# SHRP Implementation Planworks

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# Route 29 Corridor

**COR-6 (Task 4) – Develop a Range of Candidate Solution Sets**

**Draft Report**

**10/17/2016**

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# Task 4 – Develop a Range of Candidate Solutions Sets

## Introduction

This document describes in detail the four (4) candidate solution sets developed for the Route 29 corridor that were previously introduced in documentation of *Tasks 1, 2, and 3.1*. Each solution set has been designed to include a combination of geometric improvements, access management measures and land use development provisions. Developed using information provided in the Campbell County Route 29 Corridor Assessment - Public Workshop #1 and #2, the improvements incorporated into each solution set have been analyzed using methodologies for evaluating safety (Crash Modification Factors (CMF) Clearinghouse), capacity (Highway Capacity Manual and SimTraffic), travel time reliability (Smart Scale), and efficiency (Access Management Manual). The findings of the analysis are intended to serve as a resource for interaction with stakeholders and the public in the process of moving to *Task 5 – Develop a Preferred Solution Set*.

### Potential Funding Sources

Potential funding sources are listed below in order to identify funding streams for the proposed solution elements within this document. Due to the type and relevance of each solution element presented, the Highway Safety Improvement Program and Smart Scale are the most likely candidates for sources of funding. Other traditional (i.e. STP) and non-traditional (i.e. STBG) funding sources are available in addition to HSIP and Smart Scale. Both HSIP and Smart Scale focus heavily on safety improvement and the relative value each proposed project creates versus other candidate projects.

#### *Highway Safety Improvement Program (HSIP)*

The HSIP is funded through the Highway Account of the Highway Trust Fund. The goal of HSIP is to reduce traffic fatalities and serious injuries on all roadways through a data-driven process. Every state is required to develop a Strategic Highway Safety Plan (SHSP) that addresses key emphasis areas for improving safety on all roadways. The State of Virginia developed a SHSP for 2012 – 2016 and identified six areas of focus based on the safety data collected. These areas include crashes involving speeding, young drivers, occupant protection, alcohol, roadway departures, and intersections. Any Highway Safety Program proposed project is required to be submitted with a detailed project description and a benefit/cost analysis. Projects are eligible for HSIP funding after meeting the required benefit/cost ratio greater than 1.0. However, funding is not guaranteed, as other factors such as crash reduction, project cost, project timeframe, and the validation of the improvement are taken into consideration. Both non-motorized transportation projects and public-at-grade crossing surface improvement projects are funded through the Bike and Pedestrian Safety Program (BPSP) and the Highway-Rail Grade Crossing Safety Program (H-RGCP).[1]

#### *Smart Scale*

Smart Scale stands for **S**ystem for the **M**anagement and **A**llocation of **R**esources for **T**ransportation, and the key factors used in evaluating a project's merits: improvements to **s**afety, **c**ongestion reduction, **a**ccessibility, **l**and use, **e**conomic development and the environment. It has been used by VDOT for

[1] Virginia Department of Transportation. *Highway Safety Improvement Program (HSIP)*. 2016.

evaluating and prioritizing candidate improvement projects for funding. The law establishing Smart Scale (Virginia House Bill 2) requires that projects be scored based on how they address 6 evaluation factors: safety, congestion mitigation, accessibility, environmental quality, economic development, and land use coordination (for areas greater than 200,000 in population). The scoring system used to measure the merits of individual projects considers a set of performance measures that reflect how well each project addresses these factors. To compute the total improvement score, the individual scores for each factor are weighted by measures as seen in **Figure 1** below.

| Factor Areas | Measure ID | Measures |
|---|---|---|
| Safety | S.1 | Number of Fatal and Injury Crashes (50%) |
| | S.2 | Rate of Fatal and Injury Crashes (50%) |
| Congestion Mitigation | C.1 | Person Throughput (50%) |
| | C.2 | Person Hours of Delay (50%) |
| Accessibility | A.1 | Access to Jobs (60%) |
| | A.2 | Access to Jobs for Disadvantaged Persons (20%) |
| | A.3 | Access to Multimodal Choices (20%) |
| Environmental Quality | E.1 | Air Quality and Environmental Effect (50%) |
| | E.2 | Impact to Natural and Cultural Resources (50%) |
| Economic Development | ED.1 | Project Support for Economic Development (60%) |
| | ED.2 | Intermodal Access and Efficiency (20%) |
| | ED.3 | Travel Time Reliability (20%) |
| * Land Use | L.1 | Transportation-Efficient Land Use (100%) |

* For areas over 200,000 in population

Figure 1: Smart Scale Evaluation Measures[2]

The weight of each evaluation measure depends on defined PDC-MPO[3] factor weighting typology category for the location of the project. The Route 29 corridor study area is within the Central Virginia Metropolitan Planning Organization (CVMPO) which is defined as Category C for the PDC-MPO Factor Weighting Typology for Smart Scale. For the evaluation measures listed in **Figure 1**, ranking project funding grant applications within the Lynchburg District are based on the following set of factors and weights:

| Factor | Weight |
|---|---|
| Economic Development | 25% |
| Safety | 25% |
| Accessibility | 25% |
| Congestion Mitigation | 15% |
| Environmental Quality | 10% |
| Land Use[4] | 0% |

The analysis of each solution in this document is concentrated on the safety factor area as well as travel time reliability. The travel time reliability factor is estimated as part of economic development factor. The Smart Scale evaluation measures within the safety category were evaluated using appropriate CMFs

[2] Virginia Department of Transportation. *Project Evaluation and Scoring*. 2016.
[3] Planning District Commission – Metropolitan Planning Organization
[4] Land Use not included because Lynchburg MPO Area population does not exceed 200,000.

based on the type of solution. Specifically, for each applicable solution the **E**quivalent **P**roperty **D**amage **O**nly (EPDO) rate of fatal and injury crashes that would be expected to be reduced by implementation of the solution **(S1)** and the EPDO rate of fatal and injury crashes per million vehicles mile traveled (VMT) expected to be reduced **(S2)** was calculated. S1 and S2 are both measure values that are then given a score based on the comparison to the highest value within the safety evaluation measure. The measure score is a percentage of the highest value (the highest value measure is given a score of 100 percent). A measure weight is applied to each measure score, for safety, S1 and S2 have a weighting factor of 50% each and summed up to achieve the raw factor score. The raw factor is then multiplied by the percentage assigned to the specific evaluation measure; safety is 25% of the total Smart Scale benefit score based on our study area location. The weighted score for safety can then be added to the other evaluation measures (congestion mitigation, accessibility, environmental quality, and economic development) weighted scores. The final result is the project score which is "divided by the Smart Scale-funded cost of the project (in $10 millions) to determine the value of score for every dollar invested."[5]

Smart Scale evaluation methods have been used as a model to evaluate the safety and reliability of solution sets developed for the Route 29 corridor. Smart Scale provides quantitative methods for evaluating safety and reliability performance measures.

### Travel Time Reliability Improvement

Travel time reliability is one of the economic development measures in the Smart Scale process. The intent of this measure is to determine the expected impact of a project on improving travel time reliability which supports efforts to retain businesses and increase economic activity.

The corridor travel time reliability index was estimated for each solution set element, where applicable, using the approach described in the Smart Scale Implementation Policy Guide. This approach is not applicable to bicycle/pedestrian projects.

The Smart Scale uses a quantitative, corridor-based analysis to estimate projects' effect on travel time reliability. The recommended methodology includes two components: impact and frequency. Impact is defined as the ability of a project to reduce the impact of highway incidents and weather related events. Frequency is defined as the likelihood of unanticipated delays due to highway incidents and weather events.

The Smart Scale process uses the following equation to compute travel time reliability scoring index:

*Travel Time Reliability Index (TTR) =*
*Buffer Time Index *[(Incidents impact factor * Incident frequency) + (Weather impact factor * Weather frequency)]*

*Task 1* that was previously submitted estimated that Buffer Time Index (BTI) varies between 0.23 and 0.25 during the peak period for the corridor. This study adapts the corridor level BTI of 0.25 to estimate TTR for all solution sets. The BTI of 0.25 means that travelers should plan for 2

[5] Virginia Department of Transportation. *Smart Scale Technical Guide*. 2016.

to 3 minutes of additional travel time to arrive on-time more than 90 percent of time. Smart Scale process suggests using Equivalent Property Damage Only (EPDO) value as a surrogate measure to determine the incident frequency. For weather frequency, it was assumed that the corridor experience between 20 and 40 hours of combined moderate/severe snow and flood events per year.

Table 10.8 of the Smart Scale Implementation Policy Guide was used to identify crash and weather impact factors. This table includes limited number of major and sub project types. Therefore, engineering judgment was used to select the best class for the elements included in each of the solution sets to determine incident and weather impact factors.

To calculate a combined TTR, EPDOs were summed for all the elements and compared to the Smart Scale Implementation Policy Guide's thresholds. Therefore, the combined TTR is not necessarily equal to the sum of TTRs for all the elements.

The values for the EPDO rate of fatal and injury crashes that would be expected to be reduced **(S1)**, the EPDO rate of fatal and injury crashes per million vehicles mile traveled (VMT) expected to be reduced **(S2)**, and the TTR Index is shown for all solution set elements within this document.

## 2040 No Build Forecasted Conditions

Future year 2040 No Build conditions have been develop and evaluated to serve as a baseline to evaluate the benefits of each solution set. Forecasts of future year 2040 traffic volumes were developed using the Lynchburg metropolitan area travel demand model, and the model roadway network used to develop the No Build forecast does not include any of improvements in the solution sets – hence the designation "No Build." The forecasted year 2040 No Build conditions volumes were then analyzed to evaluate capacity along the corridor.

Based on the output of the travel demand model, to forecast year 2040 volumes, a growth factor of 1.29 (29% growth) was applied to existing volumes at the intersections at English Tavern Road (northern connection), Lawyers Road, Russell Woods Drive, and Liberty Mountain Drive and a growth factor of 1.54 (54% growth) was applied at the intersections at Calohan Road and Colonial Highway.

**Table 1** displays a summary of the Highway Capacity Manual (HCM) 2000 analysis for the 2040 No Build forecasted conditions and existing conditions along the Route 29 corridor from Liberty Mountain Drive to Colonial Highway in Campbell County. The existing conditions signalized intersection capacity analysis was discussed in the previous submitted *Task 3* documentation and it is displayed again in **Table 1** for comparison purposes to the 2040 No Build (NB) forecasted conditions. The 2040 No Build forecasted conditions are referenced throughout this document in specific solutions in order to compare and contrast travel conditions along the Route 29 corridor. Travel Time is also displayed for both the existing conditions and 2040 No Build forecasted conditions. Travel time was recorded from SimTraffic for both the northbound and southbound direction through the 6 intersections along this corridor. Motorists moving in the northbound direction experience a longer travel time in comparison with those in the southbound direction in both the AM and PM peak hour for both the existing and 2040 No Build forecasted conditions.

**Table 1**
**HCM 2000 Signalized Intersection Analysis/ SimTraffic Travel Time**
**Route 29 Corridor: 2040 NB Forecasted Conditions and Existing Conditions**

| Scenario | Travel Time (min.) | | Overall Intersection Delay/Veh. (sec.) (LOS) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | NB Rte. 29 | SB Rte. 29 | Rt. 29 & Liberty Mountain Drive | Rt. 29 & Russell Woods Drive | Rt. 29 & Lawyers Road | Rt. 29 & English Tavern Road | Rt. 29 & Calohan Road | Rt. 29 & Colonial Highway |
| **AM Peak Hour** | | | | | | | | |
| Existing Conditions | 9.21 | 8.07 | 13.7 (B) | 8.3 (A) | 15.1 (B) | 20.2 (C) | 21.4(C) | 21.5 (C) |
| 2040 NB Forecasted Conditions | 10.76 | 8.75 | 19.8 (B) | 22.2 (C) | 29.6 (C) | 43.6 (D) | 68.0 (E) | 43.8 (D) |
| **PM Peak Hour** | | | | | | | | |
| Existing Conditions | 9.53 | 8.62 | 17.8 (B) | 12.6 (B) | 21.9 (C) | 19.0 (B) | 19.1 (B) | 18.0 (B) |
| 2040 NB Forecasted Conditions | 10.47 | 9.80 | 27.3 (C) | 20.0 (B) | 33.6 (C) | 25.6 (C) | 33.1 (C) | 32.8 (C) |

For the 2040 No Build forecasted conditions, the intersection of Liberty Mountain Drive and Route 29 exhibits LOS B in the AM peak hour and LOS C in the PM peak hour. In the AM peak hour, the movements with higher delay at this intersection are the southbound left movement (LOS F) as well as the westbound and eastbound movements (LOS E). In the PM peak hour, the side street movements are similar to the AM peak hour exhibiting LOS E. However, the southbound left movement exhibits LOS D with less volume in the PM peak hour.

