Independence Boulevard Corridor Study

Technical Report

May 2006

Independence Boulevard (Route 122)
Corridor Study
City of Bedford, Virginia

Prepared by
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In Cooperation with
Region 2000 Local Government Council
City of Bedford, Virginia
and
Virginia Department of Transportation

May 2006

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1.1 – Roadway Geometry

Independence Boulevard (Route 122) from East Main Street (US 460 Business) to Forest Road (US 221) consists of a two to four-lane cross section with a total length of 1.78 miles, a minimum right-of-way width of 90 feet, and a posted speed limit of 45 mph. This road was built and open to traffic during 1993. The four-lane sections include curb and gutter while the two-lane and transition sections include unpaved shoulders with a width of six feet or greater. The travel lanes have a width of 12 feet. Not including the beginning and ending points, there are four intersections with public roads, including Freedom Lane, Orange Street, Dawn Drive, and Shady Knoll Avenue/Venture Boulevard. Three of these intersections are currently unsignalized; however, a traffic signal has recently been installed at the intersection of Independence Boulevard and Freedom Lane. The Norfolk & Western Railroad crosses over Independence Boulevard at a point between Orange Street and Dawn Drive. Based upon the original construction plans, the ultimate cross-section for the entire section of road consists of a four-lane undivided, curb and gutter facility with sidewalks on both sides of the road *(Exhibit 1 describes the existing roadway conditions between intersections. See Exhibits 2, 3, 4, 5, 6, 7, and 8 for digital photos of the segments).*

Exhibit 1 – Existing Roadway Geometry

Segments	Number of Lanes	Pavement Width	Typical Section
East Main Street to Freedom Lane	3 to 4	48	C&G/Shoulder
Freedom Lane to Southern States	3	34	Shoulder
Southern States to South of Orange Street	2	24[A]	Shoulder
South of Orange Street to Dawn Street	2 to 4	48[B]	C&G
Dawn Street to North of Shady Knoll Avenue	3	36[C]	Shoulder
North of Shady Knoll Avenue to South of Forest Road	2	24[D]	Shoulder
South of Forest Road to Forest Road	4	48	C&G/Shoulder

Note A: Southbound right-turn lane at Southern States
Note B: Northbound and southbound right-turn lanes at Orange Street
Note C: Southbound right-turn lane at Dawn Street and northbound right-turn lane at Venture Boulevard
Note D: Northbound right-turn lane at Dominion of Bedford, Inc.

Exhibit 2 – Segment 1 (East Main Street to Freedom Lane)

Exhibit 3 – Segment 2 (Freedom Lane to Southern States)

Exhibit 4 – Segment 3 (Southern States to South of Orange Street)

Exhibit 5 – Segment 4 (South of Orange Street to Dawn Street)

Exhibit 6 – Segment 5 (Dawn Street to North of Shady Knoll Avenue)

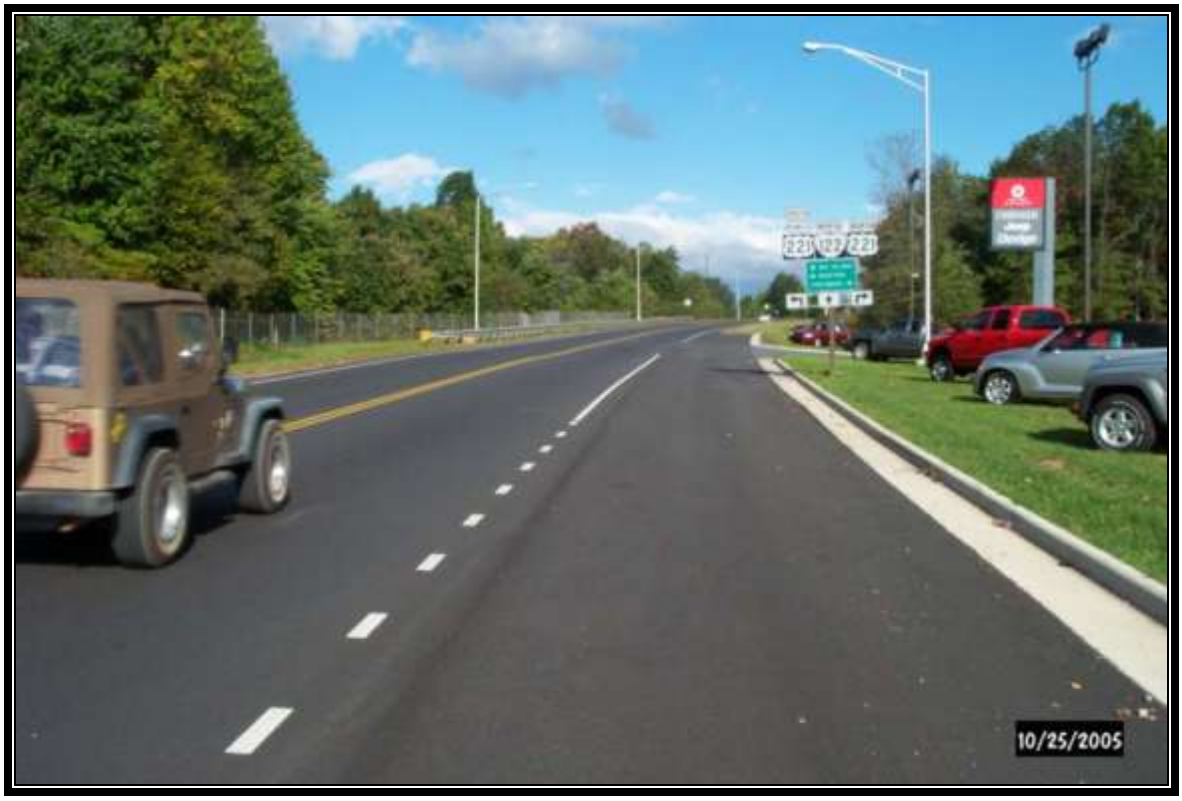

Exhibit 7 – Segment 6 (North of Shady Knoll Avenue to South of Forest Road)

Exhibit 8 – Segment 7 (South of Forest Road to Forest Road)

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1.2 - Zoning

Current zoning along the Independence Boulevard corridor includes General Business District (B-2), Manufacturing District (M-1), and Workplace Campus District (WCD). As described in the City of Bedford's zoning ordinance, the business districts have been designed to accommodate uses in a nodal development pattern. Provision is made for the conduct of general business to which the public requires direct and frequent access, but which is not characterized by either constant heavy trucking other than stocking and delivery of retail goods, or by any nuisance factors other than occasioned by incidental noise of congregation of people and passenger vehicles. The manufacturing district has been designed to accommodate industrial uses that provide desirable employment consistent with the goal of maintaining the city's high environmental quality. High performance requirements have been established including additional protection from adverse environmental effects for residential districts bordering the district. This district is protected against encroachment from commercial or residential uses. The workplace campus district has been designed to provide what is generally known as an industrial park for the location of environmentally clean light and medium manufacturing activities, warehousing, wholesale distribution, research and development, and office complexes. Certain uses of a commercial or business nature *(such as restaurants and limited retail shops)* that serve the employees who work on site are incorporated as accessory uses in order to provide an attractive work environment (See Exhibit 9).

On Tuesday, February 28, 2006, the Bedford City Council approved by unanimous vote a new zoning district known as the Special Corridor Overlay District (SCOD). The intent of this new district is to maintain the long-term mobility of arterial roadways *(such as VA 122, US 221, and US 460)*; to limit access and the number of conflicts *(thereby reducing the need for additional crossover locations and traffic signals)*; to promote improved pedestrian and vehicular circulation; to encourage land assembly and the most desirable use of land in accordance with the comprehensive plan; to promote architectural continuity; to encourage designs which produce a desirable relationship between individual buildings, the circulation systems, and adjacent areas; and to permit a flexible response of development to the market. This district shall apply only to specific areas as determined by City Council.

In addition, the City of Bedford is currently considering rezoning a major part of the Independence Boulevard corridor south of Orange Street from Manufacturing (M-1) to General Business (B-2).

At this time, much of the available property along both sides of Independence Boulevard is undeveloped with only four existing businesses having direct access to the road. These businesses include CVS Pharmacy, Southern States Cooperative, Quality Water Systems, and Dominion of Bedford *(Chrysler, Dodge, Jeep dealership)*.

Exhibit 9 – City of Bedford Zoning Map

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1.3 – Traffic Data

According to traffic volume information furnished by the Virginia Department of Transportation (VDOT), traffic counts are collected periodically at three locations along Independence Boulevard (Route 122). These locations include the section between East Main Street and Orange Street (Location # 1), the section between Orange Street and Dawn Street (Location # 2), and the section between Dawn Street and Forest Road (Location # 3). Traffic volume information is not available for the years 1994 to 1996 and the 1997 volumes were based on historical estimates and not actual counts. Data for the year 2005 is not available until later in the spring of 2006. Although the seven-year time period from 1998 to 2004 indicates an annual growth rate of 3.3 percent, the four-year time period from 2001 to 2004, indicates that the traffic volumes have actually experienced no growth (See Exhibit 10).

The City of Bedford collected 24-hour tube traffic counts at four locations along Independence Boulevard (Route 122) during February 2006. These counts range from a low of 10,300 vehicles per day to a high of 12,200 vehicles per day, which is an apparent spike compared to the volumes listed in Exhibit 10. At this time, it is not known if these traffic counts indicate a new trend along Independence Boulevard; therefore, they are not used to help determine the annual growth for this study.

Exhibit 10 –Traffic Volume History

Year	Location # 1	Location # 2	Location # 3
1998	8,100 vpd	7,500 vpd	7,500 vpd
1999	7,700 vpd	7,200 vpd	7,200 vpd
2000	7,700 vpd	7,100 vpd	7,200 vpd
2001	9,800 vpd	9,900 vpd	8,600 vpd
2002	9,600 vpd	9,700 vpd	8,500 vpd
2003	9,500 vpd	9,600 vpd	8,400 vpd
2004	9,400 vpd	9,200 vpd	8,200 vpd

Source: Virginia Department of Transportation (VDOT)
(Traffic volumes rounded up to the nearest hundred)

8-hour turning movement traffic counts were collected at the intersection of East Main Street (US 460 Business) and Independence Boulevard (Route 122) and at the intersection of Forest Road (US 221) and Independence Boulevard (Route 122) during September 2005 during the am, mid-day, and pm peak time periods (See Appendix A).

1.4 – Capacity Analyses

Using methodology contained in the ***Highway Capacity Manual (HCM) 2000 Edition***, which is published by the Transportation Research Board, capacity analyses were performed at two existing signalized intersections; specifically, the intersections at East Main Street and at Forest Road during the morning and afternoon peak hours for existing and future conditions. The existing conditions were based on turning movement traffic counts that were collected during September 2005 and the future conditions were based on these traffic counts projected at an annual growth rate of 1.5 percent for 25 years to the year 2030.

The software program ***HCS2000, Version 4.1f*** was used for the capacity analyses and the following assumptions were included in order to create a worst-case scenario. First, although the existing traffic signals operate in a semi-actuated, isolated mode, the intersections were analyzed with the traffic signals optimized in a pre-timed mode, then adjusted to the maximum and minimum timings that were furnished by the City of Bedford. If an acceptable level of service can be achieved in pre-timed operation, it is reasonable to conclude that the actuated mode of operation will perform at or better than the pre-timed level of service. It should be noted that, although this conclusion is conservative for the level of service (LOS), it would provide a lower v/c ratio than the average timings. Second, no right turns on red (RTOR) were included during any phase and third, a five percent factor for heavy vehicles was used along all approaches.

The results of the capacity analyses for the base year of 2005 and the future year of 2030 at the East Main Street intersection indicate that levels of service (LOS) of "C" or better will be realized during both the am and pm peak hours on all approaches with a level of service (LOS) of "B" realized for the entire intersection and a control delay ranging from 10.4 seconds per vehicle to 17.8 seconds per vehicle for the entire intersection (See Exhibit 11).

Exhibit 11 – East Main Street and Independence Boulevard

Approach	Peak Hour	2005		2030	
		LOS	Delay	LOS	Delay
Eastbound *(East Main Street)*	AM	A	6.8	A	7.3
Westbound *(East Main Street)*	AM	A	6.6	A	7.8
Southbound *(Independence Blvd)*	AM	C	22.1	C	25.9
Entire Intersection	AM	B	10.4	B	12.1
Eastbound *(East Main Street)*	PM	B	10.4	B	11.6
Westbound *(East Main Street)*	PM	B	13.4	B	14.5
Southbound *(Independence Blvd)*	PM	B	18.1	C	25.2
Entire Intersection	PM	B	14.3	B	17.8

The results of the capacity analyses for the base year of 2005 and the future year of 2030 at the Forest Road intersection indicate that levels of service (LOS) of "C" or better will be realized during both the am and pm peak hours on all approaches with a level of service (LOS) of "C" or better realized for the entire intersection and a control delay ranging from 19.4 seconds per vehicle to 29.6 seconds per vehicle for the entire intersection (See Exhibit 12).

Exhibit 12 – Forest Road and Independence Boulevard/Longwood Avenue

Approach	Peak Hour	2005		2030	
		LOS	Delay	LOS	Delay
Eastbound *(Forest Road)*	AM	B	16.8	C	22.1
Westbound *(Forest Road)*	AM	C	21.2	C	26.6
Northbound *(Independence Blvd)*	AM	C	20.7	C	26.7
Southbound *(Longwood Ave)*	AM	B	19.5	C	22.5
Entire Intersection	AM	B	19.4	C	24.6
Eastbound *(Forest Road)*	PM	B	17.9	C	28.5
Westbound *(Forest Road)*	PM	C	22.5	D	36.0
Northbound *(Independence Blvd)*	PM	C	21.0	C	28.2
Southbound *(Longwood Ave)*	PM	B	17.2	B	18.8
Entire Intersection	PM	B	19.8	C	29.6

1.5 – Safety Analysis – Crash History

The City of Bedford's Police Department furnished crash data along Independence Boulevard for a 6-year time period beginning on January 1, 2000 and ending on December 31, 2005. During this time period, a total of 211 reported crashes occurred. Summarizing the data reveals that the heaviest month for the crashes is December, the heaviest day is Friday, and the heaviest hour is from 3:00 pm until 4:00 pm. The most common crash type is rear-end, followed by angle and deer/other animal strikes. As discussed in the Bedford 2020 Transportation Plan, an unusually large number of crashes involving drivers hitting deer occurred in the City of Bedford during the years 1996 to 1998 *(131 reported crashes)*. 26 of these crashes occurred along Independence Boulevard during this time period compared to 50 crashes for the most recent time period. Rear-end and angle type crashes typically occur at or near intersections. It should be noted that many crashes are unreported for a variety of reasons; therefore, more crashes might have occurred in the study area (See Exhibits 13, 14, 15, and 16).

