exceeding the 1.5:1 horizontal curve ratio limit is proposed.
- D) No negative impacts to traffic operations or safety are expected from granting this variation.

**Recommendation:**

For the above reasons, it is recommended that the higher horizontal compound curve ratio be allowed for this temporary initial phase. This Design Variation will not adversely affect traffic operations or driver safety.