The intersection of Russell Woods Drive at Route 29 exhibited LOS C in the AM peak hour and LOS B in the PM peak hour. In the AM peak hour, the movements with higher delay at this intersection are the southbound left movement (LOS D) and southbound right movement (LOS E) as well as the westbound and eastbound movements (LOS E). In the PM peak hour, the eastbound shared through and left movement exhibits LOS F and both the eastbound right and westbound movement exhibits LOS E.

The Lawyers Road at Route 29 intersection displays a LOS C in both the AM and PM peak hour. In the AM peak hour, the eastbound movement exhibits LOS F and the northbound left movement exhibits LOS E. In the PM peak hour, both the eastbound movement and westbound shared through/left movement operate with LOS F. The northbound left movement and southbound left movement also exhibits LOS E.

The intersection of English Tavern Road (northern connection) at Route 29 exhibits LOS D in the AM peak hour and LOS C in the PM peak hour. In the AM peak hour, the eastbound movement exhibits LOS

E and the westbound right movement exhibits LOS D. The northbound through movement operates at LOS D in both peak hours. In the PM peak hour, the eastbound movement and westbound movements operates at LOS E.

The Calohan Road at Route 29 intersection exhibits LOS E with 68.0 seconds of delay in the AM peak hour and 33.1 seconds of delay (LOS C) in the PM peak hour. In the AM peak hour, the southbound left movement and westbound right movement exhibits LOS F. In the PM peak hour, the southbound and westbound left movement operates at LOS E and the northbound left movement operates at LOS F. This intersection has heavy conflicting volumes for the protected southbound left, northbound through, and westbound right movements in both peak hours, especially in the AM peak hour.

At the southernmost end of the corridor is the intersection of Route 29 at Colonial Highway. The AM peak hour exhibits LOS D and the PM peak hour operates at LOS C. In the AM peak hour, the eastbound shared through and left movement operates at LOS F. In the PM peak hour, all movements operate at LOS D or better.

## Rt. 29 Bypass Discussion

A Bypass for the Route 29 corridor has been discussed and studied for at least the past two decades. The fact that it has never progressed beyond the planning stages demonstrates its relative value versus other transportation priorities in the region and state. A Route 29 bypass is an extremely high cost improvement that will not provide a commensurate high value return on the investment. A general planning level estimate to bypass the 6.4 mile study area is in excess of $100,000,000 (using VDOT planning level values assuming a 6 mile 4-lane divided highway including ROW and utility costs). To provide perspective, the total current regional surface transportation funding provided to the entire region (Amherst County, Bedford County, Campbell County, and the City of Lynchburg) is only approximately $137,000,000 through the year 2040 (CVLRTP). New alignment will also have substantial environmental impacts. Traffic growth through the year 2040 is only expected to generate an additional 29% volume over the existing conditions. This level of growth can be mitigated with low cost access management measures. All of these reasons led to the conclusion that a bypass is not a feasible improvement option at this time.

## U.S. 460 Interchange Discussion

The current configuration of the U.S. Route 460 Exit Ramp to southbound Route 29 makes it difficult for vehicles desiring to turn left onto Liberty Mountain Drive. This is due to the short merging distance (around 512 feet) and vehicles having to cross 2 lanes of traffic to reach the left turn lane. Outlined in the *Chandlers Mountain Road Ramp Study*, a preferred alternative is recommended to construct a new off-ramp from eastbound U.S. Route 460 to Liberty Mountain Drive located near Liberty University. The new off-ramp would create a safer access point to Liberty Mountain Drive from eastbound U.S. Route 460 and eliminate most of the existing weaving traffic.

## Solution Set 1: Arterial Capacity and Throughput

The solutions identified in Solution Set 1 are displayed in **Figures 1-1, 1-2, 1-3, and 1-4**. The figures include the entire Route 29 study area from the U.S. Route 460 interchange ramps to the Route 24 Colonial Highway intersection.

### Solution Set 1 - Closure of Median Crossovers

Eight (8) potential median crossover closures have been identified to address safety and access management concerns along the corridor. Median closures have been proposed primarily on the basis of failure to comply with VDOT Access Management guidelines spacing requirements. The crossovers that are candidates for closure include: Anstey Road, Residential Access #3 (1,130 ft south of Patterson Road), Leland Road, Wetbanks Drive, Lyn-Dan Drive, Flat Creek Baptist Church Access, Wards Road North, and Rangoon Street.

Anstey Road – The access to Anstey Road from Route 29 will be closed as well as the median crossover. The west end of Anstey Road will be converted into a cul-de-sac, and motorists will be able to access Route 29 at Moorman Mill Road.

Residential Access #3 (1,130 ft south of Patterson Road) – This median crossover serves two residential properties. With the closure of this crossover, motorists will be able to use the median crossover located directly to the north (at Patterson Road) or another crossover located approximately 1,510 feet to the south.

Leland Road – The median crossover at Leland Road provides access to English Tavern Road and Hyland Heights Baptist Church. The proposed closure would create an additional access point from English Tavern Road to Route 29 (See **Figure 1-3**).

Wetbanks Drive – The median crossover serves a small residential area off of Route 29. With the closure of this crossover, motorists can use either median crossover located directly north at English Tavern Road or directly south at Industrial Circle.

Lyn Dan Drive – This median crossover serves a few businesses and a small residential area off of Route 29. With the closure of this crossover, motorists can use the existing signal at Lawyers Road to south or the crossover at Baker Road to the north where turn lane improvements are proposed.

Flat Creek Baptist Church – This median crossover serves the left-in entrance into Flat Creek Baptist Church on Route 29. With the closure of this crossover, motorists accessing and departing the church can use either the existing signal located directly north at Russell Woods Drive or the median crossover located directly south at Baker Road where turn lane improvements are proposed.

Wards Road North – The median crossover located at Wards Road North and Route 29 is located directly next to the overpass for the Norfolk Southern railroad which creates potential safety hazards for vehicles turning onto Wards Road North and making U-turns due to sight distance issues. Vehicles traveling southbound on Route 29 could instead access Wards Road North by the existing signal at Russell Woods Drive.

Rangoon Street – The closure of the median crossover at Rangoon Street is to realign the access at Route 29 with Terminal Drive. Motorists will then access Route 29 by the existing signal at Terminal Drive/Liberty Mountain Drive. For motorists on Rangoon Street looking to the south, the sight distance is obstructed by a slight vertical curve and the Norfolk Sothern railroad bridge barrier rail among other obstructions. A project to replace the northbound bridge over the railroad without added capacity is currently in the VDOT FY 2016 Six Year Improvement Program (UPC 104600).

As shown in **Table 2,** thirty-four (34) existing access points are within the study area limits on Route 29. After access management principles are applied along the corridor and median crossovers and full access entrances are closed, the number of access points will be reduced to 26.

The Crash Modification Factor (CMF) for the change in unsignalized cross roads is calculated as:

$$e^{0.0269(Y-X)}$$

Where X = existing number of access points
Y = future number of access points.

## Table 2
## Route 29 Corridor Access Points

| Existing Type | Access Name (by Road or Business) | Access Distance to nearest Roadway | Proposed Closure (Y/N) |
|---|---|---|---|
| Signalized Intersection | **Route 24 Colonial Hwy Signal** | - | N |
| Full Median Crossover | **BP Access** | 480 ft north of Route 24 | N |
| Full Median Crossover | **Anstey Rd.** | - | Y |
| Median Crossover without Turn Lanes | **Residential #1** | 630 ft north of Anstey Rd. | N |
| Full Median Crossover | **Moorman Mill Rd.** | - | N |
| Median Crossover without Turn Lanes | **Residential #2** | 2,460 ft north of Moorman Mill Rd | N |
| Median Crossover without Turn Lanes | **Residential #3** | 1,130 ft south of Patterson Rd. | Y |
| Full Access Entrance | **Patterson Rd.** | - | N |
| Full Access Entrance | **Antiques to Envy, Inc. Access** | 680 ft north of Patterson Rd. | N |
| Full Median Crossover | **Pick N Save Access** | 1,220 ft south of Calohan Rd. | N |
| Signalized Intersection | **Calohan Rd. Signal** | - | N |
| Full Median Crossover | **English Tavern Rd. (Southern Connection)** | - | N |
| Full Median Crossover | **Leland Rd.** | - | Y |
| Full Access Entrance | **Lynbrook Rd.** | - | N |
| Full Median Crossover | **Allendale Cir/Bennie's Homes Access** | - | N |
| Full Median Crossover | **Hyland Dr.** | - | N |
| Full Access Entrance | **Nature Stop** | 1,575 ft north of Hyland Dr. | N |
| Full Access Entrance | **Industrial Cir.** | - | N |
| Full Access Entrance | **Webanks Dr.** | - | Y |
| Full Median Crossover | **Powell's Truck Equipment Access** | 1,220 ft south of English Tavern Rd. | N |
| Signalized Intersection | **English Tavern Rd. (Northern Connection) Signal** | - | N |
| Full Median Crossover | **Watson Dr./Farm Service Company Access** | - | N |
| Full Access Entrance | **Food Lion Shopping Center Access** | 530 ft south of Lawyers Rd. | N |
| Signalized Intersection | **Lawyers Rd. Signal** | - | N |
| Full Access Entrance | **Lyn-Dan Dr.** | - | Y |
| Full Median Crossover | **Wooldridge Heating & Air, Inc. Access** | 470 ft south of Baker Rd. | N |
| Full Access Entrance | **Baker Rd.** | - | N |
| Full Access Entrance | **Flat Creek Baptist Church Access** | 700 ft south of Russell Woods Dr. | Y |
| Signalized Intersection | **Russell Woods Drive Signal** | - | N |
| Full Access Entrance | **Wendy's** | 570 ft north of Russell Woods Drive | N |
| Full Access Entrance | **Wards Rd. North** | - | Y |
| Full Median Crossover | **Rangoon St.** | - | Y |
| Full Access Entrance | **Comfort Inn & Suites Access** | 500 ft south of Liberty Mountain Dr. | N |
| Signalized Intersection | **Liberty Mountain Dr. Signal** | - | N |

The CMF for the closure of unsignalized cross roads is only applicable for fixed object, run off road, and single vehicle crash types.[6] The future number of access points along the Route 29 corridor is 20 and the number of existing access points is 28 (not including signalized intersections). Therefore, the CMF after the application of the formula is 0.80 which indicates a decrease in the crash types and severity listed above for this CMF application due to the closure of median crossovers. **Table 3** shows the type of safety measures completed by identifying fatal and injury crashes along the entire study area for both the northbound and southbound direction of Route 29. Only the fixed object, run off road, and single vehicle crashes that occurred along the Route 29 corridor were used for this particular solution in compliance with the application of the CMF.

**Table 3** also shows the travel time reliability index estimated for the closure of the median crossovers using Smart Scale scoring methods. Median design was selected as the major project type for these projects to identify incident and weather impact factors.

To calculate a combined TTR, EPDOs were summed for all the elements and compared to the Smart Scale Implementation Policy Guide's thresholds. Therefore, the combined TTR is not necessarily equal to the sum of TTRs for all the elements.