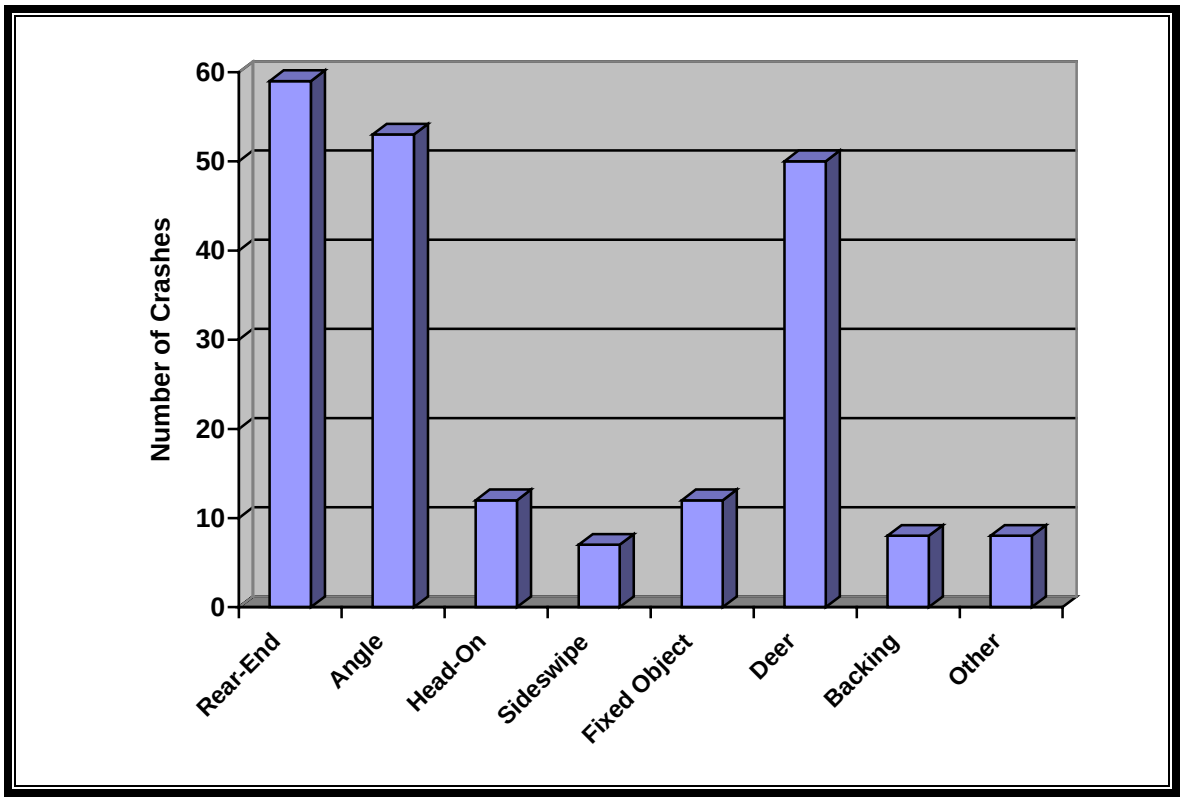

Exhibit 13 – Crash Type (6-Year History)

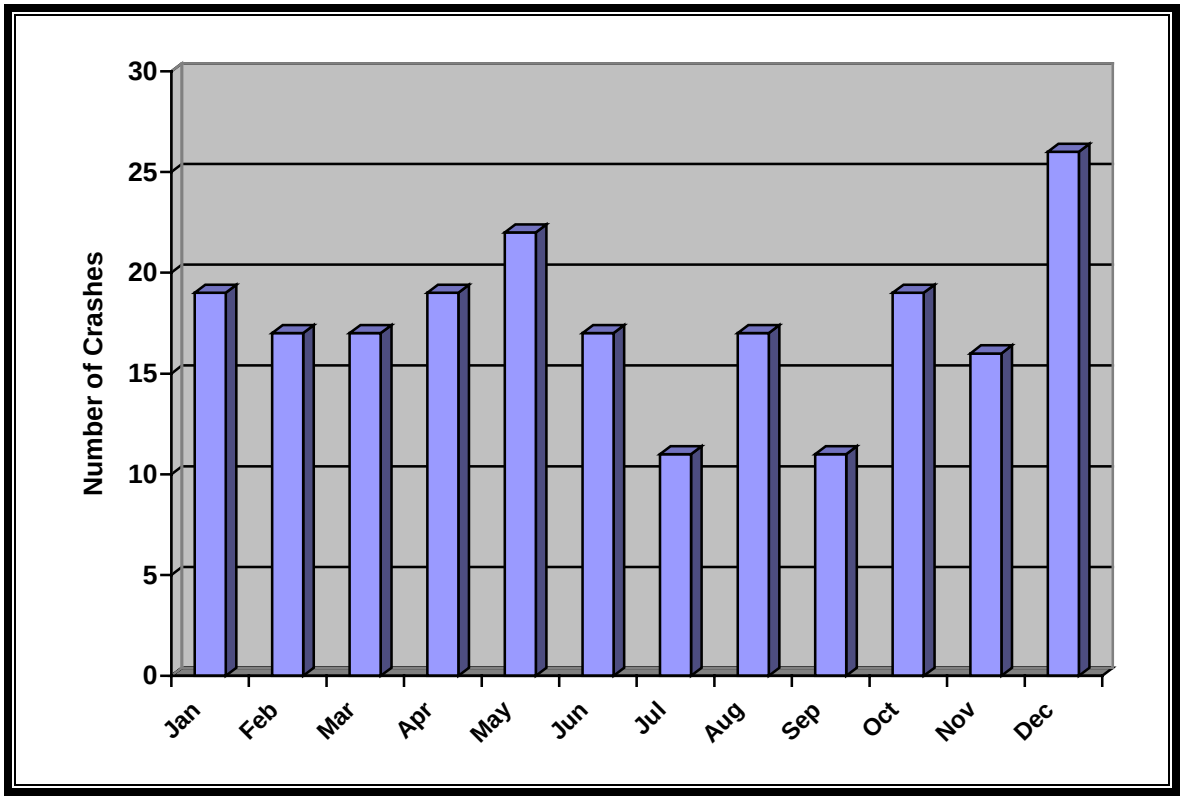

Exhibit 14 – Crashes By Month (6-Year History)

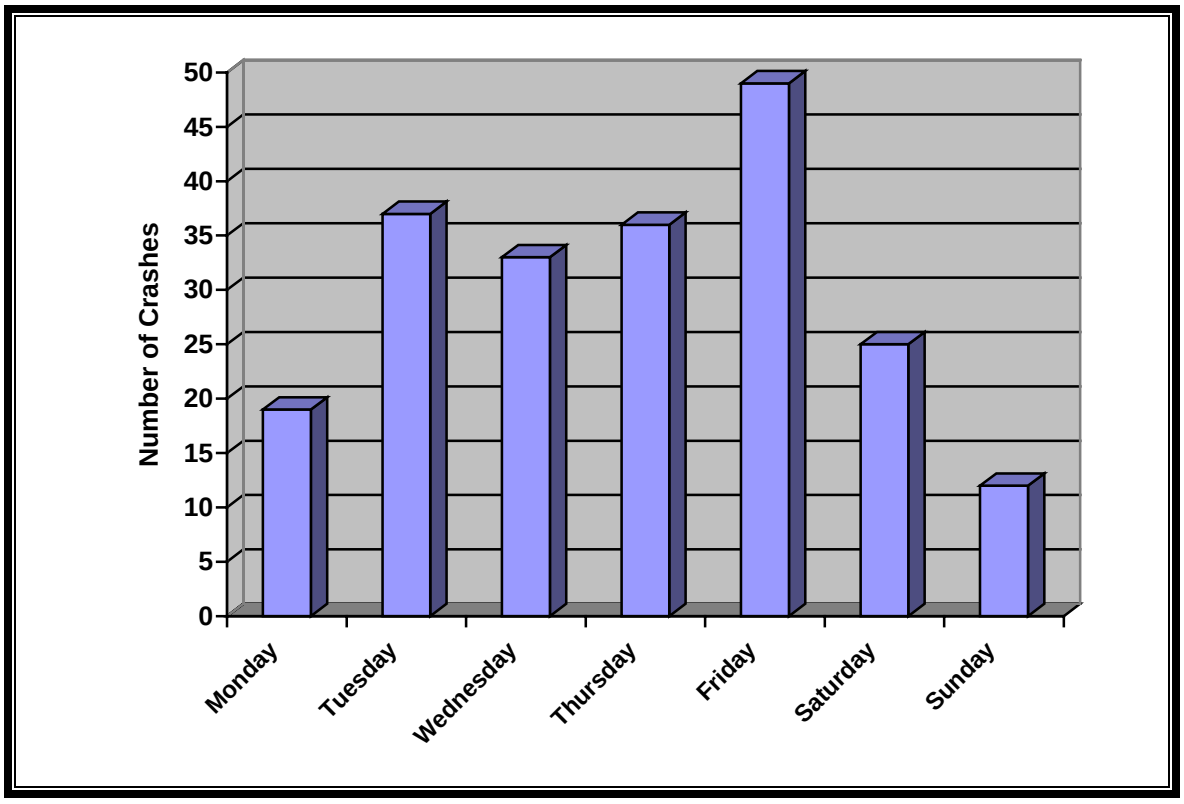

Exhibit 15 – Crashes By Day Of Week (6-Year History)

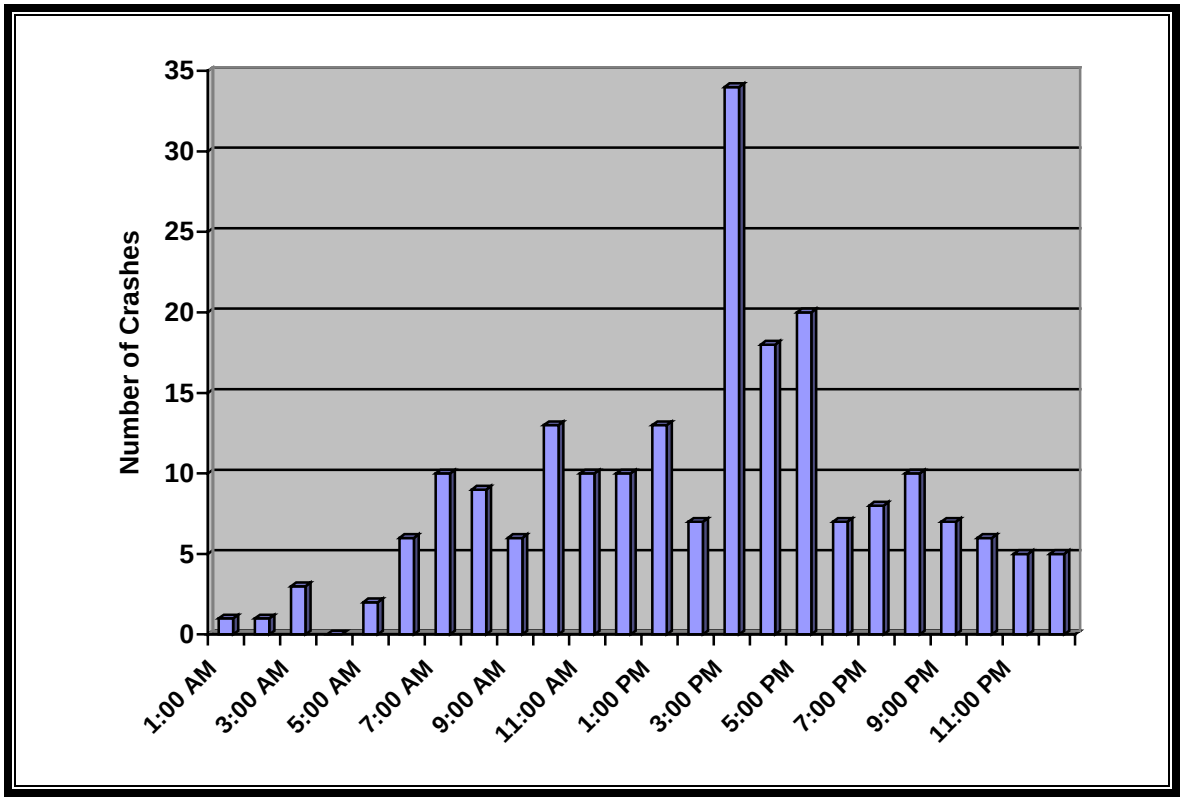

Exhibit 16 – Crashes By Time Of Day (6-Year History)

1.6 – Access Management

According to the ***Access Management Manual (2003)***, which is published by the Transportation Research Board, access management is defined as the systematic control of the location, spacing, design, and operation of driveways, median openings, interchanges, and street connections to a roadway. It also involves roadway design applications, such as median treatments and auxiliary lanes, and the appropriate spacing of traffic signals. The purpose of access management is to provide vehicular access to land development in a manner that preserves the safety and efficiency of the transportation system. Objectives to consider in establishing access design criteria include the following items:

- Preserve the functional intent of the roadway to which access is to be provided.
- Minimize the difference in speed between turning vehicles and through traffic to produce a safe traffic environment.
- Eliminate encroachment of turning vehicles on adjacent lanes.
- Use a combination of throat width and return radii that will accommodate the intended exit and entry operations of the selected design vehicle.
- Provide adequate sight distance for drivers exiting the site.
- Provide sufficient storage within the driveway for traffic entering the site to prevent spill-back onto the abutting road.
- Provide sufficient queuing within the driveway to produce efficient traffic flow for vehicles leaving the site.
- Minimize the number of conflict points at the junction of the access connection with the abutting road.
- Provide adequate storage for turn lanes and within access connections to accommodate peak traffic demand.

The Special Corridor Overlay District (SCOD) that was approved by the City of Bedford would implement many of these objectives.

Exhibit 17 illustrates various access management techniques including no direct access points along the main roadway, joint-use access *(between properties)*, a median opening with left-turn lanes and a right-turn lane, an internal roadway network, buildings located to the front of the property, and parking located to the rear of the property. This exhibit also illustrates the additional right-of-way needed to accommodate the right-turn lane *(the developer would probably be required to furnish the additional right-of-way)*.

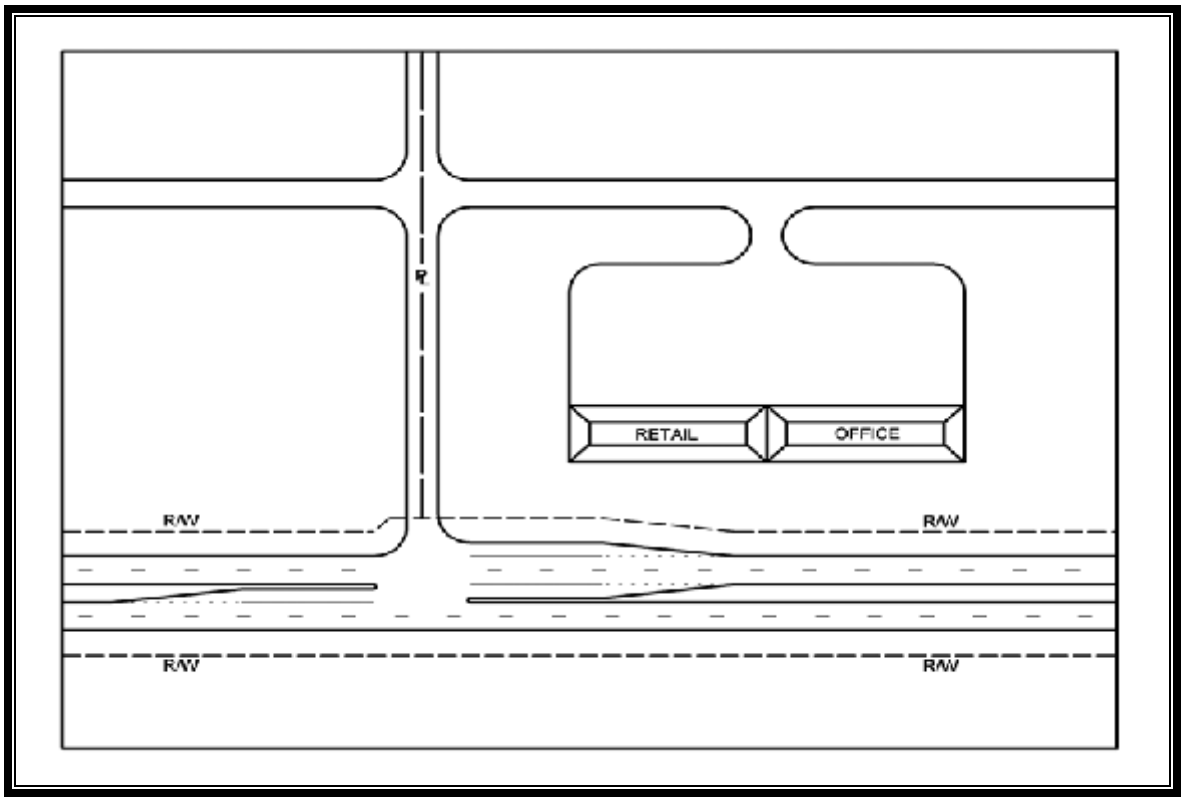

Exhibit 17 – Access Management Techniques

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1.7 – Public Involvement

Public involvement and comments are crucial to the success of this type of study and as a result, two public meetings were scheduled. The first meeting was held on Thursday, March 2, 2006 at the city council chambers in Bedford, Virginia. About 25 citizens attended this meeting and offered the following comments:

- Preserve the original concept of the corridor to efficiently move traffic from north to south while serving as a truck bypass in order to minimize truck traffic in the downtown area.
- Prefer the ultimate cross-section of the road to include a raised, landscaped median with various plantings, trees, hedges, and/or shrubs *(Plantings would help enhance the downtown flavor, would plantings hinder truck traffic?).*
- With a raised, landscaped median concept and limited median crossovers, how can trucks make appropriate u-turning movements?
- Are intersecting roads *(for example, Orange Street east of Independence Boulevard)* suitable to handle additional traffic?
- Are separate left-turn lanes better than without them?
- Should right-turn lanes be used?
- Limit access points; encourage internal interconnectivity between adjacent properties.
- Maintain consistency throughout the corridor.
- Install underground utilities on the shoulders rather than the travel lanes.
- Should bicycle lanes/facilities be added to the corridor?
- Does the actual travel speed hinder pedestrian and/or bicycle activity?
- Extend Lowry Street to intersect with Orange Street *(preferably near McGee Street).*
- Can potential developers help fund various improvements to the infrastructure?