**Table 3**
**Smart Scale Safety and Reliability Measures**
**Closure of Median Crossovers**

| Location | S1 | S2 | TTR |
|---|---|---|---|
| Entire Study Area | 30.97 | 36.50 | 1.00 |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
*TTR = Travel Time Reliability Index.*

### Solution Set 1 - Median Left-In Only with Right In/Right-Out

There are 3 potential recommendations for conversions of median crossovers to median left-in only movement from Route 29 coupled with right-in/right out movement only from the intersecting minor street. Restricting left-out access reduces conflict points (from 32 at a typical 4-way intersection to 11 when left-out access is restricted) and by converting the junction from a full movement intersection to a partial intersection, it reduces the length of the minimum intersection spacing requirements as detailed in VDOT's Access Management guidelines.

The potential crossover conversion locations include: Dennis Riddle Drive, Antiques to Envy, Inc. access, and Wooldridge Heating & Air, Inc. access. The conversion of an open median at an unsignalized intersection to a directional median has a Crash Modification Factor (CMF) of 0.65 which indicates a

[6]U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 2458. http://www.cmfclearinghouse.org/detail.cfm?facid=2458

decrease in crashes.[7] **Table 4** shows the safety measures for each location that was determined using the fatal and injury (category A, B, and C) crashes based on a 250 feet radius in both the northbound and southbound direction of Route 29. **Table 4** also shows the travel time reliability scoring index estimated for the median left-in only with right-in/right-out. Median design was selected as the major project type for these projects to identify incident and weather impact factors.

Dennis Riddle Drive – A left-in only at this location will still allow access from Route 29 to Yellow Branch Elementary School, Campbell County Technical Center, and Campbell County Animal Control. The signal at Colonial Highway and Route 29 allows an additional access point to Route 29.

Antiques to Envy, Inc. Access – This median crossover serves one of the entrances to Antiques Envy, Inc. on Route 29. Vehicles can utilize the next median crossover located directly 1,190 ft to the north (turn lane improvements are proposed at this location) to make U-turns to head south on Route 29.

Wooldridge Heating & Air, Inc. Access – This median crossover serves the entrance to Wooldridge Heating & Air Inc. on Route 29. The next median crossover directly to the north at Baker Road (turn lane improvements are proposed at this location) will allow vehicles to make U-turns to head south on Route 29.

**Table 4**
**Smart Scale Safety and Reliability Measures**
**Median Left-In Only with Right-In/Right-Out**

| Location | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| Dennis Riddle Drive | 0.35 | 0.41 | 0.25 | 0.50 |
| Antiques to Envy, Inc. Access | 0.00* | 0.00* | 0.25 | |
| Wooldridge Heating & Air, Inc. Access | 4.90 | 5.77 | 0.25 | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
**No fatal or injury crashes located within a 250 ft radius of this access for 2011 - 2015.*
*TTR = Travel Time Reliability Index.*

[7] Virginia Department of Transportation. *Expected Roadway Project Crash Reductions for HB2 Safety Factor Evaluation.* 2015.

## Solution Set 1 - Restricted Crossing U-Turn Intersections (RCUT)

The locations for potential unsignalized restricted crossing U-turn (RCUT) intersections were identified as follows: Moorman Mill Road, Patterson Road, Lynbrook Road, and Hyland Drive. Each of these locations was carefully considered based on other elements with the future closure and improvements of existing median crossovers and other access modifications. An RCUT intersection, as seen in **Figure 2**, allows left turn movements onto minor streets or U-turns from the mainline but restricts both left turn and through movements from the minor streets. Instead, vehicles from the minor street make right turns onto the mainline and continue down to the next appropriate access point and make a U-turn to continue in the opposite direction. The number of conflicts points for an RCUT intersection is 18 in comparison to a conventional intersection with 32 conflict points. Various studies have been completed on the analysis of benefits after the incorporation of an RCUT. A study completed on a system of RCUT intersections in Maryland concluded the "expected number of crashes decrease[d] between 28 and 44 percent" and the severity of crashes was lowered as well after the incorporation of an RCUT intersection.[8] This study conducted had similar existing conditions in relation to the Route 29 corridor with study areas of RCUT intersections on a rural four-lane divided highway. Specific geometric aspects for RCUT intersections are as follows:[9]

Figure 2: Restricted Crossing U-Turn (RCUT) Intersection in Frederick, MD

- The desirable minimum width for an RCUT intersection is 40 to 60 ft.
- The American Association of State Highway and Transportation Officials (AASHTO) recommend a spacing of 400 to 600 ft from the RCUT intersection to the U-turn crossover location.
- Pedestrian traffic can be accommodated by providing a diagonal path along the RCUT intersection.

Below are proposed locations for RCUT intersection installation along the Route 29 corridor. A U-turn area would need to be constructed within 400 to 600 ft of the proposed RCUT intersection in both the northbound and southbound direction of Route 29.

Moorman Mill Road – The installation of an RCUT intersection at this location would limit the left-out movement from Moorman Mill Road and Amy Road to Route 29.

[8] U.S. Department of Transportation Federal Highway Administration. *Field Evaluation of Restricted Crossing U-Turn Intersection*., 2012.
[9] U.S. Department of Transportation Federal Highway Administration. *Restricted Crossing U-Turn Intersection*, 2009.

Patterson Road – An RCUT intersection at Patterson Road and Route 29 would restrict the left out movement from Patterson Road onto northbound Route 29.

Lynbrook Road – The installation of an RCUT intersection at this location would eliminate the left-out from Lynbrook Road to northbound Route 29.

Hyland Drive – An RCUT intersection at Hyland Drive gives limited access for the residential community on Hyland Drive to Route 29 with the left-out movement from Hyland Drive to northbound Route 29 being eliminated. The Dollar General would also have limited access with the left-out movement from this property to southbound Route 29 being eliminated.

RCUTs will provide a viable intersection configuration for the near to mid-term time period (5-15 years) before they may become capacity deficient. Once RCUTs exceed their capacity traffic signals could be installed in their location to provide more capacity for turning traffic movements after a traffic signal warrants analysis has determined a traffic signal is warranted. Based on the existing land use and recent rates of development it may take 15-20+ years before these intersections meet traffic signal warrants.

Hypothetical traffic volumes (to and from the side street) were created to analyze the proposed RCUT intersections because traffic counts were not conducted at the proposed RCUT intersection locations. Hypothetical side street volume for each RCUT volume was set to 200 entering and 200 exiting vehicles for each peak hour. The volumes were distributed equally to the north and south; this distribution resulted in 100 peak hour U-turn vehicles and 100 peak hour left turns into the side street in each direction of travel. The hypothetical volumes roughly equate to a 400 home subdivision or a 100,000 sq. ft. shopping center.

**Table 5** displays each movement delay for the proposed RCUT intersections along the corridor in 2040 Build Conditions. Six (6) major movements are shown in the table, with 4 movements at the RCUT intersection and 2 movements at the opposing upstream and downstream U-turn locations. The turning movements from both the mainline and side streets were set up with capacity conditions in order to show the most extreme case competing with the 2040 Build Conditions. The 4 movements at the RCUT location displayed adequate delays in both the AM and PM peak period. The 2 movements at the U-turn location displayed moderate to significant delays. At all of the proposed RCUT intersections, the northbound U-turn experiences heavy delay in the PM peak period. The southbound U-turn also shows significant delay at the Patterson Road, Lynbrook Road, and Hyland Drive intersections.

Analysis of a hypothetical traditional median crossover (with the same volume as the RCUT) is shown for comparison to the RCUT intersection. A crossover location on both the northern and southern end of the corridor was analyzed based on the 4 major movements that occur within the crossover area. The eastbound and westbound movements experience significant delay due to the left turn movements from these approaches having to cross over two movements of mainline traffic.

**Table 5**
**HCM 2010 Unsignalized Intersection Analysis/ SimTraffic U-Turn Analysis**
**Route 29 2040 Build Conditions – RCUTS and Traditional Median Crossovers**

| Intersection Location | Movement Delay/Veh. (sec.) (LOS) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Peak Period | NBL | SBL | EBR/ EBLTR | WBR/ WBLRT | NBU | SBU |
| RCUTs (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit | | | | | | | |
| Moorman Mill Rd | AM | 10.5 (B) | 15.2 (C) | 15.3 (C) | 28.2 (D) | 12.8 (B) | 22.8 (C) |
| | PM | 17.0 (C) | 10.9 (B) | 34.7 (D) | 16.3 (C) | 86.8 (F) | 11.2 (B) |
| Patterson Rd | AM | 10.5 (B) | 27.2 (D) | 15.3 (C) | N/A | 10.6 (B) | 46.6 (E) |
| | PM | 17.0 (C) | 15.1 (C) | 34.7 (D) | N/A | 50.7 (F) | 10.5 (B) |
| Lynbrook Rd | AM | 9.9 (A) | 27.0 (D) | 14.0 (B) | 88.5 (F) | 52.8 (F) | ✳ |
| | PM | 16.5 (C) | 15.3 (C) | 32.8 (D) | 28.7 (D) | 81.8 (F) | 36.8 (E) |
| Hyland Dr | AM | 9.9 (A) | 27.0 (D) | 14.0 (B) | 88.5 (F) | 56.8 (F) | ✳ |
| | PM | 16.5 (C) | 15.3 (C) | 32.8 (D) | 28.7 (D) | 42.6 (E) | 53.7 (D) |
| Traditional Median Crossover (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit | | | | | | | |
| Northern End of Corridor | AM | 10.8 (B) | 26.1 (D) | ✳ | ✳ | N/A | N/A |
| | PM | 15.6 (C) | 10.3 (B) | ✳ | ✳ | N/A | N/A |
| Southern End of Corridor | AM | 9.9 (A) | 14.0 (B) | ✳ | ✳ | N/A | N/A |
| | PM | 25.2 (D) | 15.1 (C) | ✳ | ✳ | N/A | N/A |

✳Delay over 300 seconds.

N/A: Not applicable, no movement is served.

The installation of an RCUT intersection has a Crash Modification Factor (CMF) of 0.46 which indicates a decrease in crashes.[10] The safety measures analysis shown in **Table 6** was completed by identifying crashes within 250 ft of the proposed RCUT intersection location along Route 29 in both the northbound and southbound direction. **Table 6** also displays the RCUT Smart Scale travel time reliability index score.

**Table 6**
**Smart Scale Safety and Reliability Measures**
**Future RCUT Intersection Locations**

| Location | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| Moorman Mill Road | 3.22 | 3.80 | 0.25 | 0.25 |
| Patterson Road | 0.00* | 0.00* | 0.00* | |
| Lynbrook Road | 4.30 | 5.06 | 0.25 | |
| Hyland Drive | 1.61 | 1.90 | 0.25 | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*

*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*

**No fatal or injury crashes located within a 250 ft radius of this road for 2011 - 2015.*

*TTR = Travel Time Reliability Index.*

[10] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 5556. http://www.cmfclearinghouse.org/detail.cfm?facid=5556

### Solution Set 1 - Additional Turn Lanes and Turn Lane Storage Lengths

The Route 29 corridor has numerous access points at which motorists are not provided turn lanes. Turn lanes built to VDOT standards help to reduce rear-end and sideswipe crashes as more appropriate storage space for queuing is made available for vehicles maneuvers. The extension of an existing turn lane and storage length to appropriate standards has a Crash Modification Factor (CMF) of 0.97 indicating such actions would produce a decrease in crashes.[11] **Table 8** shows the safety measures that were developed for each location using the fatal and injury (category A, B, and C) crashes based on a 250 ft radius in both the northbound and southbound direction of Route 29. **Table 8** also shows the Smart Scale travel time reliability scoring index estimated for the additional turn lanes and turn lane extensions. Median design was selected as the major project type for these projects to identify incident and weather impact factors.

There are 10 potential locations for improvements to left turn lanes and left turn storage along the Route 29 corridor study area. They include the following: BP Gas Station Access (SBL only), Moorman Mill Road, Patterson Road (NBL only), Pick N Save access (SBL only), Calohan Road signal (NBL only), English Tavern Road (southern connection), Powell's Truck Equipment access, Watson Drive, Baker Road, and the Russell Woods Drive signal (SBL only).

There are 5 potential locations for new left turn lanes along the Route 29 corridor. They include: Residential Access #1 (630 ft north of Anstey Road), Residential Access #2 (2,460 ft north of Moorman Mill Road), Patterson Road (SBL only), Pick N Save access (NBL only), and Allendale Circle/Bennie's Home access.

Proposed right turn lane improvements are recommended at locations where they will likely meet VDOT right turn lane warrants in the forecasted design year 2040. For the improvements to existing right turn lanes along the Route 29 corridor, 4 potential locations are proposed including Moorman Mill Road (NBR only), Lynbrook Road (SBR only), Hyland Drive, and English Tavern Road (northern connection). For the installation of new right turn lanes, 5 potential locations have been identified, Moorman Mill Road (SBR only), Patterson Road (SBR only), Lynbrook Road (NBR only) for new realignment with Leland Road, Lawyers Road (SBR only), and Russell Woods Drive (NBR only). A project to construct a right turn lane at Patterson Road on Route 29 is currently listed in the VDOT FY 2016 Six Year Improvement Program (UPC 105712).

[11] Virginia Department of Transportation. *Expected Roadway Project Crash Reductions for HB2 Safety Factor Evaluation.* 2015.

**Table 7**
**Smart Scale Safety and Reliability Measures**
**Additional Turn Lanes and Turn Lane Storage Lengths**

| Location | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| **Left Turn Lane Extensions** | | | | |
| BP Gas Station Access | 0.18 | 0.21 | 0.25 | 2.75 |
| Moorman Mill Road | 0.18 | 0.21 | 0.25 | |
| Patterson Road (NBL only) | 0.00* | 0.00* | 0.25 | |
| Pick N Save Access (SBL only) | 0.00* | 0.00* | 0.25 | |
| Calohan Road (NBL only) | 0.75 | 0.88 | 0.75 | |
| English Tavern Road (southern connection) | 7.35 | 8.65 | 1.00 | |
| Powell's Truck Equipment Access | 0.12 | 0.14 | 0.25 | |
| Watson Drive | 0.00* | 0.00* | 0.25 | |
| Russell Woods Drive (SBL only) | 1.02 | 1.20 | 0.75 | |
| Baker Road | 0.27 | 0.32 | 0.25 | |
| **Addition of Left Turn Lane** | | | | |
| Residential Access #1 (630 ft north of Anstey Road) | 0.90 | 1.06 | 0.25 | 0.25 |
| Residential Access #2 (2,460 ft north of Moorman Mill Road) | 0.15 | 0.18 | 0.25 | |
| Patterson Road (SBL only) | 0.00* | 0.00* | 0.25 | |
| Pick N Save Access (NBL only) | 0.00* | 0.00* | 0.25 | |
| Allendale Circle/Bennie's Home Access | 1.20 | 1.41 | 0.25 | |
| **Location** | **S1** | **S2** | **TTR** | **TTR (Combined)** |
| **Right Turn Lane Extensions** | | | | |
| Moorman Mill Road (NBR only) | 0.18 | 0.21 | 0.25 | 0.75 |
| Lynbrook Road | 0.24 | 0.28 | 0.25 | |
| Hyland Drive | 0.09 | 0.11 | 0.25 | |
| English Tavern Road (northern connection) | 0.51 | 0.60 | 0.25 | |
| **Addition of Right Turn Lane** | | | | |
| Moorman Mill Road (SBR) | 0.90 | 1.06 | 0.25 | 0.75 |
| Patterson Road (SBR only) | 0.00* | 0.00* | 0.25 | |
| Lawyers Road (SBR only) | 2.7 | 3.18 | 0.25 | |
| Russell Woods Drive (NBR only) | 5.1 | 6.00 | 0.75 | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
**No fatal or injury crashes located within a 250 ft radius of this road/access for 2011 - 2015.*
*TTR = Travel Time Reliability Index.*

## Solution Set 1 – Combine Access Points

The Transportation Corridor Overlay District for Campbell County states that "shared entrances and internal service roads shall be encouraged in order to reduce the number of direct access points on a

highway." The following locations are proposed for eliminating direct access on Route 29 and either creating an adjacent shared access or using a nearby access to Route 29.

Anstey Road – The access to Anstey Road from Route 29 is recommended for closure. The west end of Anstey Road will be converted into a cul-de-sac and residents can access Route 29 by the proposed signal at Moorman Mill Road.

Realignment of Leland Road – A new alignment of Leland Road is recommended that will allow vehicles to access the residential areas of English Tavern Road and Lynbrook Road. It is recommended to eliminate the existing median crossover at Leland Road.

Realignment of Rangoon Street – The median crossover at Rangoon Street is recommended to be eliminated and Rangoon Street realigned with Terminal Drive. Traffic will now access Route 29 by the existing signal at Terminal Drive/Liberty Mountain Drive. Terminal Drive serves the Lynchburg Regional Airport, so any impacts from the realignment of Rangoon Street and increased traffic on Terminal Drive would have to be analyzed. Rangoon Street currently serves the commercial services of Banker Steel Company and its employees.

### Solution Set 1 - Route 29 Progression – Flashing Yellow Arrow Installations

A flashing yellow arrow (FYA) is a proposed solution element at the intersection of Calohan Road and Route 29. The existing signal timing gives motorists turning left from southbound Route 29 to Calohan Road a protected phase only. The new FYA will give vehicles a permissive phase and a protective phase. The vehicles turning onto Route 29 from Calohan Road will not be allowed to turn right on red. Instead, motorists turning right onto northbound Route 29 from Calohan Road will be given an overlap phase with motorists turning left from southbound Route 29; southbound U-turns would be restricted.

The change from a protected only left turn phase to a FYA left turn has a Crash Modification Factor (CMF) of 1.206 indicating an increase in crashes.[12] The increase in crashes is due to an increase in conflict points, which in this case refers to those vehicles traveling northbound on Route 29 and vehicles turning left from southbound Route 29 to Calohan Road during the permissive phase of the FYA. **Table 9** shows the safety measures for the FYA that were determined using the fatal and injury (category A, B, and C) crashes based on a 250 ft radius for the Calohan Road and Route 29 intersection. Even though the safety evaluation measure shows an increase in crashes, the installment of a FYA has tradeoff benefits by increasing the capacity of the traffic signal and lowering delay. Furthermore, the FYA provides benefits by decreasing the length of vehicle queues in the left turn lane on southbound Route 29 and consequently reducing the potential risk for vehicle queue spillback into the mainline of Route 29, which would increase the risk for both rear-end and sideswipe crashes. **Table 9** also shows the Smart Scale travel time reliability scoring index estimated for the installation of a FYA at the Calohan Road and Route 29 Intersection. Active traffic management was selected as the major project type to identify incident and weather impact factors.

[12] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 7687. http://www.cmfclearinghouse.org/detail.cfm?facid=7687

**Table 8**
**Smart Scale Safety and Reliability Measures**
**Install FYA at Calohan Road and Route 29 Intersection**

| Location | S1 | S2 | TTR |
|---|---|---|---|
| SBL at Intersection | -5.15 | -6.07 | 0.25 |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
*TTR = Travel Time Reliability Index.*

**Table 10** displays each movement delay at the Calohan Road intersection for the 2040 Build Conditions with the FYA in comparison to the protected southbound left turn conditions (No Build Conditions). Every movement at the intersection exhibits a decrease in delay with the exception of the southbound through movement in the PM peak hour, which exhibits a slight increase in delay. Overall, delays will decrease with the incorporation of a FYA at this intersection. Travel time recorded using SimTraffic is also displayed for this proposed solution in comparison to the 2040 No Build Conditions. There is a decrease in travel time with the incorporation of a FYA at the Calohan Road and Route 29 intersection.

**Table 9**
**HCM 2000 Signalized Intersection Analysis/ SimTraffic Travel Time**
**Route 29 2040 Build Conditions – FYA Solution at Calohan Road**

| Scenario | Travel Time (min.) | | Overall Intersection Delay/Veh. (sec.) | Movement Delay/Veh. (sec.) | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | NB Rte. 29 | SB Rte. 29 | | WBL | WBR | NBL | NBT | NBR | SBL | SBT |
| **AM Peak Hour** | | | | | | | | | | |
| 2040 NB Conditions | 10.76 | 8.75 | 68.0 (E) | 48.3 (D) | 158.1 (F) | 75.9 (E) | 53.0 (D) | 23.9 (C) | 118.2 (F) | 12.6 (B) |
| 2040 Build Conditions w/FYA | 10.54 | 8.57 | 41.0 (D) | 33.9 (C) | 63.1 (E) | 46.9 (D) | 34.8 (C) | 14.7 (B) | 104.0 (F) | 10.7 (B) |
| **PM Peak Hour** | | | | | | | | | | |
| 2040 NB Conditions | 10.47 | 9.80 | 33.1 (C) | 61.6 (E) | 56.0 (E) | 86.3 (F) | 39.8 (D) | 25.7 (C) | 62.3 (E) | 8.0 (A) |
| 2040 Build Conditions w/FYA | 10.24 | 9.63 | 25.1 (C) | 41.9 (D) | 19.6 (C) | 54.1 (D) | 29.8 (C) | 18.4 (B) | 58.0 (E) | 9.5 (A) |

## Solution Set 2: Corridor Safety

The solutions identified in Solution Set 2 are displayed in **Figures 2-1, 2-2, 2-3, and 2-4**. The figures include the entire Route 29 study area from the U.S. Route 460 interchange ramps to the Route 24 Colonial Highway intersection. Many of the elements of Solution Set 1 are also found in Solution Set 2, in these cases the analysis information is not presented a second time, Solution Set 2's analysis refers back to Solution Set 1's analysis.

### Solution Set 2 - Closure of Median Crossovers

Refer to Solution Set 1.

### Solution Set 2 - Median Left-In Only with Right In/Right-Out

Refer to Solution Set 1.

### Solution Set 2 - Additional Turn Lanes and Turn Lane Storage Lengths

Refer to Solution Set 1.

### Solution Set 2 - Modify Transportation Corridor Overlay District

One component of Solution Set 2 is updating the existing Transportation Corridor Overlay District to address issues relating to minimum lot widths and minimum lot frontage widths.

Focusing first on minimum lot area and frontage, in defining provisions of the Transportation Corridor Overlay District Section 22.16.4(d) of the Campbell County Code states:

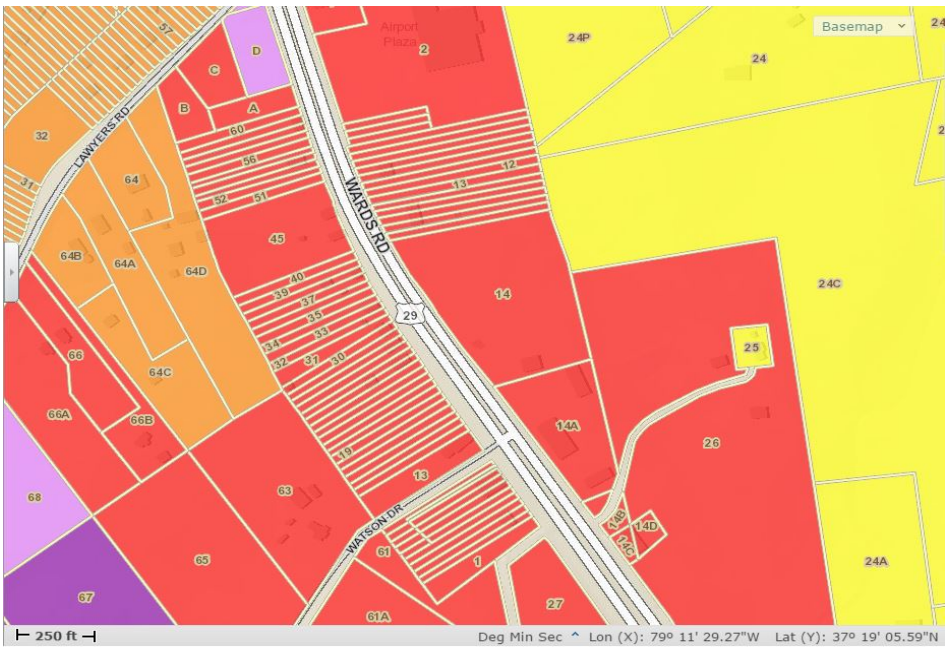


Figure 3: Zoning and Parcel Configuration on Route 29 between Lawyers Road and Watson Drive

*The minimum required lot area shall be the same as in the underlying zoning district. The minimum frontage for any lot along a primary highway shall be eight hundred feet. The minimum frontage requirement may be reduced to that which is normally required in the underlying zoning district where there is provided one shared entrance between adjacent lots or other road construction approved by the Planning Commission, provided that no additional direct access to the primary highway is proposed.*

For most of the parcels with frontage onto Route 29 within the corridor limits, the underlying zoning districts consist of:

- Business-Limited Commercial (B-LC)[13]
- Business-General Commercial (B-GC)[14]

[13] Campbell County Code. Section 22.12

- Industrial-General (I-G)[15]

For the two Business districts (B-LC and B-GC), the minimum lot size is set at 7,500 square feet (assuming public water and sewer are available). However, if only public water or public sewer is available, the minimum lot size is 15,000 square feet, and if neither is available the minimum lot size is 20,000 square feet. In contrast for the Industrial-General district, no minimum lot size is provided. For all three zoning districts, the minimum frontage lot width is 75 feet.