The second meeting was held on Thursday, April 6, 2006 at the city council chambers in Bedford, Virginia with about 15 citizens in attendance. These citizens offered the following comments:

- Why was the 4-lane, undivided facility originally designed?
- What is the purpose of the road; encourage development, pedestrian friendly, limited access, hide development behind screening, etc.?
- The Planning Commission recommends that the Special Corridor Overlay District (SCOD) be applied to Independence Boulevard.
- Can street lights be placed in the median?
- Terrain makes widening beyond the existing 90-foot right-of-way very costly.
- City should decide on land-use type before selecting a typical cross-section.
- City is considering changing zoning from Manufacturing District to General Business District.
- Would like a 4-lane, undivided, curb and gutter facility with sidewalks along both sides of the road.

All of the input from the citizens was invaluable and indicated a strong interest in the future development of the entire corridor. Many of the comments are addressed in this report; however, other comments will be monitored by the city because they are beyond the scope of this project. Subsequent to the public meetings, it was determined that decisions on bicycle lanes for the Independence Boulevard corridor should be made as a part of a City-wide bicycle facilities planning process. This process is currently underway as a separate project. The recommendations included in this report do not preclude the addition of bicycle facilities to the corridor. Additional right-of-way may be needed to accommodate such facilities.

2.1 – 2030 Traffic Forecasts

Future traffic volumes in the Bedford 2020 Transportation Plan were developed based on an analysis of historic traffic data for roadways within the city limits of Bedford from 1980 until 1999 using 1999 as the base year. This data indicated that an annual growth rate of 1.5 percent was used along most roads in Bedford including Independence Boulevard *(This annual growth rate was reviewed and approved by VDOT).* The future traffic volumes along Independence Boulevard for the years 2010 and 2020 are summarized in Exhibit 18. For purposes of this study, the future traffic volumes for the year 2030 are calculated using the traffic volumes from the year 2020 as the base year and growing them at an annual rate of 1.5 percent *(simple rate methodology)* yielding daily traffic volumes of less than 15,000 vehicles per day.

Exhibit 18 – Future Traffic Volumes

Year	Location # 1	Location # 2	Location # 3
2010	11,000 vpd	10,600 vpd	10,600 vpd
2020	12,400 vpd	12,000 vpd	12,000 vpd
2030	14,300 vpd	13,800 vpd	13,800 vpd

Source: The Bedford 2020 Transportation Plan (Exhibits 19 and 24)
(Traffic volumes rounded up to the nearest hundred)

= ***Calculated traffic volumes using 2020 as the base year***

Location # 1 = East Main Street to Orange Street
Location # 2 = Orange Street to Dawn Street
Location # 3 = Dawn Street to Forest Road

The 2001 to 2004 results are similar to the conclusions reached in the Bedford 2020 Transportation Plan where a 1.5 percent annual growth rate was used for forecasting purposes along most roads in Bedford including Independence Boulevard. As stated in Appendix B of the subject plan *(page B-8)*, this growth rate represents a small yearly growth that ensures that the transportation system can accommodate some level of growth for Bedford, while recognizing that the trends show little or negative overall growth in traffic and population. It should be noted that the annual growth rate in the subject plan was based on simple rate methodology and rounded to the nearest hundred rather than compound rate methodology.

3.1 – No-Build

The originally designed ultimate cross-section along Independence Boulevard consists of a four-lane undivided, curb and gutter facility with sidewalks along both sides of the road. Recommendations discussed in the Bedford 2020 Transportation Plan for the year 2010 *(Interim Year)* included a traffic signal at the intersection of Independence Boulevard and Orange Street, when the appropriate traffic signal warrants are satisfied, and the completion of the widening of Independence Boulevard to four lanes to provide lane continuity and capacity.

The Special Corridor Overlay District (SCOD), approved by the City of Bedford, emphasizes efficient traffic flow and mobility by restricting direct access and encouraging *(requiring)* connectivity. Any parcel or lot having frontage along an arterial road shall be permitted one direct access to that arterial, unless the parcel or lot has other means of access to the arterial. In addition, all private drives shall be interconnected with adjoining development with stubs provided to adjacent undeveloped property for future development.

Based on information contained in this report and public input, six options could be considered for the future typical cross-section that meets the needs for lane continuity and capacity. These options include a no-build option, a 4-lane undivided, curb and gutter, with sidewalks on both sides of the road option, a 5-lane divided with flush median, curb and gutter, without sidewalks option, a 4-lane divided with raised median, curb and gutter, without sidewalks option, a 4-lane, divided with raised median, curb and gutter, with sidewalks on one side of the road option, and a 4-lane divided with raised median, curb and gutter, with sidewalks on both sides of the road option *(this option would need additional right-of-way).*

The no-build option means exactly what it implies and that is to leave the existing road with its current geometry alone. Although this option might be satisfactory for the immediate future, operational problems will occur when the surrounding property develops. At that point, reactive mitigation measures instead of proactive measures would need to be taken. Safety concerns for turning vehicles will increase as the total traffic volumes increase.

3.2 – 4-Lane, Undivided, Curb and Gutter with Sidewalks

This option represents the ultimate cross-section for the widening of Independence Boulevard as shown on the approved roadway plans. This cross-section has a horizontal distance of 76 feet from shoulder break point to shoulder break point and can be accommodated within the existing right-of-way width of 90 feet.

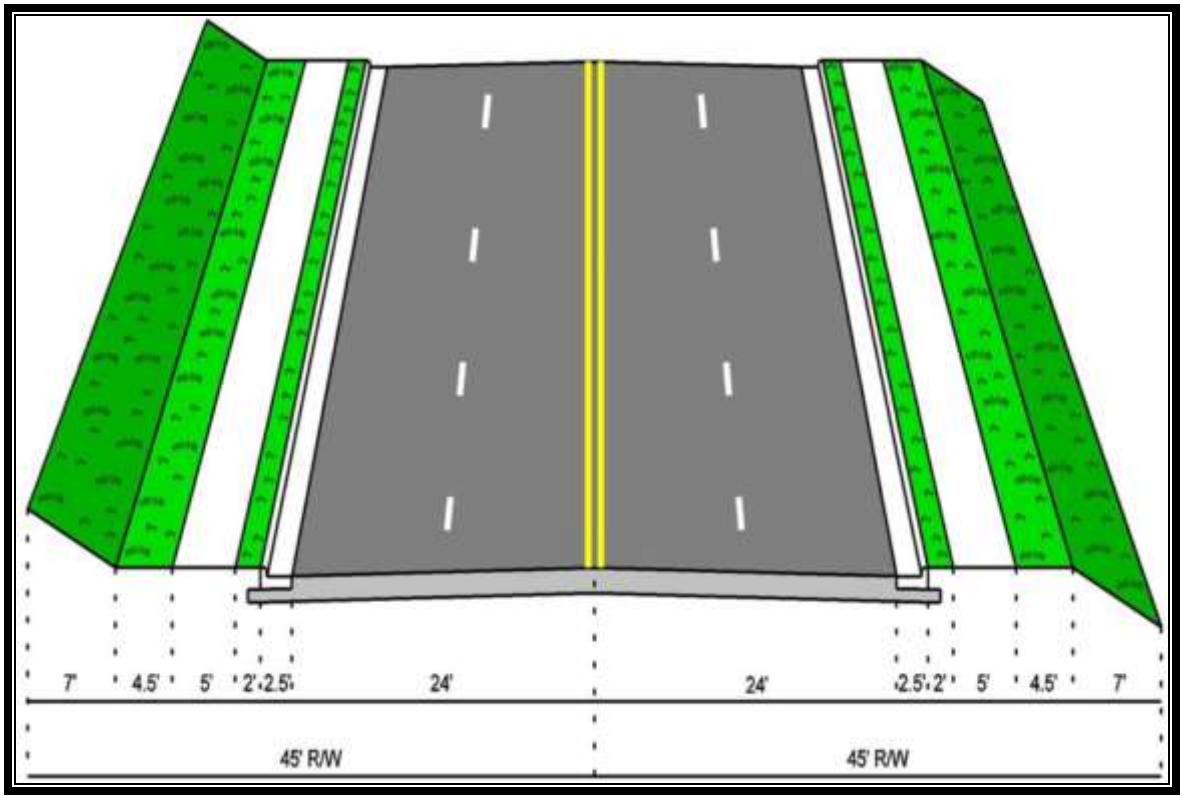

Exhibit 19 – 4-Lane, Undivided, Curb & Gutter, Sidewalks (Both Sides)

3.3 – 5-Lane, Divided (Flush Median), Curb and Gutter, without Sidewalks

This option would include a continuous two-way left-turn lane (TWLTL); however, in order for it to fit within the existing right-of-way, the sidewalks would need to be excluded. According to the ***Access Management Manual (2003)***, which is published by the Transportation Research Board, median-divided highways *(including TWLTL)* are generally safer and more efficient than undivided highways. Average crash rates are about 35 percent lower compared to undivided roadways and the capacity increases while delay decreases. This type of roadway is generally appropriate when the daily traffic volumes are less than 24,000 vehicles per day. Although a TWLTL generally improves safety, it also encourages strip commercial development; therefore, it is not considered a good access management tool.

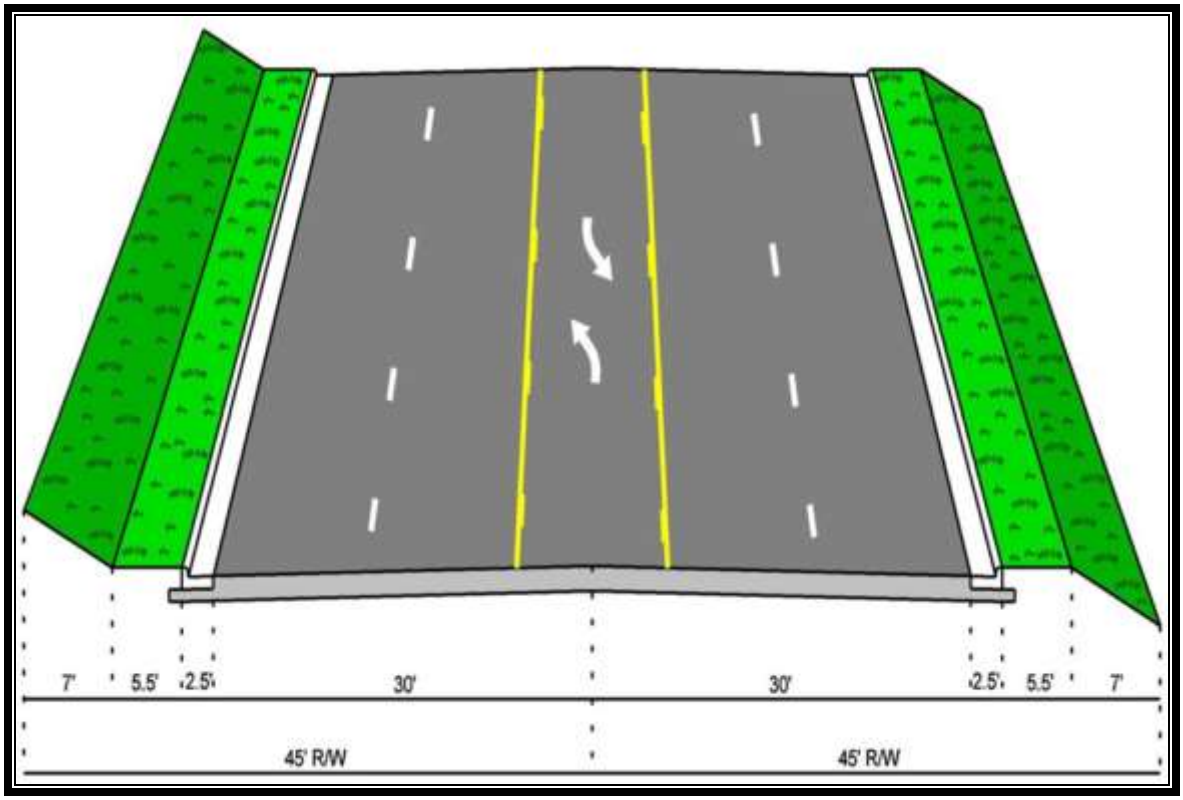

Exhibit 20 – 5-Lane, Divided (Flush Median), Curb & Gutter, No Sidewalks

3.4 – 4-Lane, Divided (Raised Median), Curb and Gutter, without Sidewalks

As indicated by the first community meeting, this option is the preferred one primarily because of its aesthetic considerations. As in the case of the 5-Lane alternative, the sidewalks would need to be excluded in order for it to fit within the existing right-of-way. In addition, the median width would be limited to 16 feet, which is the minimum width allowed by the Virginia Department of Transportation to accommodate a left-turn lane with a width of 12 feet. Benefits of this type of roadway include enhanced safety *(average crash rate 30 percent less than TWLTL)* and set locations for left-turning movements. This type of roadway is generally appropriate when daily traffic volumes are in the 24,000 to 28,000 vehicles per day range. Since the design speed is greater than 45 mph, a mountable type curb (CG-3) is required for the raised median.

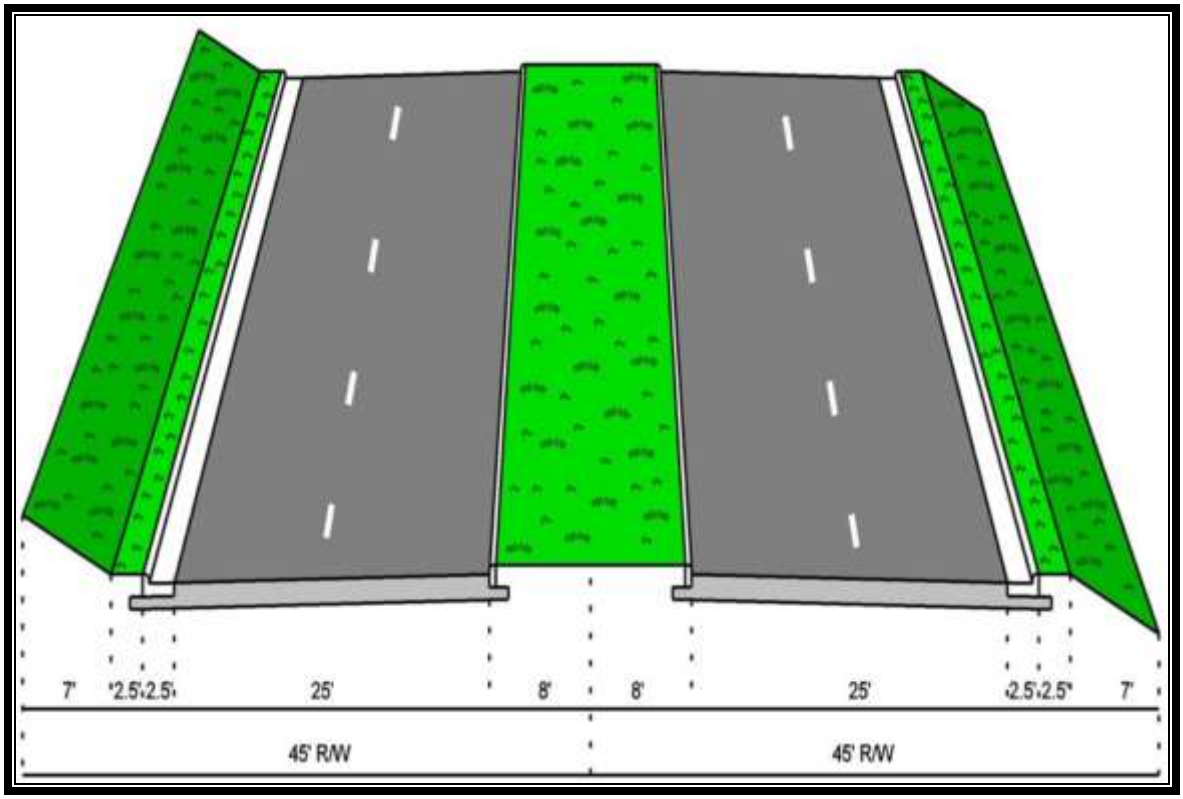

Exhibit 21 – 4-Lane, Divided (Raised Median), Curb & Gutter, No Sidewalks

3.5 – 4-Lane, Divided (Raised Median), Curb and Gutter, with Sidewalk on One Side

By shifting the centerline, this option attempts to provide a sidewalk along one side of the road and keep all improvements within the existing right-of-way width of 90 feet.

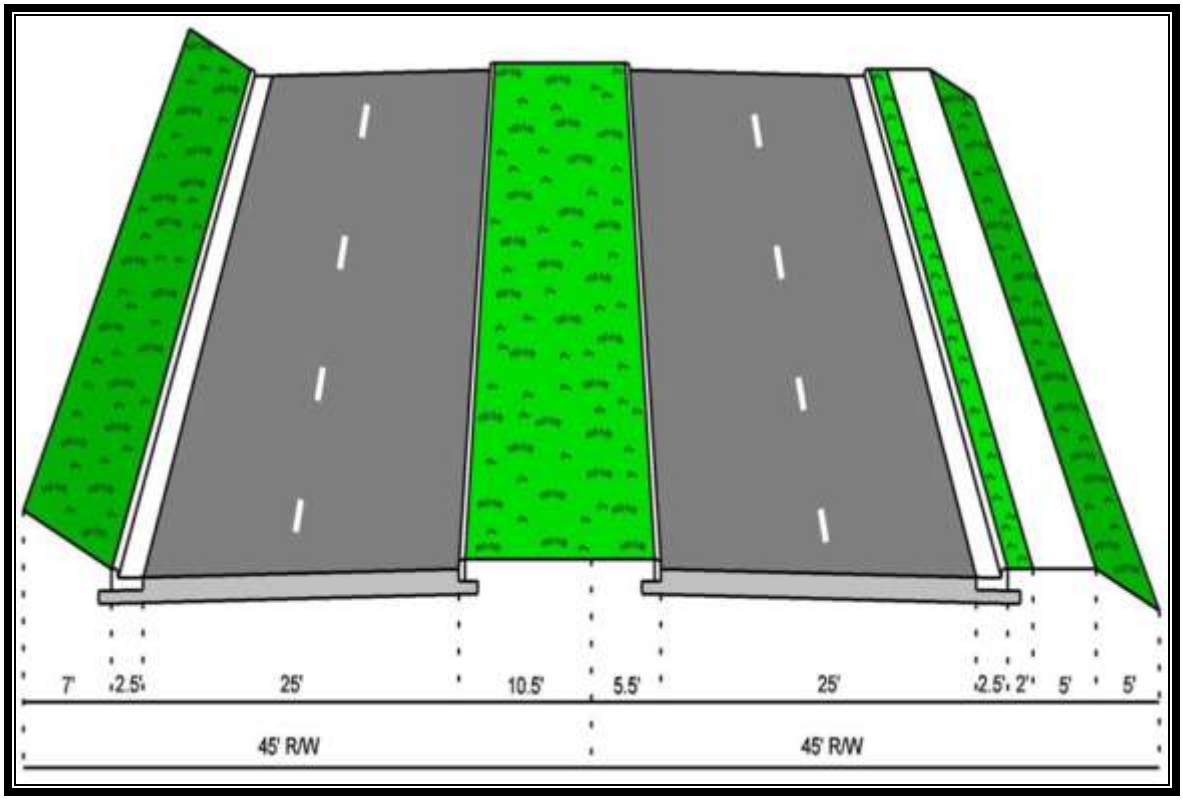

Exhibit 22 – 4-Lane, Divided (Raised Median), Curb & Gutter, Sidewalk One Side

3.6 – 4-Lane, Divided (Raised Median), Curb and Gutter, with Sidewalks and Additional Right-of-Way

This option provides the preferred cross-section with sidewalks on both sides of the road. The minimum right-of-way width to accommodate this option would be 110 feet.

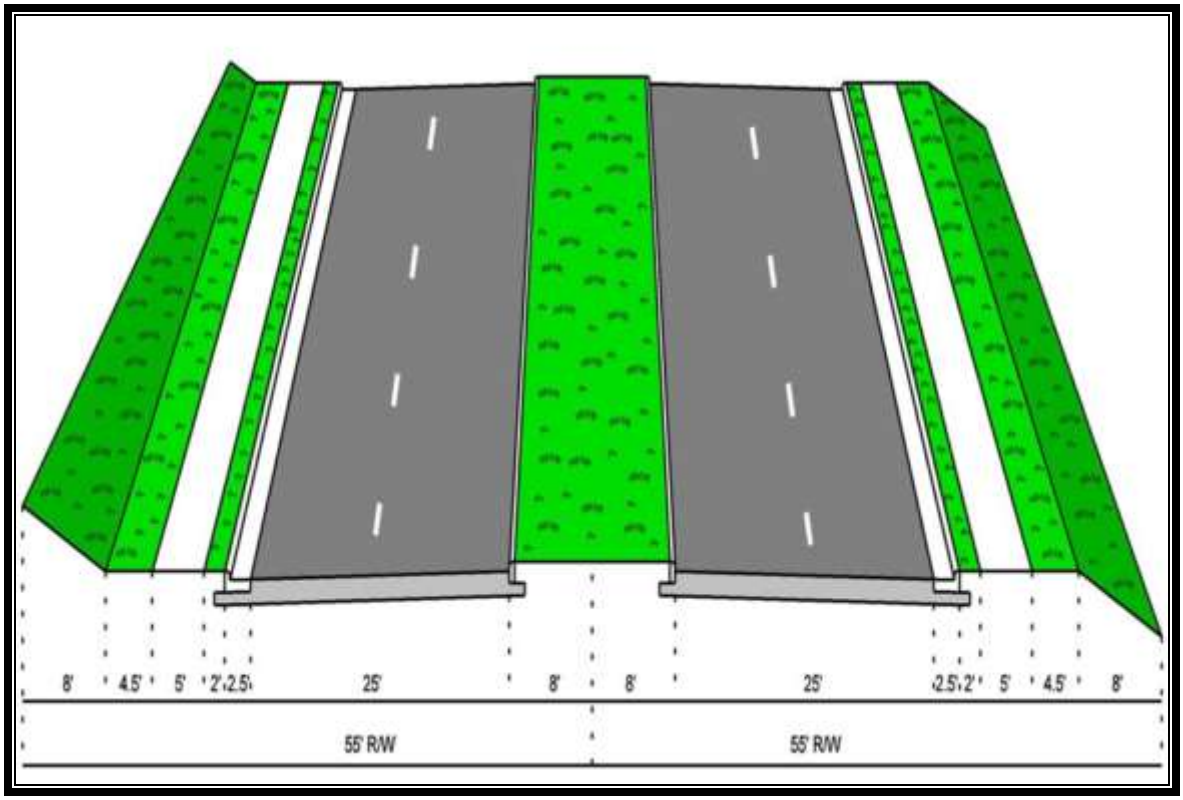

Exhibit 23 – 4-Lane, Divided (Raised Median), Curb and Gutter, Sidewalks Both Sides

3.7 – Comparison of Future Options

In developing the various options, an attempt was made to stay within the existing right-of-way width of 90 feet and the existing horizontal distance between the shoulder break points of 76 feet. When the road was first constructed, the rough grading at a minimum would have been accomplished throughout the entire length of the project. Therefore, it is reasonable to conclude that the overall cost of these options should be less than options requiring additional right-of-way.

It is possible that two options would fit within the horizontal distance between the shoulder break points; specifically, the 5-lane, divided *(flush median)* option and the 4-lane, divided *(raised median)* option. However, in order for these two options to fit, the sidewalks would need to be excluded. A third option would be to use the 4-lane, divided *(raised median)* cross-section and offset the centerline 2.5 feet on the cut side to accommodate a sidewalk on the fill side. With a 2-foot utility strip, this cross-section would encroach beyond the shoulder break point on the fill side. Even without the 2-foot utility strip, it would be difficult to contain this option between the shoulder break points (See Exhibit 24).

In order to accommodate the desired cross-section including sidewalks on both sides of the road, additional right-of-way would be needed (See Exhibit 25).

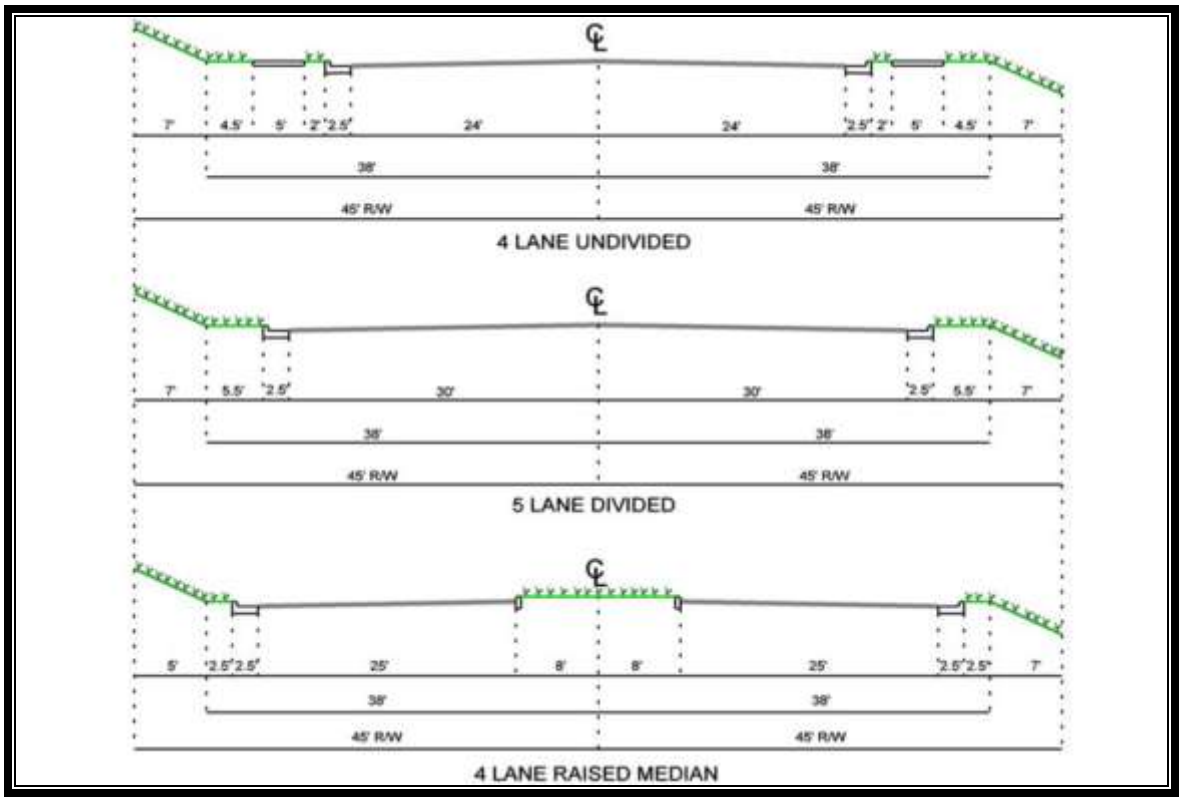

Exhibit 24 – Comparison of Future Options (A)

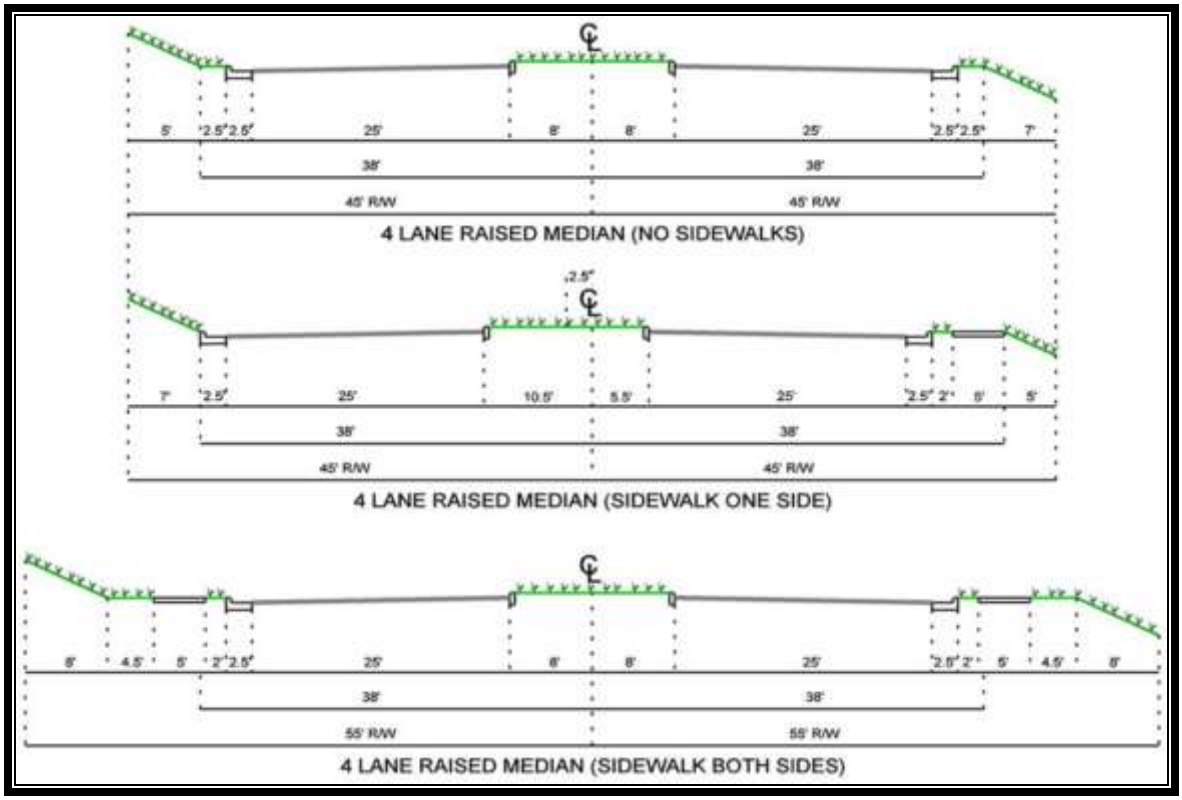

Exhibit 25 – Comparison of Future Options (B)

4.1 – Typical Cross-Sections

One of the comments at the first community public meeting was a desire to maintain consistency throughout the entire corridor. Due to physical constraints, including the existing Norfolk & Western Railroad Bridge and traffic signal pole spacing at both ends of Independence Boulevard, one typical cross-section is not possible. The following two typical cross-sections are recommended:

- Recommend a typical cross-section consisting of a four-lane, undivided, curb and gutter facility and sidewalks *(width of 5 feet and a 2-foot buffer strip)* on both sides of the road from East Main Street to a point north of the Southern States access point and from a point south of Forest Road to Forest Road.

- Recommend a typical cross-section consisting of a four-lane, divided, curb and gutter facility with a raised, landscaped median *(width of 16 feet)* and sidewalks *(width of 5 feet and a 2-foot buffer strip)* on both sides of the road from a point north of the Southern States access point to a point near the Norfolk & Western railroad southern right-of-way and from the Norfolk & Western railroad northern right-of-way to a point south of Forest Road ***(a minimum right-of-way width of 110 feet would be needed)*** including the following features:

    1. Median openings will be provided at the intersections of all public roads, Cheatham Park Drive, and Dominion of Bedford, Inc. In addition, a median opening will be provided between Cheatham Park Drive and Orange Street to serve property on both sides of Independence Boulevard *(VDOT guidelines for median openings and nationally recognized guidelines for traffic signal spacing will be used to determine additional locations for median openings).*
    2. Left-turn lanes will be provided at all median openings in both directions of travel *(per VDOT guidelines).*

- Maintain existing cross-section consisting of a four-lane, undivided, curb and gutter facility and sidewalks *(width of 5 feet and a 2-foot buffer strip)* on both sides of the road within the Norfolk & Western railroad right-of-way *(sidewalks have not been installed).*

For planning purposes, the total estimated cost including additional right-of-way to provide the subject cross-sections along Independence Boulevard from East Main Street to Forest Road is about $7.5 million.

4.2 – Traffic Signals

Not including the intersections at each end of Independence Boulevard, there are a total of four intersections with public roads including Freedom Lane, Orange Street, Dawn Street, and Shady Knoll Avenue/Venture Boulevard. Currently, the intersection at Freedom Lane is signalized and the other three intersections are unsignalized. As traffic volumes grow along this corridor, the need for additional traffic signals might become evident. In order to maintain efficient mobility along Independence Boulevard, the installation of traffic signals should be kept to a minimum. Since the Bedford 2020 Transportation Plan and the Eastside Master Plan *(2005)* identified the intersection of Independence Boulevard and Orange Street as a possible candidate for signalization whenever traffic signal warrants are satisfied, the following recommendation is made:

- Install a traffic signal at the intersection of Independence Boulevard and Orange Street whenever traffic signal warrants are satisfied.

4.3 – Access Management Techniques

One of the comments at the first community public meeting was a desire to preserve the original concept of the corridor to efficiently move traffic from north to south while serving as a truck bypass in order to minimize truck traffic in the downtown area. The use of various access management techniques would help to accomplish this goal; therefore, the following recommendations are made:

- Encourage the use of various access management techniques to preserve the mobility of the corridor without causing an undue burden to the adjacent property owners. These techniques include, but are not limited to, the use of a raised median, the use of joint access points, interconnectivity between properties, internal roadway networks, buildings located to the front of the property, and parking located to the back of the properties.

- Consider the need for right-turn lanes and/or tapers on a *case-by-case basis* based on guidelines set forth by the Virginia Department of Transportation (VDOT).

- Consistent with city regulations, require developers to fund off-site improvements including, but not limited to, left-turn lanes, right-turn lanes, curb and gutter, sidewalks, closed stormwater drainage systems, street lights, traffic signals, and relocating existing utilities.

As development occurs along the Independence Boulevard corridor and traffic increases, the speed limit should be evaluated periodically to assure that the current 45 mph speed limit is appropriate.