Considering that the underlying zoning provides for a minimum frontage width of 75 feet and that the Transportation Corridor Overlay District (TCOD) allows for narrower frontage if a shared access point with an adjacent lot is provided, the effectiveness of the overlay district in spacing access points is compromised. Moreover, VDOT's Access Management guidelines provide for minimum access spacing of 300 feet for Principal Arterials as Route 29 is functionally classified. For spacing access points, the gap between the intent of the VDOT guidelines and the likely outcome of development under county zoning (both underlying zoning and the TCOD) is substantial.

Moreover, as shown in **Figure 3,** many fronting parcels along Route 29 do not conform to the provisions in current zoning for a minimum frontage width of 75 feet. The parcels in red are zoned B-GC, and many parcels were subdivided with less than 75 feet of frontage on Route 29. Under the current TCOD provisions, with shared access points, each parcel would be allowed an access, provided the proposed development plan complied with the other provisions of the underlying B-GC, such a minimum lot size.

To more effectively achieve the intent of the TCOD and anticipate development access configurations that are more closely aligned with VDOT's Access Management guidelines, modifications to the TCOD should be considered. As part of the development of Solution Set 2, two modifications are proposed: 1) Expand the minimum lot frontage to 200 feet in width; and, 2) Expand the minimum lot size to 1 acre (or 40,000 square feet). These two modifications should be applied regardless of the underlying zoning.

The configuration of the narrow lots is likely a product of subdivision in anticipation of future residential development. However, the *Campbell County Comprehensive Plan* and the Zoning Ordinance document states that Campbell County does not anticipate residential development along the frontage of Route 29. In addition, VDOT's Access Management guidelines are not supportive for accommodating individual points of access to numerous narrow parcels on a principal arterial. Consequently, the parcel configurations along several segments within the corridor study area are not consistent with implementing local growth and use policies and VDOT Access Management guidelines. The most effective method of addressing this dilemma is to encourage re-subdivision of the problematic parcels to configurations more consistent with local and state policies.

### Solution Set 2 - Speed Limit Changes

This improvement was analyzed in Synchro to update the speed limit with a cohesive steady decrease as travelers approach the more congested areas of the study corridor. Speed limit changes are being

[14] Campbell County Code. Section 22.12.1
[15] Campbell County Code. Section 22.14

proposed to improve safety and to respond to frequent public comments related to speeding issues. The existing speed limit (60 MPH) drops to 45 MPH around the Calohan Road intersection and increases back to 60 MPH just after the signal in both the northbound and southbound direction. The speed limit again drops to 45 MPH near Lawyers Road. The proposed speed limit change on the southern portion of Route 29 from 60 MPH to 55 MPH within the study area is from the Colonial Highway and Route 29 signalized intersection to the area surrounding Calohan Road. The speed limit would then be a continuous 45 MPH from the area surrounding the Calohan Road signalized intersection to Lawyers Road. From Lawyers Road to the U.S. Route 460 interchange ramps, the speed limit would be changed from 45 MPH to 35 MPH.

As seen in **Table 11**, for the intersection of Liberty Mountain Drive and Route 29, there would be a speed limit decrease of 10 MPH for both the northbound and southbound movements. In both the AM and PM peak hour, the overall intersection delay increased with higher delay for the northbound through movement.

The intersection of FNB/Russell Woods Drive and Route 29 also would experience a decrease in speed limit of 10 MPH with this solution on the northbound and southbound approach. In the AM peak hour, the overall intersection delay slightly decreased and in the PM peak hour the overall intersection delay slightly increased. The volume at this intersection is heavier in the PM peak hour, particularly in the southbound and eastbound direction.

The intersection of Lawyers Road and Route 29 exhibits an increase in delay for both the AM and PM peak hour. This intersection would experience a decrease in speed limit of 10 MPH from 45 MPH to 35 MPH. The volume at this intersection is heavier in the PM peak hour with significant delays for the southbound and westbound movements.

For the intersection of English Tavern Road and Route 29, the overall intersection delay decreased slightly in the AM peak hour and increased slightly in the PM peak hour, with approach delays having minor changes with this improvement.

The Calohan Road and Route 29 intersection remained constant with the overall intersection delay in both the AM and PM peak hour since the speed limit remained the same at 45 MPH with this solution. Also, this intersection is isolated and is not coordinated with the 4 northernmost intersections.

The Colonial Highway and Route 29 intersection also remained constant with the overall intersection delay in both the AM and PM peak hour since the speed limit only decreased by 5 MPH from 60 MPH to 55 MPH with this solution. This intersection is isolated and is not coordinated with the 4 northernmost intersections after Calohan Road and Route 29.

Overall, the proposed speed limit changes would have a minor to moderate effect on delay at most intersections. The intersection that would experience a significant increase in delay (>20 sec/veh) is Lawyers Road and Route 29 due to the heavy southbound and westbound volume. **Table 11** displays travel time which is recorded with SimTraffic for the northbound and southbound direction along the corridor. The travel time for the corridor increases from the 2040 No Build Conditions in both the AM

and PM peak hours. The increase is mostly due to the northernmost section of the corridor starting at the English Tavern Road (northern connection) and Route 29 intersection where the proposed speed limit change is from 45 MPH to 35 MPH. In conclusion, a speed study throughout the study area limits would be needed for an appropriate justification in lowering of the speed limit.

**Table 10**
**HCM 2000 Signalized Intersection Analysis/SimTraffic Travel Time**
**Route 29 2040 Build Condition – Speed Limit Change Solution**

| Scenario | Travel Time (min.) | | Overall Intersection Delay/Veh. (sec.) (LOS) | | | | | |
|---|---|---|---|---|---|---|---|---|
| | NB Rte. 29 | SB Rte. 29 | Rt. 29 & Liberty Mountain Drive | Rt. 29 & Russell Woods Drive | Rt. 29 & Lawyers Road | Rt. 29 & English Tavern Road | Rt. 29 & Calohan Road | Rt. 29 & Colonial Highway |
| **AM Peak Hour** | | | | | | | | |
| 2040 NB Conditions | 10.76 | 8.75 | 19.8 (B) | 22.2 (C) | 29.6 (C) | 43.6 (D) | 68.0 (E) | 43.8 (D) |
| Speed Limit Change | 12.13 | 10.08 | 34.3 (C) | 13.8 (B) | 46.3 (D) | 40.4 (D) | 68.0 (E) | 43.8 (D) |
| **PM Peak Hour** | | | | | | | | |
| 2040 NB Conditions | 10.47 | 9.80 | 27.3 (C) | 20.0 (B) | 33.6 (C) | 25.6 (C) | 33.1 (C) | 32.8 (C) |
| Speed Limit Change | 11.06 | 11.42 | 32.3 (C) | 29.6 (C) | 55.3 (E) | 28.5 (C) | 33.1 (C) | 32.8 (C) |

The proposed speed limit changes for the corridor were also analyzed using the safety measures outlined in Smart Scale. For analysis purposes, the 6.4 mile corridor was split into 3 segments based on where the proposed speed limit changes would occur as mentioned previously.

Segment 1 begins at the intersection of Colonial Highway and Route 29 to the area just before the signalized intersection at Calohan Road and Route 29. This segment has a proposed speed limit change from 60 MPH to 55 MPH. A Crash Modification Factor (CMF) of 0.68[16] for fatal injuries and 0.85[17] for both serious and minor injury types has been assigned to this segment (10% reduction in mean speed) which indicates a decrease in crashes.

Segment 2 begins at the intersection of Calohan Road and Route 29 to the area just before the signalized intersection at Lawyers Road and Route 29. This segment has a proposed speed limit change

[16] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 144. http://www.cmfclearinghouse.org/detail.cfm?facid=144
[17] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 145. http://www.cmfclearinghouse.org/detail.cfm?facid=145

from 60 MPH to 45 MPH in most areas. A Crash Modification Factor (CMF) of 0.56[18] for fatal injuries and 0.78[19] for both serious and minor injury types has been assigned to this segment (15% reduction in mean speed-maximum available) which indicates a decrease in crashes.

Segment 3 begins at the intersection of Lawyers Road and Route 29 to the U.S. Route 460 interchange ramps. This segment has a proposed speed limit change from 45 MPH to 35 MPH. A Crash Modification Factor (CMF) of 0.56 for fatal injuries and 0.78 for both serious and minor injury types has been assigned to this segment (15% reduction in mean speed-maximum available) which indicates a decrease in crashes.

The safety measures analysis shown in **Table 12** was completed by identifying fatal and injury crashes within each segment. **Table 12** also shows the Smart Scale travel time reliability scoring index estimated for the proposed speed limit changes along the corridor. Active traffic management was selected as the major project type for these projects to identify incident and weather impact factors.

**Table 11**
**Smart Scale Safety and Reliability Measures**
**Proposed Speed Limit Changes**

| Injury Type | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| **Segment 1** | | | | 3.00 |
| Fatal | 0.00* | 0.00* | 1.00 | |
| Serious & Minor | 9.30 | 35.96 | | |
| **Segment 2** | | | | |
| Fatal | 142.56 | 368.75 | 3.00 | |
| Serious & Minor | 40.26 | 104.14 | | |
| **Segment 3** | | | | |
| Fatal | 47.52 | 249.20 | 2.50 | |
| Serious & Minor | 22.22 | 116.53 | | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
**No fatal crashes located on this segment for 2011 - 2015.*
*TTR = Travel Time Reliability Index.*

## Solution Set 2 - Restricted Crossing U-Turn Intersections (RCUT)

**Table 13** displays each movement delay for the proposed RCUT intersections along the corridor in 2040 Build Conditions with the newly proposed speed limit changes. Six (6) major movements are shown in the table with 4 movements at the RCUT intersection and 2 movements at the opposing upstream and downstream U-turn location. The turning movements from both the mainline and side streets were set up with capacity conditions in order to show the most extreme case competing with the traffic volumes in 2040 Build Conditions. The delays are the majority the same in comparison to the RCUTs that were

[18] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 147. http://www.cmfclearinghouse.org/detail.cfm?facid=147
[19] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 148. http://www.cmfclearinghouse.org/detail.cfm?facid=148

analyzed with the existing posted speed limit in Solution Set 1. The 2 U-turn movements analyzed in SimTraffic were different in comparison to RCUTs analyzed in Solution Set 1. The U-turn delay decreases it both the AM and PM peak hour for Lynbrook Road and Hyland Drive due to the newly proposed speed limit of 45 MPH whereas the existing was 60 MPH. The U-turn delays for Moorman Mill Road and Patterson Road change slightly as the newly proposed speed limit is only decreased by 5 MPH (60 MPH to 55 MPH).