4.4 – Eastside Master Plan

The Bedford City Council approved the Eastside Master Plan on July 12, 2005. The purpose of this plan is to provide guidance to the future development of the Independence Boulevard corridor especially along the east side of the road between East Main Street (US 460 Business) and Orange Street. The recommendations were based on the following assumptions:

1. There is a present market-driven demand for commercial development along Independence Boulevard.
2. The current level of service for traffic flow on Independence Boulevard *(i.e. its functionality as a bypass connector between US 460 Business and US 221)* must be preserved to the greatest possible extent.
3. A large 48-acre property near the intersection of Independence Boulevard and Orange Street will likely be developed as a mixed-use project in the future.
4. Development along the Independence Boulevard corridor will directly impact Centertown both positively and negatively.
5. Two traffic signals will be installed along Independence Boulevard, one at its intersection with Freedom Lane and one at Orange Street.
6. Lowry Street will be used as a primary access road for future development *(both residential and commercial)*.
7. Freedom Lane will be extended across Lowry Street into the Wal-Mart shopping center in Bedford County.

Using these assumptions, the following recommendations were developed:

1. Development of an interconnected roadway network must take place in conjunction with future development of the Independence Boulevard corridor.
2. Regulations should be drafted and applied which specifically prohibit private entrances on Independence Boulevard and require connectivity between individual properties.
3. Lowry Street should be improved and developed to serve as the principal access for development along the east side of the Independence Boulevard corridor at the expense of developers and/or adjacent property owners (See Exhibit 26).
4. The land along Lowry Street presently zoned M-1 should be rezoned to allow for commercial use. B-2 would be the most appropriate existing category for this area.
5. The property occupied by Southern States and adjacent to the R-3 district should be rezoned to B-2.
6. The existing M-1 district provisions should be amended to include design requirements for all uses at a minimum.
7. Overlay regulations for the Independence Boulevard corridor need to be drafted and applied. Such regulations should be similar to the Traditional Neighborhood Overlay district requirements, but allow mixed-use development by right *(as opposed to the conditional use process currently espoused by TNO)*.

Exhibit 26 – Improvements to Lowry Street

In order to complement the recommendations from the Eastside Master Plan, the following recommendation is included as one of the recommendations for the Independence Boulevard corridor study:

- Encourage the recommendations contained in the Eastside Master Plan including improvements to Lowry Street and the creation of an internal roadway network to serve future commercial development along this section of Independence Boulevard. Encourage the extension of Lowry Street to serve all possible properties. Although the extension of Lowry Street to Orange Street would be ideal, it is probably cost prohibitive due to terrain issues.

4.5 - Aesthetics

According to both community public meetings, aesthetics is an important factor to be considered in the future development of the Independence Boulevard corridor.

Today's Independence Boulevard has the look of a rural highway passing through a dense, deciduous forest. As the area converts to more of a business/commercial-type corridor, the roadway should be modeled as a landscaped boulevard with broad stretches of lawn and preserved groupings of trees. Large size canopy trees could line the boulevard at a regular interval of about 67 feet, centered between the existing light standards. Viewed from either direction, this layout would achieve a sense of order and spatial continuity while at the same time permitting lateral views of proposed commercial developments (See Exhibit 27).

Because Zelkova trees are a reliable street tree and they already exist along Independence Boulevard, it is suggested that they be planted at both ends of the road as well as continuing to adorn the entire length of road. To avoid monotony, additional varieties of large canopy trees could be intermingled among the Zelkovas.

Small, multi-trunk flowering trees could be used in the boulevard median. Multi-trunk trees are preferred because they occupy more space and offer greater visual interest than individual, single trunk specimens. For greater visual impact, it is suggested that single species be planted in uniform blocks. Median-planting species should alternate at mid-block locations and mirror at intersecting crossroads. Ornamental tree plantings should also be planted in sequence with paired street trees and skipped opposite light fixtures for better light throw (See Exhibits 27 and 29).

Landscape plantings fronting proposed building parcels should be artfully clumped to accentuate natural landforms and soften large building masses. Trees of a scale to have a meaningful impact on the anticipated large commercial or industrial buildings should be favored to small, individually planted ornamental or flowering trees (See Exhibit 28).

Where slopes exceed a practically mowable gradient, it is suggested that low-maintenance shrubs or groundcover be established. These should be planted in bold swathes to be in scale with the parkway landscape setting. If establishing groundcover or shrubs proves cost-prohibitive, Weeping Lovegrass *(Eragrostis curvula)* might be considered. Weeping Lovegrass is fast-growing, easily established from seed, and requires fewer mowings due to its weeping habit.

Since a desired outcome is to make Independence Boulevard a ***gateway*** to the community, it is important that both ends of the road are aesthetically pleasing although the typical cross-section would be a four-lane, undivided, curb and gutter facility with sidewalks on both sides of the road. To accomplish this outcome, increased plantings along the shoulders of the road would be needed. At East Main Street, the west side of the intersection is currently bracketed by a matched row of handsome Zelkova trees. It is

suggested that this species also be installed at the intersection's east corner. Consideration could also be given to providing some type of identification signing in this area as well as Forest Road *(provided the signing conforms with current City of Bedford's and VDOT's guidelines and regulations)*. Since Bradford Pear trees are typically fragile, it is suggested that all Bradford Pear trees be replaced with Zelkovas throughout the entire corridor (See Exhibit 29).

- Encourage the use of various plantings *(per VDOT guidelines)* to enhance the aesthetics of the corridor as a ***gateway*** to the community without compromising the safety of the traveling public.

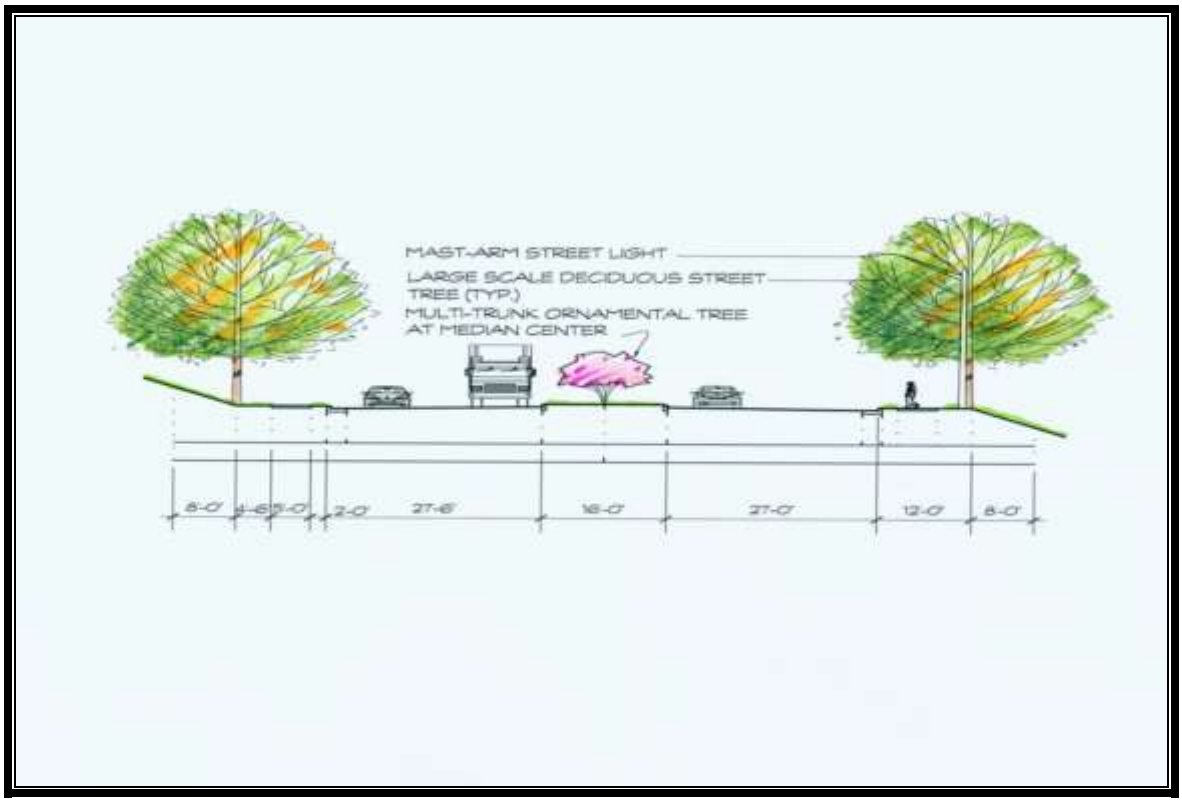

Exhibit 27 – Typical Landscaping Along Independence Boulevard

Exhibit 28 – Typical Landscaping Near East Main Street

Exhibit 29 – Typical Landscaping Near Commercial Development

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APPENDIX A

Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/E Main S
Date: Wednesday, September 21, 2005
Counter: MM

File Name : BedfordA
Site Code : 00000000
Start Date : 9/21/2005
Page No : 1

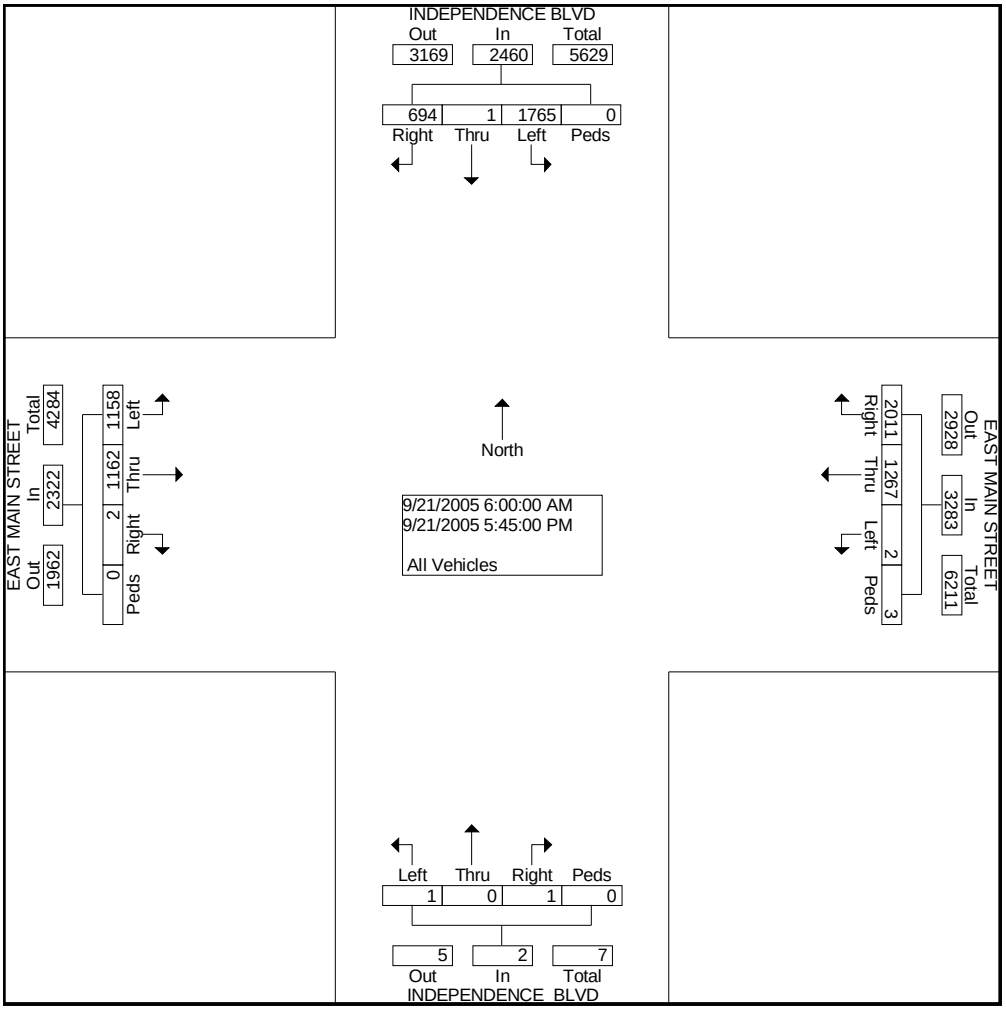
Groups Printed- All Vehicles

	INDEPENDENCE BLVD Southbound					EAST MAIN STREET Westbound					INDEPENDENCE BLVD Northbound					EAST MAIN STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	2	0	17	0	19	21	11	0	0	32	1	0	1	0	2	0	13	15	0	28	81
06:15 AM	5	0	23	0	28	48	15	0	0	63	0	0	0	0	0	0	21	8	0	29	120
06:30 AM	6	0	27	0	33	84	33	0	1	118	0	0	0	0	0	0	37	17	0	54	205
06:45 AM	10	0	48	0	58	91	27	0	0	118	0	0	0	0	0	0	22	24	0	46	222
Total	23	0	115	0	138	244	86	0	1	331	1	0	1	0	2	0	93	64	0	157	628
07:00 AM	10	0	66	0	76	58	23	0	0	81	0	0	0	0	0	0	36	12	0	48	205
07:15 AM	3	0	47	0	50	71	24	0	1	96	0	0	0	0	0	0	21	18	0	39	185
07:30 AM	9	0	66	0	75	79	51	0	0	130	0	0	0	0	0	0	25	23	0	48	253
07:45 AM	22	0	58	0	80	131	62	0	0	193	0	0	0	0	0	0	30	27	0	57	330
Total	44	0	237	0	281	339	160	0	1	500	0	0	0	0	0	0	112	80	0	192	973
08:00 AM	8	0	60	0	68	118	49	0	0	167	0	0	0	0	0	0	27	24	0	51	286
08:15 AM	30	0	51	0	81	87	54	0	0	141	0	0	0	0	0	0	31	31	0	62	284
08:30 AM	21	0	45	0	66	51	44	0	0	95	0	0	0	0	0	0	30	26	0	56	217
08:45 AM	12	1	45	0	58	69	44	0	0	113	0	0	0	0	0	0	33	26	0	59	230
Total	71	1	201	0	273	325	191	0	0	516	0	0	0	0	0	0	121	107	0	228	1017
*** BREAK ***																					
11:00 AM	16	0	40	0	56	40	40	0	1	81	0	0	0	0	0	0	19	32	0	51	188
11:15 AM	20	0	40	0	60	57	25	0	0	82	0	0	0	0	0	0	31	46	0	77	219
11:30 AM	23	0	49	0	72	33	33	0	0	66	0	0	0	0	0	0	37	40	0	77	215
11:45 AM	38	0	39	0	77	46	35	0	0	81	0	0	0	0	0	0	35	57	0	92	250
Total	97	0	168	0	265	176	133	0	1	310	0	0	0	0	0	0	122	175	0	297	872
12:00 PM	30	0	56	0	86	54	37	0	0	91	0	0	0	0	0	0	37	54	0	91	268
12:15 PM	22	0	36	0	58	41	34	0	0	75	0	0	0	0	0	0	32	57	0	89	222
12:30 PM	24	0	43	0	67	43	34	0	0	77	0	0	0	0	0	0	24	50	0	74	218
12:45 PM	25	0	45	0	70	48	43	0	0	91	0	0	0	0	0	0	34	40	0	74	235
Total	101	0	180	0	281	186	148	0	0	334	0	0	0	0	0	0	127	201	0	328	943
*** BREAK ***																					
03:00 PM	26	0	69	0	95	69	43	1	0	113	0	0	0	0	0	1	41	32	0	74	282
03:15 PM	33	0	76	0	109	48	36	0	0	84	0	0	0	0	0	0	48	55	0	103	296
03:30 PM	47	0	102	0	149	70	48	0	0	118	0	0	0	0	0	0	49	36	0	85	352
03:45 PM	32	0	78	0	110	71	48	0	0	119	0	0	0	0	0	0	47	34	0	81	310
Total	138	0	325	0	463	258	175	1	0	434	0	0	0	0	0	1	185	157	0	343	1240
04:00 PM	28	0	51	0	79	64	55	0	0	119	0	0	0	0	0	0	56	57	0	113	311
04:15 PM	28	0	73	0	101	47	46	0	0	93	0	0	0	0	0	0	47	47	0	94	288
04:30 PM	23	0	57	0	80	60	41	0	0	101	0	0	0	0	0	0	43	47	0	90	271
04:45 PM	31	0	62	0	93	61	56	0	0	117	0	0	0	0	0	0	37	36	0	73	283
Total	110	0	243	0	353	232	198	0	0	430	0	0	0	0	0	0	183	187	0	370	1153
05:00 PM	19	0	88	0	107	62	41	0	0	103	0	0	0	0	0	0	87	60	0	147	357
05:15 PM	39	0	67	0	106	59	39	0	0	98	0	0	0	0	0	0	50	46	0	96	300
05:30 PM	32	0	67	0	99	69	41	0	0	110	0	0	0	0	0	1	49	45	0	95	304
05:45 PM	20	0	74	0	94	61	55	1	0	117	0	0	0	0	0	0	33	36	0	69	280
Total	110	0	296	0	406	251	176	1	0	428	0	0	0	0	0	1	219	187	0	407	1241
Grand Total	694	1	1765	0	2460	2011	1267	2	3	3283	1	0	1	0	2	2	1162	1158	0	2322	8067
Apprch %	28.2	0.0	71.7	0.0		61.3	38.6	0.1	0.1		50.0	0.0	50.0	0.0		0.1	50.0	49.9	0.0		
Total %	8.6	0.0	21.9	0.0	30.5	24.9	15.7	0.0	0.0	40.7	0.0	0.0	0.0	0.0	0.0	0.0	14.4	14.4	0.0	28.8	

Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/E Main S
Date: Wednesday, September 21, 2005
Counter: MM

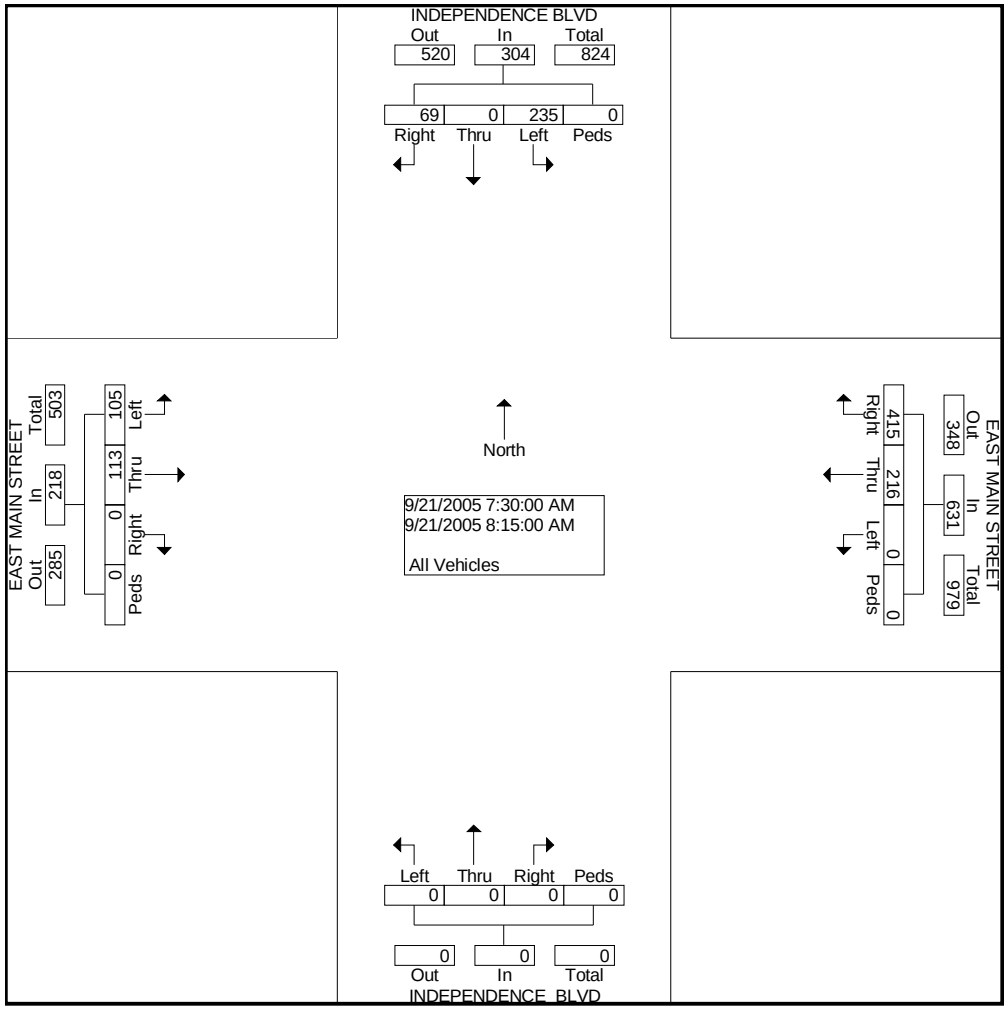
File Name : BedfordA
Site Code : 00000000
Start Date : 9/21/2005
Page No : 2



Tri-State Traffic Data, Inc.
184 Baker Road
Location: Bedford, VA Coatesville, PA 19320
Intersection: Independence Blvd/E Main S 610-466-1469
Date: Wednesday, September 21, 2005
Counter: MM

File Name : BedfordA
Site Code : 00000000
Start Date : 9/21/2005
Page No : 3

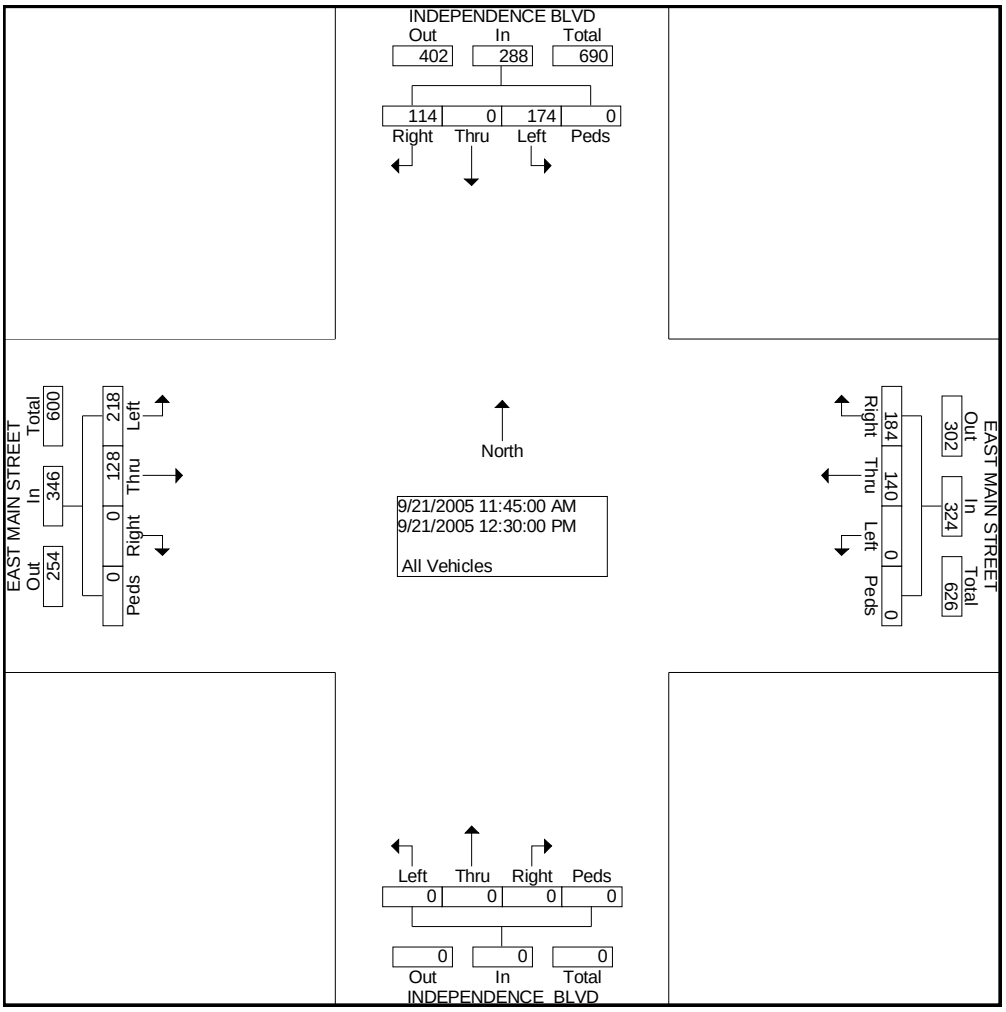
	INDEPENDENCE BLVD Southbound					EAST MAIN STREET Westbound					INDEPENDENCE BLVD Northbound					EAST MAIN STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:00 AM to 09:45 AM - Peak 1 of 1																					
Intersection 07:30 AM																					
Volume	69	0	235	0	304	415	216	0	0	631	0	0	0	0	0	0	113	105	0	218	1153
Percent	22.7	0.0	77.3	0.0		65.8	34.2	0.0	0.0		0.0	0.0	0.0	0.0		0.0	51.8	48.2	0.0		
07:45 Volume	22	0	58	0	80	131	62	0	0	193	0	0	0	0	0	0	30	27	0	57	330
Peak Factor																					0.873
High Int. 08:15 AM						07:45 AM					5:45:00 AM					08:15 AM					
Volume	30	0	51	0	81	131	62	0	0	193	0	0	0	0	0	0	31	31	0	62	
Peak Factor					0.938					0.817										0.879	



Tri-State Traffic Data, Inc.
184 Baker Road
Location: Bedford, VA Coatesville, PA 19320
Intersection: Independence Blvd/E Main S 610-466-1469
Date: Wednesday, September 21, 2005
Counter: MM

File Name : BedfordA
Site Code : 00000000
Start Date : 9/21/2005
Page No : 4

	INDEPENDENCE BLVD Southbound					EAST MAIN STREET Westbound					INDEPENDENCE BLVD Northbound					EAST MAIN STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 10:00 AM to 01:45 PM - Peak 1 of 1																					
Intersection	11:45 AM																				
Volume	114	0	174	0	288	184	140	0	0	324	0	0	0	0	0	0	128	218	0	346	958
Percent	39.6	0.0	60.4	0.0		56.8	43.2	0.0	0.0		0.0	0.0	0.0	0.0		0.0	37.0	63.0	0.0		
12:00 Volume	30	0	56	0	86	54	37	0	0	91	0	0	0	0	0	0	37	54	0	91	268
Peak Factor																					0.894
High Int.	12:00 PM					12:00 PM										11:45 AM					
Volume	30	0	56	0	86	54	37	0	0	91	0	0	0	0	0	0	35	57	0	92	
Peak Factor					0.837					0.890										0.940	

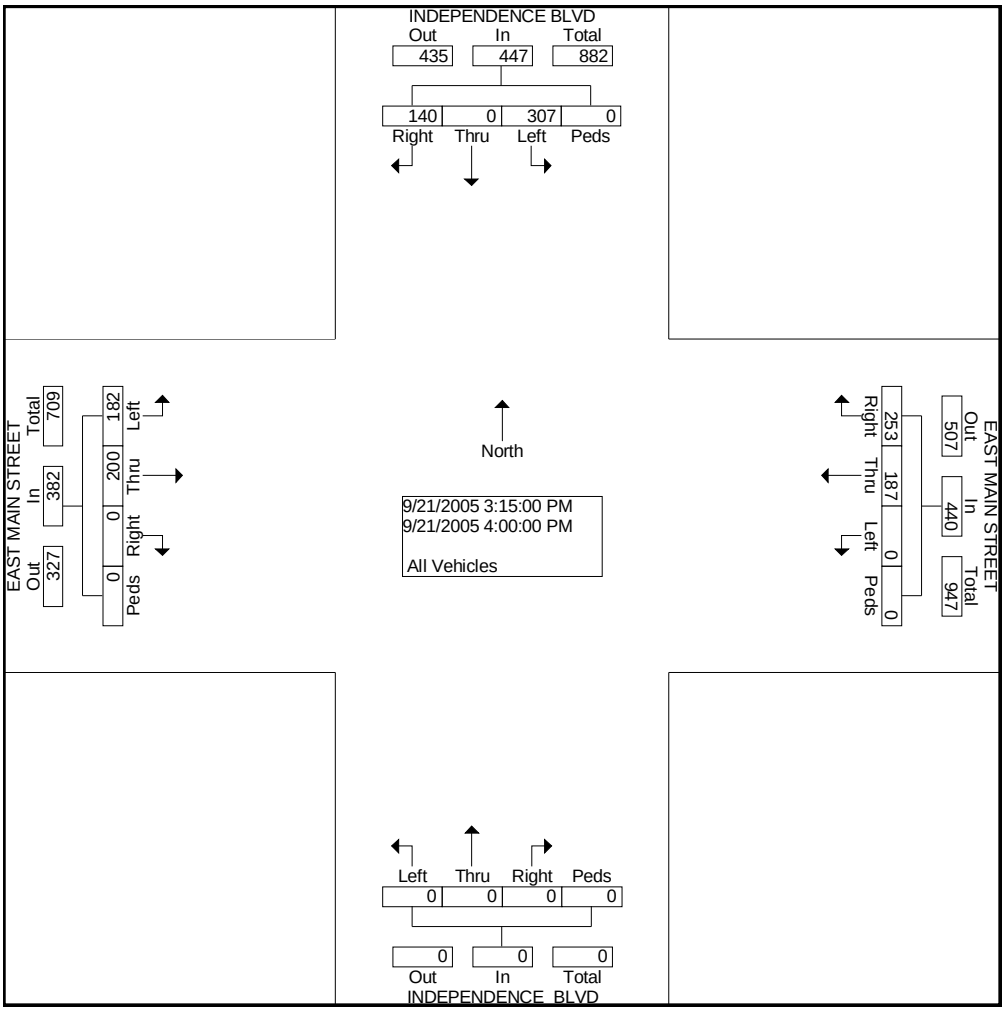


Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320 610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/E Main S
Date: Wednesday, September 21, 2005
Counter: MM

File Name : BedfordA
Site Code : 00000000
Start Date : 9/21/2005
Page No : 5

	INDEPENDENCE BLVD Southbound					EAST MAIN STREET Westbound					INDEPENDENCE BLVD Northbound					EAST MAIN STREET Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	03:15 PM																				
Volume	140	0	307	0	447	253	187	0	0	440	0	0	0	0	0	0	200	182	0	382	1269
Percent	31.3	0.0	68.7	0.0		57.5	42.5	0.0	0.0		0.0	0.0	0.0	0.0		0.0	52.4	47.6	0.0		
03:30 Volume	47	0	102	0	149	70	48	0	0	118	0	0	0	0	0	0	49	36	0	85	352
Peak Factor																					0.901
High Int.	03:30 PM					03:45 PM										04:00 PM					
Volume	47	0	102	0	149	71	48	0	0	119	0	0	0	0	0	0	56	57	0	113	
Peak Factor					0.750					0.924										0.845	



Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/Forest D
Date: Tuesday, September 20, 2005
Counter: PF