**Table 12**
**HCM 2010 Unsignalized Intersection Analysis/ SimTraffic U-Turn Analysis**
**Route 29 2040 Build Conditions – RCUTS and Traditional Median Crossovers**

| Intersection Location | Movement Delay/Veh. (sec.) (LOS) | | | | | | |
|---|---|---|---|---|---|---|---|
| | Peak Period | NBL | SBL | EBR/ EBLTR | WBR/ WBLTR | NBU | SBU |
| RCUTs (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit | | | | | | | |
| Moorman Mill Rd | AM | 10.5 (B) | 15.2 (C) | 15.3 (C) | 28.2 (D) | 12.6 (B) | 23.0 (C) |
| | PM | 17.0 (C) | 10.9 (B) | 34.7 (D) | 16.3 (C) | 103.0 (F) | 14.8 (B) |
| Patterson Rd | AM | 10.5 (B) | 27.2 (D) | 15.3 (C) | N/A | 10.3 (B) | 33.6 (D) |
| | PM | 17.0 (C) | 15.1 (C) | 34.7 (D) | N/A | 51.2 (E) | 14.5 (B) |
| Lynbrook Rd | AM | 9.9 (A) | 27.0 (D) | 14.0 (B) | 88.5 (F) | 10.0 (A) | 160.7 (F) |
| | PM | 16.5 (C) | 15.3 (C) | 32.8 (D) | 28.7 (D) | 76.8 (F) | 33.9 (D) |
| Hyland Dr | AM | 9.9 (A) | 27.0 (D) | 14.0 (B) | 88.5 (F) | 13.4 (B) | ✳ |
| | PM | 16.5 (C) | 15.3 (C) | 32.8 (D) | 28.7 (D) | 33.8 (D) | 33.9 (D) |
| Traditional Median Crossover (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit | | | | | | | |
| Northern End of Corridor | AM | 10.8 (B) | 26.1 (D) | ✳ | ✳ | N/A | N/A |
| | PM | 25.2 (D) | 15.1 (C) | ✳ | ✳ | N/A | N/A |
| Southern End of Corridor | AM | 9.9 (A) | 14.0 (B) | ✳ | ✳ | N/A | N/A |
| | PM | 15.6 (C) | 10.3 (B) | ✳ | ✳ | N/A | N/A |

✳Delay over 300 seconds.

N/A: Not applicable, no movement is served.

## Solution Set 3: Economic Development

The solutions identified in Solution Set 3 are displayed in **Figures 3-1, 3-2, 3-3, and 3-4**. The figures include the entire Route 29 study area from the U.S. Route 460 interchange ramps to the Route 24 Colonial Highway intersection.

### Solution Set 3 - Connectivity/Realignment

In order to increase economic development, new roadway alignments are important to incorporate along the Route 29 corridor. Detailed below are some key improvement areas that can create safer connection points on Route 29. These improvements will also create an opportunity for future phased development of local street connectors for both residential and business properties by providing consolidated and safe major access points. Local street connectors will not only improve the flow of commuter traffic but also the overall attractiveness of the corridor as there will be more space for development outside of the main driveways along Route 29.[20]

[20] Campbell County, Virginia. *Route 29 Corridor Management Study*. 2001.

### *Lynbrook Road/Leland Road*

The new realignment of Lynbrook Road with Leland Road and the addition of a traffic signal at this intersection would allow for safe and easy access to the residential areas around English Tavern Road and the multiple residential properties near Lynbrook Road. A traffic signal should only be installed after a traffic signal warrant analysis determines a traffic signal is warranted. Lynbrook Road is also used as an access point to Lawyers Road. Hyland Heights Baptist Church and other commercial properties are located within the realignment area that could benefit with the addition of a signalized intersection by reducing side street traffic delays and alleviating safety concerns. The relevance of economic development and this solution within this area is important to note, since it would provide residents easier access to the Route 29 corridor making their trips safer and more reliable.

### *Lawyers Road*

This alignment solution to Lawyers Road and Route 29 would add a right turn lane on southbound Route 29, starting at Lyn Dan Drive, and also realign Lawyers Road with the existing signal. The current intersection geometry of Lawyers Road and Route 29 makes right turns onto Lawyers Road from southbound Route 29 and right turns onto Route 29 from Lawyers Road very difficult. Trucks turning right onto southbound Route 29 from Lawyers Road have a small turning radius due to the alignment of Lawyers Road with the intersection. Existing areas along the Route 29 corridor can be improved so that residents and truck traffic, in this particular case, can view the corridor as a safe and reliable route of travel which ultimately improves economic development within the area.

### *Rangoon Street*

Rangoon Street is currently connected to Route 29 by a full median crossover and encompasses Banker Steel Company and its employees. A proposed improvement would be to realign Rangoon Street with Terminal Drive in order to reduce conflict points on Route 29 as traffic would now flow to the existing signalized intersection at Terminal Drive/Liberty Mountain Drive.

## Solution Set 3 - Two-Way Left Turn Lane along the Route 29 Corridor

Converting the median space along Route 29 to a continuous two-way left turn lane (TWLTL) would allow direct access to both residential and commercial properties. Some of the advantages of incorporating a TWLTL along Route 29 are as follows:

- Delay can be reduced for both the through and side street volume by removing the left turning vehicles from the through lanes.
- Efficient access to both residential areas and businesses for vehicles which can produce an increase in economic development.
- Additional area is provided for the throughput of emergency vehicles.

Converting an open median to a TWLTL from an unsignalized intersection has a Crash Modification Factor (CMF) of 0.80 which indicates a decrease in the number of crashes.[21] The safety measures analysis shown in **Table 14** was completed by identifying fatal and injury crashes along the entire study area. **Table 14** also shows the Smart Scale travel time reliability scoring index estimated for the two-way left turn lane along the Route 29 Corridor. Travel lane design was selected as the major project type for these projects to identify incident and weather impact factors.

**Table 13**
**Smart Scale Safety and Reliability Measures**
**Two-Way Left Turn Lane along the Route 29 Corridor**

| Location | S1 | S2 | TTR |
|---|---|---|---|
| Entire Study Area | 155.60 | 183.28 | 2.75 |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
*TTR = Travel Time Reliability Index.*

### Solution Set 3 - Continuous Right Turn Lanes along the Route 29 Corridor

Specific areas of the Route 29 corridor can benefit from dedicated right turn lanes due to the dense number of frontage properties. This would allow easier direct access to the properties located on Route 29 without affecting the through movement of travel. However, additional right of way may need to be purchased in order to extend existing right turn lanes from one intersection to the next. Below are some areas along the Route 29 corridor that could benefit from continuous right turn lanes.

- Calohan Road to Lynbrook Road – The area from Calohan Road to Lynbrook Road is approximately 0.75 miles with a small commercial development area at Calohan Road, residential properties along Route 29 (both northbound and southbound) approaching English Tavern Road (southern connection), and Hyland Heights Baptist Church. There are existing northbound right turn lanes within this area that would be beneficial to connect together from one access point to the next.
- English Tavern Road (northern connection) to FNB Drive/Russell Woods Drive – English Tavern Road (northern connection) up to FNB Drive/Russell Woods Drive is approximately 1 mile in distance encompassing dense property frontages along Route 29. There are residential areas such as apartments, a Food Lion/Shopping Center, and various other commercial properties located in this 1 mile stretch of roadway. There are existing right turn lanes in both the northbound and southbound direction of Route 29 that could be extended from one access point to another.

The FHWA Crash Modification Factors Clearinghouse does not provide any CMFs that apply to continuous right turn lane configurations. However, the Transportation Research Board (TRB) Access

[21] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 1292 & 2341.

Management Manual provides some guidance on the use of continuous right turn lanes; a brief summary is provided below:

**Continuous Right-Turn Lane Special Considerations:**

- The maximum length of the turn lane is ½ mile.
- All connections have low volumes.
- A non-traversable median is present with no median openings.
- The continuous right-turn lane is discontinuous between signalized intersections.

**Continuous Right-Turn Lane Advantages:**

- This technique removes right-turn vehicles from the through-traffic lane.
- The difference in speed between turning and through traffic is limited.
- Safety is improved.
- Capacity is increased.
- Delay is reduced.

**Continuous Right-Turn Lane Disadvantages:**

- Safety and operational problems occur if the restrictive use of the lane is not obvious to drivers.
- Use of the technique may be impractical where cyclists are present, as the continuous right-turn lane can increase confusion for cyclist who are using the curb lane.

### Solution Set 3 - Modify Transportation Corridor Overlay District

Refer to Solution Set 2

### Solution Set 3 - Future Traffic Signal Locations

Proposed traffic signals could be recommended for long-term improvements at the following locations: Moorman Mill Road, Patterson Road, Lynbrook Road, and Hyland Drive. These locations would require a traffic signal warrants analysis to determine if a traffic signal is warranted. Based on the existing land use and recent rates of development it may take 10-20+ years before these intersections meet traffic signal warrants. Installing signals along the Route 29 corridor at these locations can help areas of future development by providing a direct access to businesses and dense areas of residential property.

The installation of a new signalized intersection has a Crash Modification Factor (CRF) of 0.65 which indicates a decrease in crashes.[22] The safety measures analysis shown in **Table 15** was completed by identifying crashes within a 250 ft radius of the proposed intersection location along Route 29 in both the northbound and southbound direction. **Table 15** also shows the Smart Scale travel time reliability scoring index estimated for the identified future signal locations. Traffic signal was selected as the major project type for these projects to identify incident and weather impact factors

[22] Virginia Department of Transportation. *Expected Roadway Project Crash Reductions for HB2 Safety Factor Evaluation.* 2015.

**Table 14**
**Smart Scale Safety and Reliability Measures**
**Future Signal Locations**

| Location | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| Moorman Mill Road | 2.10 | 2.47 | 0.25 | 0.25 |
| Patterson Road | 0.00* | 0.00* | 0.00* | |
| Lynbrook Road | 2.80 | 3.30 | 0.25 | |
| Hyland Drive | 1.05 | 1.24 | 0.25 | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
**No fatal or injury crashes located within a 250 ft radius of this road for 2011 - 2015.*
*TTR = Travel Time Reliability Index.*

**Table 16** displays the overall intersection delay for the proposed signalized intersections along the corridor. The analysis shows adequate delays for the 2040 Forecasted conditions using hypothetical volumes for the side streets (see discussion on hypothetical volumes on page 13).

**Table 15**
**HCM 2000 Signalized Intersection Analysis**
**Route 29 2040 Forecasted Conditions**

| Proposed Intersection Location | Overall Intersection Delay/Veh. (sec.) (LOS) | |
|---|---|---|
| | AM Peak Period | PM Peak Period |
| Moorman Mill Road | 22.2 (C) | 29.6 (C) |
| Patterson Road | 14.4 (B) | 50.1 (B) |
| Lynbrook Road | 29.9 (C) | 22.8 (C) |
| Hyland Drive | 21.1 (C) | 18.0 (B) |

## Solution Set 4: Smart and Alternative Transportation Solutions

The solutions identified in Solution Set 4 are displayed in **Figures 4-1, 4-2, 4-3, and 4-4**. The figures include the entire Route 29 study area from the U.S. Route 460 interchange ramps to the Route 24 Colonial Highway intersection.

### Solution Set 4 - TMS – Traffic Management System

A traffic management system along the Route 29 corridor would reduce congestion as well as to provide flexibility to respond to the conditions of the corridor in real time. Through the use of signal system communication, signals can respond appropriately to the current traffic conditions and also give priority to emergency response vehicles.

The installation of red-light cameras will help to lower the amount of red light running violators at the signalized intersections along the Route 29 corridor. The installation of red light running enforcement cameras has a Crash Modification Factor (CMF) of 0.676 which indicates a decrease in crashes.[23]

[23] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 6877. http://www.cmfclearinghouse.org/detail.cfm?facid=6877

TMS improvements could also include automated speed enforcement cameras (CMF of 0.83)[24] and updated signal system optimization/adaptive for the entire corridor (CMF of 0.92).[25] The safety measures analysis shown in **Table 17** was completed by identifying fatal and injury crashes along the entire study area. **Table 17** also shows the Smart Scale travel time reliability scoring index estimated for the TMS – traffic management system along the Route 29 corridor. Active traffic management and traffic signal design were selected as the major project type for these projects to identify incident and weather impact factors.