File Name : BedfordD
Site Code : 00000000
Start Date : 9/20/2005
Page No : 1

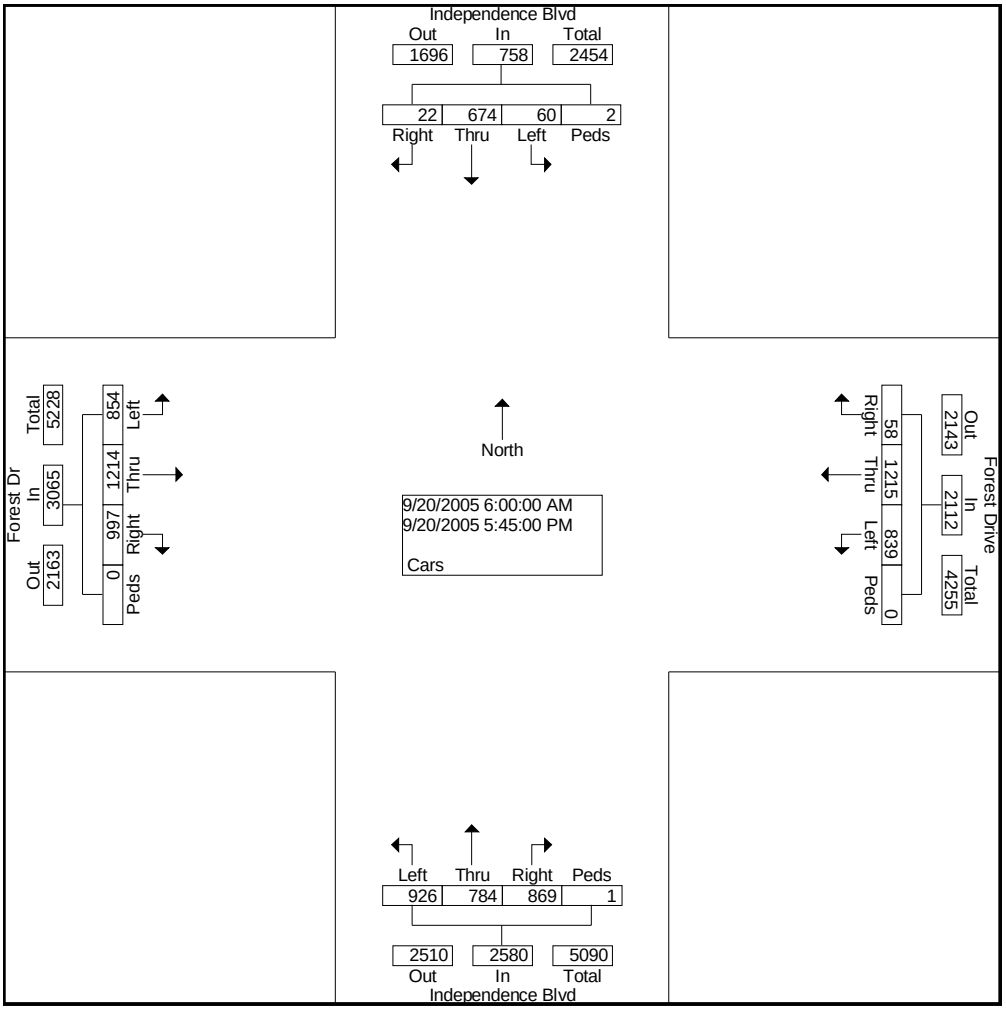
Groups Printed- Cars

	Independence Blvd Southbound					Forest Drive Westbound					Independence Blvd Northbound					Forest Dr Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Factor	1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		1.0	1.0	1.0	1.0		
06:00 AM	0	7	0	0	7	1	8	10	0	19	16	3	5	0	24	9	11	4	0	24	74
06:15 AM	0	11	1	0	12	0	16	25	0	41	17	15	8	0	40	18	19	10	0	47	140
06:30 AM	1	27	1	0	29	1	22	13	0	36	21	12	19	1	53	14	27	8	0	49	167
06:45 AM	0	40	0	0	40	0	30	31	0	61	21	10	17	0	48	27	17	7	0	51	200
Total	1	85	2	0	88	2	76	79	0	157	75	40	49	1	165	68	74	29	0	171	581
07:00 AM	0	11	2	0	13	0	21	26	0	47	22	11	16	0	49	25	21	7	0	53	162
07:15 AM	0	21	1	0	22	1	39	30	0	70	28	17	23	0	68	30	42	19	0	91	251
07:30 AM	2	17	0	0	19	5	34	24	0	63	28	26	20	0	74	38	39	25	0	102	258
07:45 AM	1	35	1	0	37	1	52	36	0	89	34	53	28	0	115	29	33	35	0	97	338
Total	3	84	4	0	91	7	146	116	0	269	112	107	87	0	306	122	135	86	0	343	1009
08:00 AM	0	41	2	1	44	3	37	23	0	63	32	65	27	0	124	26	29	75	0	130	361
08:15 AM	0	43	5	0	48	1	47	21	0	69	29	38	25	0	92	31	34	41	0	106	315
08:30 AM	1	19	3	0	23	2	32	19	0	53	14	17	26	0	57	22	39	12	0	73	206
08:45 AM	0	16	0	0	16	1	34	22	0	57	29	14	17	0	60	27	31	14	0	72	205
Total	1	119	10	1	131	7	150	85	0	242	104	134	95	0	333	106	133	142	0	381	1087
*** BREAK ***																					
11:00 AM	0	18	1	0	19	0	25	19	0	44	21	11	25	0	57	19	34	17	0	70	190
11:15 AM	1	8	1	0	10	3	21	22	0	46	17	9	24	0	50	30	40	22	0	92	198
11:30 AM	0	8	1	0	9	2	36	15	0	53	23	18	28	0	69	36	35	18	0	89	220
11:45 AM	0	16	1	0	17	1	38	25	0	64	20	13	32	0	65	21	30	11	0	62	208
Total	1	50	4	0	55	6	120	81	0	207	81	51	109	0	241	106	139	68	0	313	816
12:00 PM	1	11	1	1	14	2	30	25	0	57	28	22	42	0	92	29	48	17	0	94	257
12:15 PM	2	9	5	0	16	5	43	23	0	71	34	15	37	0	86	42	43	15	0	100	273
12:30 PM	0	13	4	0	17	1	22	29	0	52	20	13	31	0	64	33	19	13	0	65	198
12:45 PM	1	20	1	0	22	0	33	23	0	56	17	15	39	0	71	35	32	16	0	83	232
Total	4	53	11	1	69	8	128	100	0	236	99	65	149	0	313	139	142	61	0	342	960
*** BREAK ***																					
03:00 PM	0	15	3	0	18	4	38	26	0	68	39	46	27	0	112	34	21	42	0	97	295
03:15 PM	1	55	4	0	60	2	45	40	0	87	33	37	34	0	104	33	43	49	0	125	376
03:30 PM	0	32	2	0	34	2	40	26	0	68	31	31	44	0	106	38	56	36	0	130	338
03:45 PM	2	22	4	0	28	3	67	33	0	103	38	33	32	0	103	42	54	39	0	135	369
Total	3	124	13	0	140	11	190	125	0	326	141	147	137	0	425	147	174	166	0	487	1378
04:00 PM	0	20	3	0	23	2	43	35	0	80	32	32	30	0	94	39	39	29	0	107	304
04:15 PM	1	22	0	0	23	2	59	31	0	92	17	25	24	0	66	29	41	23	0	93	274
04:30 PM	1	17	1	0	19	2	39	29	0	70	35	26	45	0	106	31	39	31	0	101	296
04:45 PM	1	16	2	0	19	1	45	18	0	64	28	23	34	0	85	35	47	34	0	116	284
Total	3	75	6	0	84	7	186	113	0	306	112	106	133	0	351	134	166	117	0	417	1158
05:00 PM	0	20	4	0	24	2	45	44	0	91	37	31	55	0	123	52	65	55	0	172	410
05:15 PM	1	23	3	0	27	3	63	35	0	101	37	36	39	0	112	43	65	47	0	155	395
05:30 PM	3	22	1	0	26	2	62	32	0	96	39	32	41	0	112	41	62	41	0	144	378
05:45 PM	2	19	2	0	23	3	49	29	0	81	32	35	32	0	99	39	59	42	0	140	343
Total	6	84	10	0	100	10	219	140	0	369	145	134	167	0	446	175	251	185	0	611	1526
Grand Total	22	674	60	2	758	58	1215	839	0	2112	869	784	926	1	2580	997	1214	854	0	3065	8515
Apprch %	2.9	88.9	7.9	0.3		2.7	57.5	39.7	0.0		33.7	30.4	35.9	0.0		32.5	39.6	27.9	0.0		
Total %	0.3	7.9	0.7	0.0	8.9	0.7	14.3	9.9	0.0	24.8	10.2	9.2	10.9	0.0	30.3	11.7	14.3	10.0	0.0	36.0	

Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/Forest D
Date: Tuesday, September 20, 2005
Counter: PF

File Name : BedfordD
Site Code : 00000000
Start Date : 9/20/2005
Page No : 2

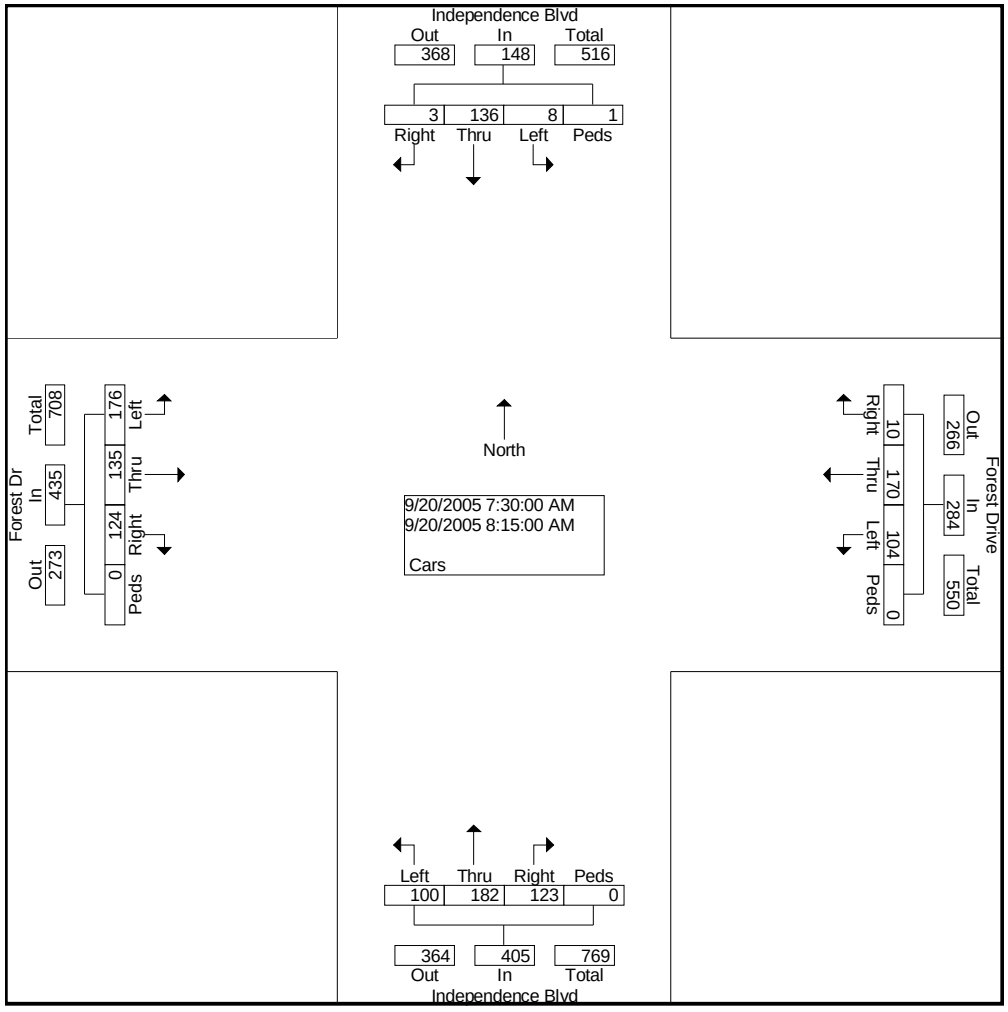


Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/Forest D
Date: Tuesday, September 20, 2005
Counter: PF

File Name : BedfordD
Site Code : 00000000
Start Date : 9/20/2005

	Independence Blvd Southbound					Forest Drive Westbound					Independence Blvd Northbound					Forest Dr Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 06:00 AM to 09:45 AM - Peak 1 of 1																					
Intersection	07:30 AM																				
Volume	3	136	8	1	148	10	170	104	0	284	123	182	100	0	405	124	135	176	0	435	1272
Percent	2.0	91.9	5.4	0.7		3.5	59.9	36.6	0.0		30.4	44.9	24.7	0.0		28.5	31.0	40.5	0.0		
08:00 Volume	0	41	2	1	44	3	37	23	0	63	32	65	27	0	124	26	29	75	0	130	361
Peak Factor																					0.881
High Int.	08:15 AM					07:45 AM					08:00 AM					08:00 AM					
Volume	0	43	5	0	48	1	52	36	0	89	32	65	27	0	124	26	29	75	0	130	
Peak Factor					0.771					0.798					0.817					0.837	

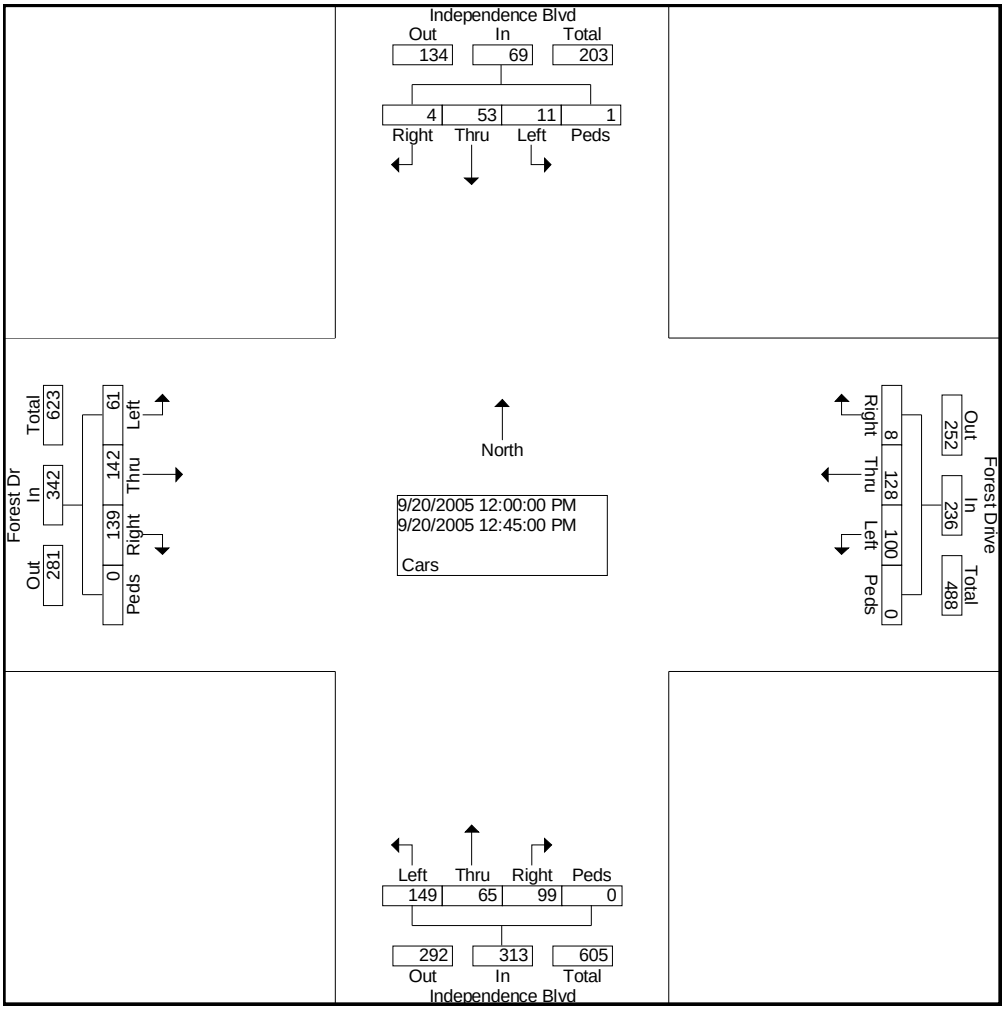


Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/Forest D
Date: Tuesday, September 20, 2005
Counter: PF

File Name : BedfordD
Site Code : 00000000
Start Date : 9/20/2005
Page No : 4

	Independence Blvd Southbound					Forest Drive Westbound					Independence Blvd Northbound					Forest Dr Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 10:00 AM to 01:45 PM - Peak 1 of 1																					
Intersection	12:00 PM																				
Volume	4	53	11	1	69	8	128	100	0	236	99	65	149	0	313	139	142	61	0	342	960
Percent	5.8	76.8	15.9	1.4		3.4	54.2	42.4	0.0		31.6	20.8	47.6	0.0		40.6	41.5	17.8	0.0		
12:15 Volume	2	9	5	0	16	5	43	23	0	71	34	15	37	0	86	42	43	15	0	100	273
Peak Factor																					0.879
High Int.	12:45 PM					12:15 PM					12:00 PM					12:15 PM					
Volume	1	20	1	0	22	5	43	23	0	71	28	22	42	0	92	42	43	15	0	100	
Peak Factor					0.784					0.831					0.851					0.855	