**Table 16**
**Smart Scale Safety and Reliability Measures**
**TMS – Traffic Management System**

| Solution | S1 | S2 | TTR | TTR (Combined) |
|---|---|---|---|---|
| Red-Light Cameras | 252.07 | 296.92 | 1.50 | 1.50 |
| Speed Enforcement Cameras | 132.26 | 155.79 | 1.50 | |
| Signal Optimization/Adaptive | 62.24 | 73.31 | 1.25 | |

*S1 = Equivalent property damage only (EPDO) of fatal and injury crashes expected to be reduced by the solution improvement.*
*S2 = Equivalent property damage only (EPDO) rate of fatal and injury crashes per million vehicle miles traveled (VMT) expected to be reduced by the solution improvement.*
*TTR = Travel Time Reliability Index.*

## Solution Set 4 - Smart Scale Funding Potential

Smart Scale, as previously described, is a project prioritization process in which regional entities submit projects to be considered to receive funding. Various types of projects may be submitted for funding eligibility including highway improvement projects such as roadway widening, access management, intelligent transportation systems (ITS), transit and rail projects, and transportation demand management projects. The projects are then scored after passing through a screening process related to VTRANS 2040. The scoring process breaks down the project into six different evaluation scores based on safety, congestion mitigation, accessibility, environmental quality, economic development, and land use (if applicable based on population) to achieve a final score. After a final score is given for each project, the project is ranked and given to the Commonwealth Transportation Board for future funding consideration. Below are four projects within Campbell County that could be considered for potential Smart Scale funding.[26]

### *Update Signalization of the Route 29 Corridor*

Shown in **Table 1**, the existing conditions of the Route 29 corridor displays acceptable overall intersection delays. However, the side street delays experience moderate to significant delays in both the AM and PM peak period. Also, the four northernmost intersections use INSYNC

[24] U.S. Department of Transportation Federal Highway Administration; Crash Modification Factors Clearinghouse, CMF ID: 4583. http://www.cmfclearinghouse.org/detail.cfm?facid=4583
[25] Virginia Department of Transportation. *Expected Roadway Project Crash Reductions for HB2 Safety Factor Evaluation.* 2015.
[26] Virginia Department of Transportation; Smart Scale: Funding the Right Transportation Projects. http://vasmartscale.org/about/default.asp

adaptive traffic control system which continually monitors traffic while making adjustments, providing slightly better operations than typical coordinated traffic systems. It would be beneficial to update the entire Route 29 corridor with the adaptive traffic control system to provide for the most optimal throughput on Route 29 and prepare for future year traffic conditions. **Table 17** shows the benefit with the safety measures for completing a corridor-wide optimization.

#### *Realignment of Leland Road with Lynbrook Road*

The realignment of Leland Road will allow a safe access to the residential communities on English Tavern Road and Lynbrook Road off of Route 29. The right-in/right-out entrance to Hyland Heights Student Ministries will be closed since there is a direct access on Leland Road. The median crossover at Leland Drive on Route 29 will be closed but the right-in/right-out access will remain open.

#### *Addition of Right Turn Lane from Lyn-Dan Drive to Lawyers Road*

The current intersection geometry of Lawyers Road and Route 29 makes both right turns onto Lawyers Road from southbound Route 29 and onto Route 29 from Lawyers Road very difficult. Trucks turning right onto southbound Route 29 from Lawyers Road have a small turning radius due to the alignment of Lawyers Road approaching Route 29. The proposed realignment would add a right turn lane on southbound Route 29, starting at Lyn-Dan Drive, and also properly realign Lawyers Road with the intersection.

#### *Realignment of Rangoon Street with Terminal Drive*

Realigning Rangoon Street with Terminal Drive would close the median crossover at Rangoon Street and traffic would access Route 29 by the signal at Terminal Drive/Liberty Mountain Drive. Terminal Drive serves the Lynchburg Regional Airport so the effects from the realignment of Rangoon Street and increased traffic on Terminal Drive would have to be analyzed to determine the operational impacts. Rangoon Street currently serves the commercial services of Banker Steel Company and its employees.

### Solution Set 4 - Multi-modal Service

A transportation strategy outlined in *Campbell County's Comprehensive Plan* is to incorporate bicycle and pedestrian facilities into appropriate areas within the county. The incorporation of a comprehensive bicycle and pedestrian plan will be necessary to determine the specific areas in need of multi-modal facilities that would benefit the residents and commuters throughout Campbell County. There were no pedestrian or bicycle related crashes within the crash analysis period (2011 - 2015) for the Route 29 corridor study area. According to the Desktop Reference for Crash Reduction Factors (CRF) from the Federal Highway Administration, the CRF range is 65% to 89% for the installation of both sidewalks and shared-use paths which indicates a decrease in vehicle-pedestrian related crashes.[27]

[27] Federal Highway Administration; An Analysis of Factors Contributing to "Walking Along Roadway" Crashes: Research Study and Guidelines for Sidewalks and Walkways. FHWA-RD-01-101, 2002.

### *Sidewalks and Shared-Use Paths*

A completed network of both sidewalk and shared-use path facilities along the corridor would allow trips of up to 1 mile to be completed comfortably by walking. Shared-use paths provide multi-modal transportation for both pedestrians and bicyclists, with bicyclists being the primary users. It also creates an opportunity for both recreational activity and scenic views within the County. Shared-use paths can be a separate pathway alongside the roadway or be a connected system away from the roadway. However, access and placement of shared-use paths is important so that users can gain full benefits. If the shared-use path is not near a developed residential area or within the popular area of the County, it may be necessary to incorporate a parking lot for users who are using their vehicle as a component of their trip. A network including a sidewalk and shared-use path can be completed in phases in areas where densities warrant installation based on both the current and developing population and businesses. The area from Calohan Road to the U.S. Route 460 interchange is a good candidate for multi-modal facilities as it serves as both a residential and commercial area. It is recommended that the sidewalk network be installed in the southbound direction of Route 29 and the shared-use path be installed in the northbound direction of Route 29, so that all multi-modal users can gain full benefit. Campbell County should prepare for multi-modal transportation by addressing it in the *Campbell County Comprehensive Plan* so that any new development can set aside right of way (ROW) for the future multi-modal facilities.

## Conclusion

Each defined solution set was developed to address the previously identified problems and provide themed solutions along the Route 29 corridor. Problems were identified by crash analysis, capacity analysis, reliability analysis, and through the public involvement process. **Table 18** summarizes the performance measures for each candidate solution set and well as the overall planning level cost for the solution set. **Table 19** displays a summary of the planning level costs for each of the solution set elements. The next step is to determine a preferred solution set for the Route 29 corridor based on the analysis and description of each solution element within this document. A blended solution set is the expected outcome based on a combination of solutions that have been presented. The recommended blended solution set is outlined in **Table 20,** with the respective VDOT planning level costs, for consideration by the stakeholders. The culmination of this stage of the project will provide a blended solution set that will be presented at a public meeting for citizens' input to provide the final tweaks to the blended solution set.

**Table 18 - Performance Measures Applied to the Candidate Solution Sets**

| Goal | Objective | Performance Measure | Set 1 - Arterial Capacity and Throughput | Set 2 - Corridor Safety | Set 3 - Economic Development | Set 4 - Smart and Alternative Transportation Solutions |
|---|---|---|---|---|---|---|
| Promote a Safe Transportation System | Reduce motor vehicle crashes | Equivalent Property Damage Only (EPDO) of fatal and injury crashes expected to be reduced | • 34 - Median Crossover Closures<br>• 11 - Turn Lane Extensions<br>• 11 - New Turn Lanes<br>• 5 - RCUT Intersections | • 190 (Fatal Injury) & 72 (Serious Injury) - Speed Limit Reduction<br>• 34 - Median Crossover Closures<br>• 11 - Turn Lane Extensions<br>• 11 - New Turn Lanes<br>• 5 - RCUT Intersections | • 156 - Install TWLTL in median space along Route 29 | Traffic Management System<br>• 252 - Red Light Camera<br>• 132 - Speed Enforcement Cameras<br>• 62 - Signal Optimization |
| Promote an Efficient Transportation System | Reduce delay | SimTraffic delay - 2040 conditions | • 0.80 min. decrease - Flashing Yellow Arrow (FYA) Installation at Calohan Rd. and Route 29 intersection | • 4.91 min. increase (two directions combined)- Speed Limit Reduction along Route 29 | N/A | N/A |
| | Improve Reliability | Travel Time Reliability Index | • 1.00 - Median Crossover Closures<br>• 0.50 - Median Left-In Only with Right-In/Right-Out<br>• 2.75 - Left Turn Lane Extensions<br>• 0.75 - Right Turn Lane Extensions<br>• 0.25 - Left Turn Lane Addition<br>• 0.75 - Right Turn Lane Addition<br>• 0.25 - RCUTS<br>• 0.25 - Install FYA at Calohan Rd. Signal | • 1.00 - Median Crossover Closures<br>• 0.50 - Median Left-In Only with Right-In/Right-Out<br>• 2.75 - Left Turn Lane Extensions<br>• 0.75 - Right Turn Lane Extensions<br>• 0.25 - Left Turn Lane Addition<br>• 0.75 - Right Turn Lane Addition<br>• 0.25 - RCUTS<br>• 3.00 - Proposed Speed Limit Changes | • 0.25 - Future Signal Locations:<br>Moorman Mill Road<br>Patterson Road<br>Lynbrook Road<br>Hyland Drive<br>• 2.75 - Install Two-way left-turn lane within the median space along Route 29 | • 1.50 – Traffic Management System to include red-light camera, speed enforcement cameras, and signal optimization/adaptive |
| Promote a Transportation System Compatible with Existing and Future Land Use | Improve vehicular access to points in the corridor for passenger travel | Movement Delay for turning lefts and rights at existing and proposed solution conditions - 2040 conditions | **RCUTs (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit** | **RCUTs (Movement Delay/Veh. (sec.)) with Speed Limit Changes along the Corridor** | **Future Signalized Intersections** | N/A |

| Intersection | NBL | SBL | EBR | WBR | NBU | SBU |
|---|---|---|---|---|---|---|
| Moorman Mill Rd | 10.5 (17.0) | 15.2 (10.9) | 15.3 (34.7) | 28.2 (16.3) | 12.8 (86.8) | 22.8 (11.2) |
| Patterson Rd | 10.5 (17.0) | 27.2 (15.1) | 15.3 (34.7) | N/A | 10.6 (50.7) | 46.6 (10.5) |
| Lynbrook Rd | 9.9 (16.5) | 27.0 (15.3) | 14.0 (32.8) | 88.5 (28.7) | 52.8 (81.8) | 324.4 (36.8) |
| Hyland Drive | 9.9 (16.5) | 27.0 (15.3) | 14.0 (32.8) | 88.5 (28.7) | 56.8 (42.6) | 469.2 (53.7) |

Median Crossover (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit

| Median Locations on Route 29 Corridor | NBL | SBL | EBR | WBR |
|---|---|---|---|---|
| Northern End of Corridor | 10.8 (25.2) | 26.1 (15.1) | ∗ | ∗ |
| Southern End of Corridor | 9.9 (15.6) | 14.0 (10.3) | ∗ | ∗ |

| Intersection | NBL | SBL | EBR | WBR | NBU | SBU |
|---|---|---|---|---|---|---|
| Moorman Mill Rd | 10.5 (17.0) | 15.2 (10.9) | 15.3 (34.7) | 28.2 (16.3) | 12.6 (103.0) | 23.0 (14.8) |
| Patterson Rd | 10.5 (17.0) | 27.2 (15.1) | 15.3 (34.70) | N/A | 10.3 (51.2) | 33.6 (14.5) |
| Lynbrook Rd | 9.9 (16.5) | 27 (15.3) | 14.0 (32.8) | 88.5 (28.7) | 10.0 (76.8) | 160.7 (33.9) |
| Hyland Drive | 9.9 (16.5) | 28 (15.3) | 14.0 (32.8) | 88.5 (28.7) | 13.4 (33.8) | 385.5 (33.9) |

Median Crossover (Movement Delay/Veh. (sec.)) with Existing Corridor Speed Limit

| Median Locations on Route 29 Corridor | NBL | SBL | EBR | WBR |
|---|---|---|---|---|
| Northern End of Corridor | 10.8 (25.2) | 26.1 (15.1) | ∗ | ∗ |
| Southern End of Corridor | 9.9 (15.6) | 14.0 (10.3) | ∗ | ∗ |

| Proposed Signalized Intersection | AM Overall Intersection Delay/Veh. (sec) | PM Overall Intersection Delay/Veh. (sec) |
|---|---|---|
| Moorman Mill Rd | 22.2 (LOS C) | 29.6 (LOS C) |
| Patterson Rd | 14.4 (LOS B) | 50.1 (LOS B) |
| Lynbrook Rd | 29.9 (LOS C) | 22.8 (LOS C) |
| Hyland Dr | 21.1 (LOS C) | 18.0 (B) |

| VDOT Planning Level Cost Estimates per Solution Set | $11,155,000 | $10,295,000 | $26,350,000 | $11,245,000 |
|---|---|---|---|---|

∗- Movement Delay Exceeds 300s
XX(XX) - AM(PM)

**Table 19 - VDOT Planning Level Cost for Solution Set Elements**

| Solution Set | Proposed Improvement | Number of Sites | Planning Level Cost per Site (2016) | Total Element Cost | Total Solution Cost |
|---|---|---|---|---|---|
| Solution Set 1 – Arterial Capacity and Throughput | Closure of Median Crossovers Low Cost | 2 | $10,000 | $20,000 | $11,155,000 |
| | Closure/Modification of Median Crossovers High Cost | 10 | $25,000 | $250,000 | |
| | Lengthen Left Turn Lane Storage & Taper | 15 | $100,000 | $1,500,000 | |
| | Install Left Turn Lane | 8 | $225,000 | $1,800,000 | |
| | Lengthen Right Turn Lane Storage & Taper | 6 | $100,000 | $600,000 | |
| | Install Right Turn Lane | 5 | $225,000 | $1,125,000 | |
| | Various Signal Improvements (Calohan Road) | 1 | $10,000 | $10,000 | |
| | Access Modification - Antsey Road | 1 | $25,000 | $25,000 | |
| | Access Modification - Realignment of Leyland Drive @ Hyland Heights Church | 1 | $775,000 | $775,000 | |
| | Access Modification - Realignment of Rangoon Street | 1 | $50,000 | $50,000 | |
| | Install R-Cut Median Access Points | 4 | $1,250,000 | $5,000,000 | |
| Solution Set 2 – Corridor Safety | Closure of Median Crossovers Low Cost | 2 | $10,000 | $20,000 | $10,295,000 |
| | Closure/Modification of Median Crossovers High Cost | 10 | $25,000 | $250,000 | |
| | Lengthen Left Turn Lane Storage & Taper | 15 | $100,000 | $1,500,000 | |
| | Install Left Turn Lane | 8 | $225,000 | $1,800,000 | |
| | Lengthen Right Turn Lane Storage & Taper | 6 | $100,000 | $600,000 | |
| | Install Right Turn Lane | 5 | $225,000 | $1,125,000 | |
| | Install R-Cut Median Access Points | 4 | $1,250,000 | $5,000,000 | |
| Solution Set 3 – Economic Development | Acc. Mod. - Realignment of Leyland Drive @ Hyland Heights Church w/signal | 1 | $1,075,000 | $1,075,000 | $26,350,000 |
| | Lawyers Road Intersection Realignment - 2 new turn lanes. | 2 | $225,000 | $450,000 | |
| | Access Modification - Realignment of Rangoon Street | 1 | $50,000 | $50,000 | |
| | Future Signals (Moorman Mill, Patterson, Lynbrook, Hyland) | 4 | $300,000 | $1,200,000 | |
| | Lengthen Turn Lanes at Future Signals | 9 | $100,000 | $900,000 | |
| | Install New Turn Lanes at Future Signals | 3 | $225,000 | $675,000 | |
| | Two-Way Center Left-Turn Lane Installation - 6 miles | 1 | $12,000,000 | $12,000,000 | |
| | Continuous Right Turn Lane Installation - 6 miles (both directions) | 1 | $10,000,000 | $10,000,000 | |
| Solution Set 4 – Smart and Alternative Transportation Solutions | Sidewalks - Calohan to Rt. 460 | 1 | $2,750,000 | $2,750,000 | $11,245,000 |
| | Shared Use Path- Calohan to Rt. 460 | 1 | $6,200,000 | $6,200,000 | |
| | Red -Light Cameras | 6 | $100,000 | $600,000 | |
| | Signal Optimization/Adaptive | 2 | $60,000 | $120,000 | |
| | Speed Enforcement Cameras | 4 | $75,000 | $300,000 | |
| | Access Modification - Realignment of Leyland Drive @ Hyland Heights Church | 1 | $775,000 | $775,000 | |
| | Roadway Improvement - Right Turn Lane from Lyn Dan Drive to Lawyers Road on Route 29 and realign Lawyers Road with the signal to better serve trucks turning right onto SB Route 29 | 2 | $225,000 | $450,000 | |
| | Access Modification - Realignment of Rangoon Street | 1 | $50,000 | $50,000 | |

## Blended Solution Set

It is recommended to adopt a blended solution set for the Route 29 corridor containing various elements of each solution set previously identified within COR-6. The blended solution set listed in **Table 20** was developed based on the evaluation measures, public and stakeholder input, and costs.

**Table 20**
**Blended Solution Set Planning Level Costs**

| Blended Solution Set | | | | |
|---|---|---|---|---|
| **Solution Element** | **Solution Set Category** | **# Sites** | **Cost per site (2016)** | **Total Element Cost** |
| Closure of Median Crossovers Low Cost | 1 & 2 | 2 | $10,000 | $20,000 |
| Closure/Modification of Median Crossovers High Cost | 1 & 2 | 10 | $25,000 | $250,000 |
| Lengthen Left Turn Lane Storage & Taper | 1 & 2 | 15 | $100,000 | $1,500,000 |
| Install Left Turn Lane | 1 & 2 | 8 | $225,000 | $1,800,000 |
| Lengthen Right Turn Lane Storage & Taper | 1 & 2 | 6 | $100,000 | $600,000 |
| Install Right Turn Lane | 1 & 2 | 5 | $225,000 | $1,125,000 |
| Various Signal Improvements (Calohan Road) | 1 & 2 | 1 | $10,000 | $10,000 |
| Access Modification - Antsey Road | 1 | 1 | $25,000 | $25,000 |
| Access Modification - Realignment of Leyland Drive @ Hyland Heights Church | 1, 2 & 3 | 1 | $775,000 | $775,000 |
| Access Modification - Realignment of Rangoon Street | 1, 2 & 3 | 1 | $50,000 | $50,000 |
| Install RCUT Median Access Points | 1 & 2 | 4 | $1,250,000 | $5,000,000 |
| Sidewalks - Calohan to Rt. 460 | 4 | 1 | $2,750,000 | $2,750,000 |
| Shared Use Path - Calohan to Rt. 460 | 4 | 1 | $6,200,000 | $6,200,000 |
| Speed Limit Reduction | 2 | 2 | N/A | $0 |
| **Total Estimated Cost** | | | | **$20,105,000** |

### *Blended Solution Set Elements*

Median Crossover Closures and Modifications – The median crossover locations chosen for closure and modifications (median left-in with right-in/right-out) were recommended for the blended solution set based on VDOT Access Management guidelines. Majority of these crossovers were serving U-turn movements or an access a small residential area of business. The closure/modification of these median crossovers would not hinder crucial access because there is nearby intersections for vehicles to utilize.

Turn Lane Extensions and New Turn Lanes – Various locations of new turn lanes and turn lane extensions in accordance with VDOT standards are recommended in the blended solution set. A turn lane gives vehicles time to safely decelerate out of the mainline traffic lane. The common rear-end crashes that occur as vehicles access businesses and residential areas without appropriate turn lanes can be reduced by this solution element.

Signal Improvement at the Calohan Road Intersection – A flashing yellow arrow (FYA) at the Calohan Road intersection for the southbound left turn movement on Route 29 to eastbound Calohan Road is a

low cost solution that would decrease delay for vehicles. A FYA is installed at 3 of the northern signals within this corridor, so both the commuter and local traffic would be familiar with the operation of the proposed FYA.

Restricted Crossing U-Turn (RCUT) Intersection – RCUT intersections are proposed at 4 locations and are recommended in the blended solution as they reduce the number of conflicts in comparison to a traditional median crossover. Even though the cost is relatively high per installation (estimated at $1,250,000), the delay for the side street movements will significantly decrease.

Speed Limit Reduction – There are 3 areas suggested for reducing the existing speed limit. The recommendation was made in order to have a consistent flow of traffic from the beginning to the end of the Route 29 study corridor. The recommendation outlined in Solution Set 2 suggests that the first segment from the Colonial Highway intersection to the Calohan Road intersection be reduced from 60 MPH to 55 MPH. The next segment from the Calohan Road intersection to the Lawyers Road intersection would be reduced from 60 MPH to 45 MPH. The third segment from the Lawyers Road intersection to the U.S. Route 460 Interchange is suggested to be reduced from 45 MPH to 35 MPH. A compromise in balancing travel time (higher speed limits) and safety (lower speed limits) is reached by modifying the speed limit to 45 MPH for both segments 2 and 3 (which is different than what is presented in Solution Set 2). Segment 1 is recommended to be reduced from 60 MPH to 55 MPH as originally described.

Multi-modal Facilities – Pedestrian and bicycle facilities are non-existent along the Route 29 corridor. It is important that these facilities be provided for the percentage of the population that cannot operate a motorized vehicle or do not have access to one. The recommended facilities of sidewalks and shared-use paths can be completed in phases when funding is available. This is an important element to include in the blended solution set as it provides vital access to residential areas and businesses for all users.

New Realignments/Roadway Modifications – The new realignment or roadway modification of Lynbrook Road, Lawyers Road, Rangoon Street, and Anstey Road are recommended in the blended solution set based on stakeholder and public input. These 4 locations have sight distance, geometric, and access management concerns which create safety issues for travelers.

### *Solution Elements Eliminated*

Two-Way Left-Turn Lane (TWLTL) – It was determined that the high cost ($12,000,000) for installing a TWLTL along the Route 29 corridor median space was not worth the benefit gained of providing direct access for vehicles. Even though the performance evaluation measures showed a reduction in EPDO and a high travel time reliability index, there are alternative solutions that are substantially less in cost. These more cost effective solutions include the turn lane extensions and new turn lanes along the corridor with a total cost of $5,025,000. The left turn volume on majority of the corridor, in both existing and future year conditions, does not have operational demands that would indicate a need for a TWLTL.

Continuous Right Turn Lane – A continuous right turn lane along the Route 29 corridor was eliminated from the blended solution set for the same reasons as the TWLTL, the cost outweigh the benefits.

Traffic Management System (TMS) – The traffic management system along the Route 29 corridor would include a combination of red-light cameras, speed enforcement cameras, and an update to the signals' optimization/adaptive control. The 4 northernmost signals within this corridor (English Tavern Road – northern connection, Lawyers Road, Russell Woods Drive, and Terminal Drive/Liberty Mountain Drive) have INSYNC adaptive traffic control for responding to the corridor's real time traffic conditions. These solution elements were eliminated due to the corridor's current traffic conditions as well as input from the stakeholders and Campbell County Comprehensive Plan that the addition of new signals along the corridor is not favored. Therefore, the TMS solution element for the existing 6 signals along the corridor is a low priority.

Future Signalized Intersections – New signalized intersections were proposed at 4 locations including Moorman Mill Road, Patterson Road, Lynbrook Road, and Hyland Drive. These signalized intersections were proposed to accommodate future land development areas along the corridor. Based on the input from the stakeholders, it was recommended that additional signals not be installed along the Route 29 corridor. There are benefits from signalized intersections, mostly with economic development; however, the intersection would have to undergo a signal warrants analysis. Without substantial growth, it is unlikely that these intersections will meet warrant conditions.

Modify the Transportation Corridor Overlay District – Modifying the current Transportation Corridor Overlay District would help minimize future development of properties with small lot frontages. Access management and capacity and throughput of the Route 29 corridor could be improved with this type of solution. However, this solution element was eliminated based on input from the stakeholders and the amount of collaboration that would be required from property owners to agree upon shared access points instead of their existing direct access on the Route 29 corridor.