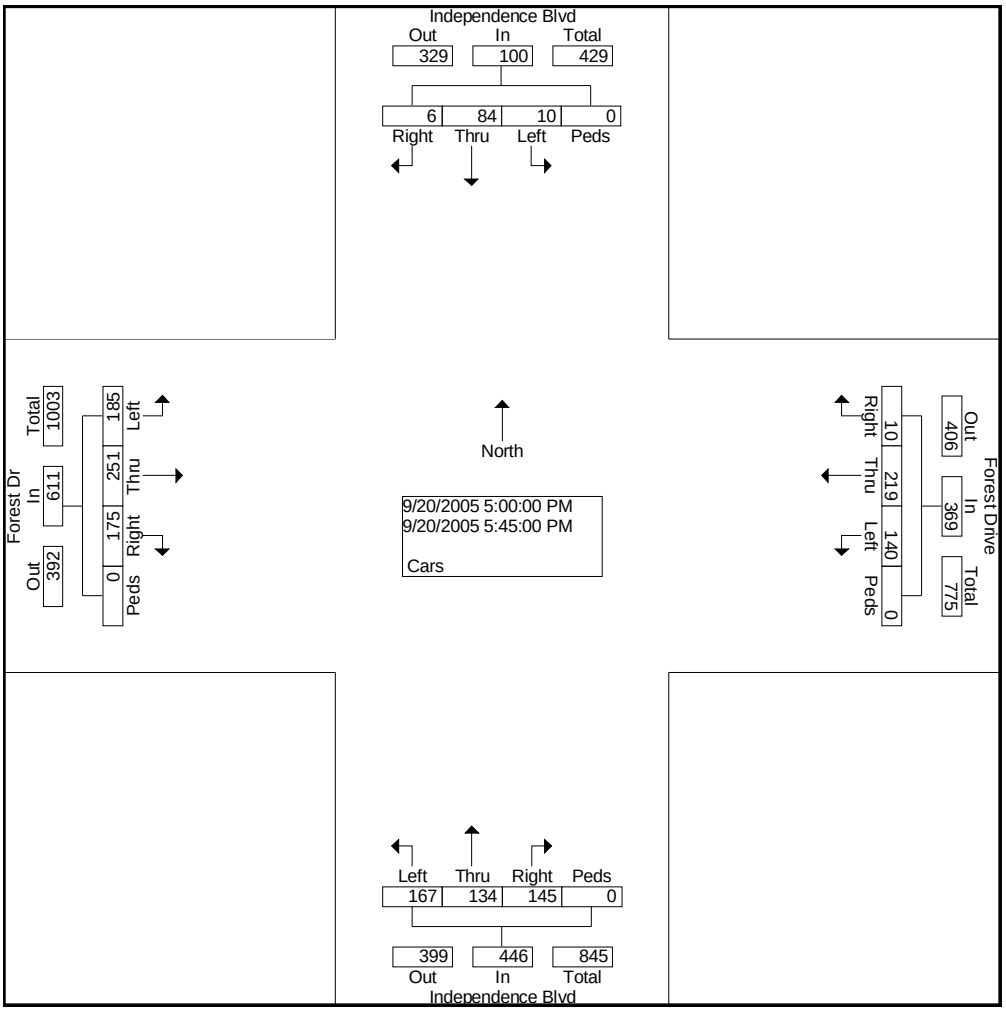


Tri-State Traffic Data, Inc.
184 Baker Road
Coatesville, PA 19320
610-466-1469

Location: Bedford, VA
Intersection: Independence Blvd/Forest D
Date: Tuesday, September 20, 2005
Counter: PF

File Name : BedfordD
Site Code : 00000000
Start Date : 9/20/2005
Page No : 5

	Independence Blvd Southbound					Forest Drive Westbound					Independence Blvd Northbound					Forest Dr Eastbound					
Start Time	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Right	Thru	Left	Peds	App. Total	Int. Total
Peak Hour From 02:00 PM to 05:45 PM - Peak 1 of 1																					
Intersection	05:00 PM																				
Volume	6	84	10	0	100	10	219	140	0	369	145	134	167	0	446	175	251	185	0	611	1526
Percent	6.0	84.0	10.0	0.0		2.7	59.3	37.9	0.0		32.5	30.0	37.4	0.0		28.6	41.1	30.3	0.0		
05:00 Volume	0	20	4	0	24	2	45	44	0	91	37	31	55	0	123	52	65	55	0	172	410
Peak Factor																					0.930
High Int.	05:15 PM					05:15 PM					05:00 PM					05:00 PM					
Volume	1	23	3	0	27	3	63	35	0	101	37	31	55	0	123	52	65	55	0	172	
Peak Factor					0.926					0.913					0.907					0.888	



APPENDIX B

Traffic Growth Worksheet
East Main Street and Independence Blvd

AM PEAK HOUR
7:30 - 8:30

Growth Rate = 1.5%

Growth Time Period = 25.00 years

	Existing Traffic	Background Traffic
Northbound Lefts	0	0
Northbound Thrus	0	0
Northbound Rights	0	0
Southbound Lefts	235	323
Southbound Thrus	0	0
Southbound Rights	69	95
Westbound Lefts	0	0
Westbound Thrus	216	297
Westbound Rights	415	571
Eastbound Lefts	105	144
Eastbound Lefts Thrus	113	155
Eastbound Rights	0	0
Totals =	1,153	1,585

NOTE: Simple Interest Methodology

Traffic Growth Worksheet
East Main Street and Independence Blvd

PM PEAK HOUR
3:15 - 4:15

Growth Rate = 1.5%

Growth Time Period = 25.00 years

	Existing Traffic	Background Traffic
Northbound Lefts	0	0
Northbound Thrus	0	0
Northbound Rights	0	0
Southbound Lefts	307	422
Southbound Thrus	0	0
Southbound Rights	140	193
Westbound Lefts	0	0
Westbound Thrus	187	257
Westbound Rights	253	348
Eastbound Lefts	182	250
Eastbound Lefts Thrus	200	275
Eastbound Rights	0	0
Totals =	1,269	1,745

NOTE: Simple Interest Methodology

Traffic Growth Worksheet
Forest Road and Independence Blvd

AM PEAK HOUR
7:30 - 8:30

Growth Rate = 1.5%

Growth Time Period = 25.00 years

	Existing Traffic	Background Traffic
Northbound Lefts	100	138
Northbound Thrus	182	250
Northbound Rights	123	169
Southbound Lefts	8	11
Southbound Thrus	136	187
Southbound Rights	3	4
Westbound Lefts	104	143
Westbound Thrus	170	234
Westbound Rights	10	14
Eastbound Lefts	176	242
Eastbound Lefts Thrus	135	186
Eastbound Rights	124	171
Totals =	1,271	1,748

NOTE: Simple Interest Methodology

Traffic Growth Worksheet
Forest Road and Independence Blvd

PM PEAK HOUR
5:00 - 6:00

Growth Rate = 1.5%

Growth Time Period = 25.00 years

	Existing Traffic	Background Traffic
Northbound Lefts	167	230
Northbound Thrus	134	184
Northbound Rights	145	199
Southbound Lefts	10	14
Southbound Thrus	84	116
Southbound Rights	6	8
Westbound Lefts	140	193
Westbound Thrus	219	301
Westbound Rights	10	14
Eastbound Lefts	185	254
Eastbound Lefts Thrus	251	345
Eastbound Rights	175	241
Totals =	1,526	2,098

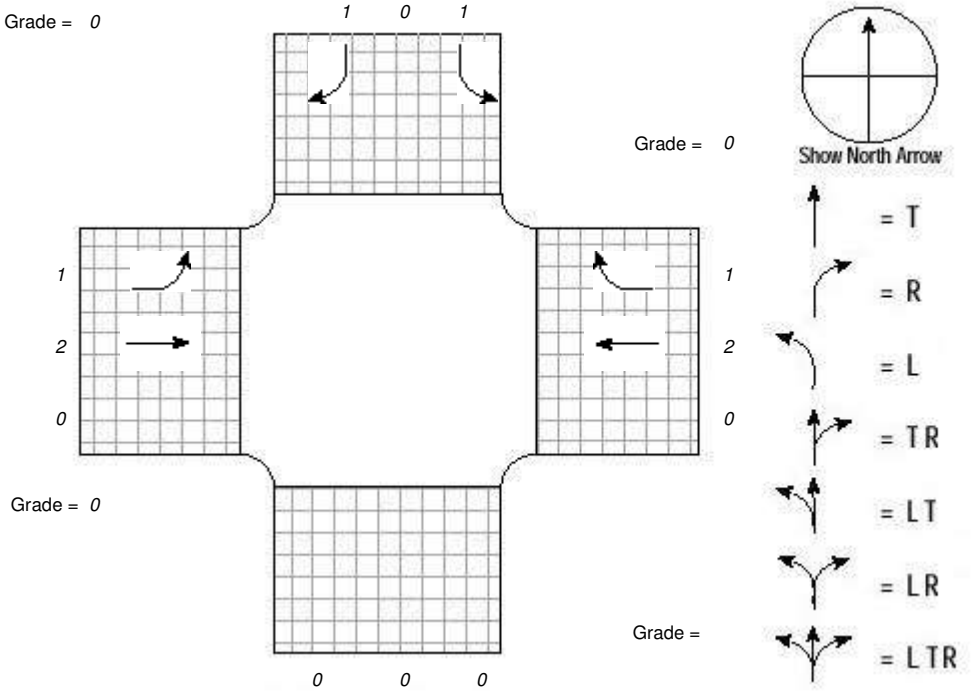
NOTE: Simple Interest Methodology

APPENDIX C

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*East Main & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*2/20/2006*	Jurisdiction	*VDOT*
Time Period	*AM Peak Hour (Existing)*	Analysis Year	*2005*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*105*	*113*			*216*	*415*				*235*		*69*
% Heavy veh	*5*	*5*			*5*	*5*				*5*		*5*
PHF	*0.88*	*0.88*			*0.82*	*0.82*				*0.94*		*0.94*
Actuated (P/A)	*P*	*P*			*P*	*P*				*P*		*P*
Startup lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Ext. eff. green	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Unit Extension	*3.0*	*3.0*			*3.0*	*3.0*				*3.0*		*3.0*
Ped/Bike/RTOR Volume				*0*		*0*	*0*			*0*		*0*
Lane Width	*12.0*	*12.0*			*12.0*	*12.0*				*12.0*		*12.0*
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*			*0*	*0*				*0*		*0*
Ped timing				*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	SB Only	06	07	08
Timing	G = *7.0*	G = *30.0*	G =	G =	G = *21.3*	G =	G =	G =
	Y = *4*	Y = *4*	Y =	Y =	Y = *4*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *70.3*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*105*	*113*			*216*	*415*				*235*		*69*
PHF	*0.88*	*0.88*			*0.82*	*0.82*				*0.94*		*0.94*
Adj. Flow Rate	*119*	*128*			*263*	*506*				*250*		*73*
Lane Group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*119*	*128*			*263*	*506*				*250*		*73*
Prop. LT or RT	*0.000*	--	*0.000*	*0.000*	--	*0.000*		--			--	

Saturation Flow Rate

Base satflow	*1900*	*1900*			*1900*	*1900*				*1900*		*1900*
Num. of lanes	*1*	*2*	*0*	*0*	*2*	*1*	*0*	*0*	*0*	*1*	*0*	*1*
fW	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fHV	*0.952*	*0.952*			*0.952*	*0.952*				*0.952*		*0.952*
fg	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fp	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fbb	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fa	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fLU	*1.000*	*0.952*			*0.952*	*1.000*				*1.000*		*1.000*
fLT	*0.950*	*1.000*	--		*1.000*	--			--	*0.950*		--
Secondary fLT	*0.532*		--			--			--			--
fRT	--	*1.000*		--	*1.000*	*0.850*	--			--		*0.850*
fLpb	*1.000*	*1.000*	--		*1.000*	--			--	*1.000*		--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--			--		*1.000*
Adj. satflow	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Sec. adj. satflow	*962*		--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*119*	*128*			*263*	*506*				*250*		*73*
Satflow rate	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Green ratio	*0.58*	*0.58*			*0.43*	*0.79*				*0.30*		*0.30*
Lane group cap.	*636*	*2009*			*1470*	*1210*				*521*		*466*
v/c ratio	*0.19*	*0.06*			*0.18*	*0.42*				*0.48*		*0.16*
Flow ratio		*0.04*			*0.08*	*0.33*				*0.15*		*0.05*
Crit. lane group	*N*	*N*			*N*	*Y*		*N*		*N*	*N*	*N*
Sum flow ratios	*0.40*											
Lost time/cycle	*8.00*											
Critical v/c ratio	*0.45*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*119*	*128*			*263*	*506*				*250*		*73*
Lane group cap.	*636*	*2009*			*1470*	*1210*				*521*		*466*
v/c ratio	*0.19*	*0.06*			*0.18*	*0.42*				*0.48*		*0.16*
Green ratio	*0.58*	*0.58*			*0.43*	*0.79*				*0.30*		*0.30*
Unif. delay d1	*6.6*	*6.3*			*12.5*	*2.4*				*20.0*		*17.9*
Delay factor k	*0.50*	*0.50*			*0.50*	*0.50*				*0.50*		*0.50*
Increm. delay d2	*0.7*	*0.1*			*0.3*	*1.1*				*3.1*		*0.7*
PF factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
Control delay	*7.3*	*6.4*			*12.8*	*3.4*				*23.1*		*18.6*
Lane group LOS	*A*	*A*			*B*	*A*				*C*		*B*
Apprch. delay	*6.8*			*6.6*						*22.1*		
Approach LOS	*A*			*A*						*C*		
Intersec. delay	*10.4*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*70.3*			
Prot. phase eff. green intvl, g (s)	*7.0*			
Opposed queue eff. green intvl, g_q (s)	*3.35*			
Unopposed green intvl, g_u (s)	*30.65*			
Red time, r(s)	*29.3*			
Arrival rate, q_a (veh/s)	*0.03*			
Prot. phase departure rate, s_p (veh/s)	*0.478*			
Perm. phase departure rate, s_s (veh/s)	*0.30*			
X_{perm}	*0.12*			
X_{prot} (N/A for lagging left-turns)	*0.36*			

Uniform Queue Size and Delay Computations

	EB	WB	NB	SB
Queue at start of green arrow, Q_a	*0.97*			
Queue at start of unsaturated green, Q_u	*0.11*			
Residual queue, Q_r	*0.00*			
Uniform delay, d_1	*6.6*			

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

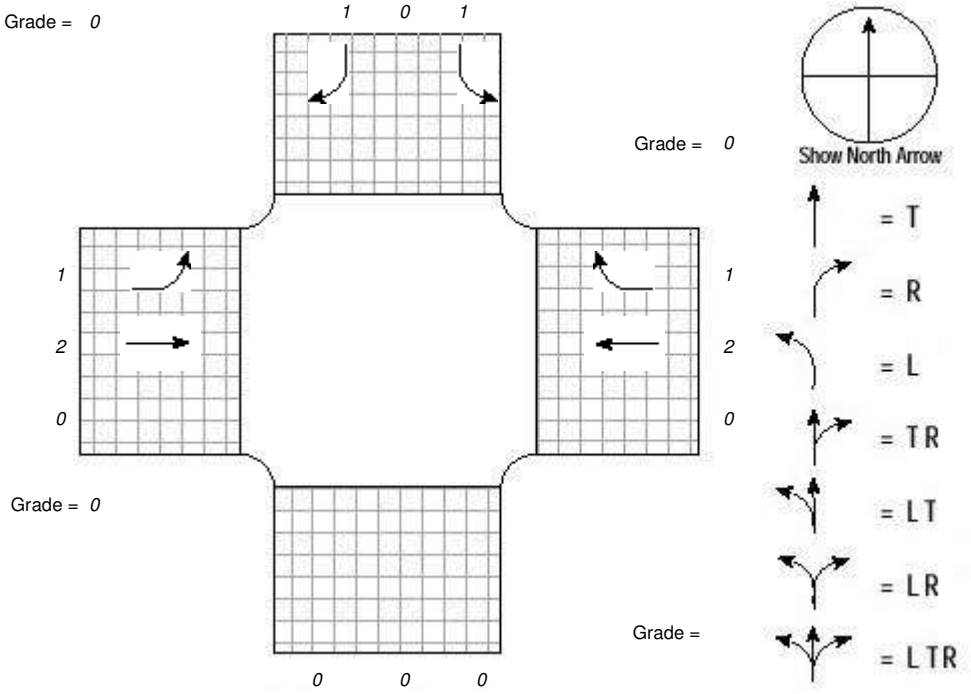
Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Init. queue/lane	*0.0*	*0.0*			*0.0*	*0.0*				*0.0*		*0.0*
Flow rate/lane	*119*	*128*			*263*	*506*				*250*		*73*
Satflow per lane	*1091*	*1809*			*1809*	*1538*				*1719*		*1538*
Capacity/lane	*636*	*2009*			*1470*	*1210*				*521*		*466*
Flow ratio	*0.11*	*0.04*			*0.08*	*0.33*				*0.15*		*0.05*
v/c ratio	*0.19*	*0.06*			*0.18*	*0.42*				*0.48*		*0.16*
I factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*	*1.000*	*1.000*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Platoon ratio	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
PF factor	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
Q_1	*1.0*	*0.6*			*1.7*	*3.1*				*4.0*		*1.0*
k_B	*0.7*	*1.0*			*0.8*	*1.1*				*0.6*		*0.6*
Q_2	*0.2*	*0.1*			*0.2*	*0.8*				*0.6*		*0.1*
Q avg.	*1.1*	*0.6*			*1.8*	*3.9*				*4.5*		*1.1*
Percentile Back of Queue (95th percentile)												
$f_{B\%}$	*2.4*	*2.5*			*2.3*	*2.1*				*2.0*		*2.4*
BOQ, $Q_{\%}$	*2.7*	*1.6*			*4.2*	*8.1*				*9.1*		*2.7*
Queue Storage Ratio												
Q spacing	*25.0*	*25.0*			*25.0*	*25.0*				*25.0*		*25.0*
Q storage	*0*	*0*			*0*	*0*				*0*		*0*
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*East Main & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*2/20/2006*	Jurisdiction	*VDOT*
Time Period	*AM Peak Hour (Future)*	Analysis Year	*2030*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*144*	*155*			*297*	*571*				*323*		*95*
% Heavy veh	*5*	*5*			*5*	*5*				*5*		*5*
PHF	*0.88*	*0.88*			*0.82*	*0.82*				*0.94*		*0.94*
Actuated (P/A)	*P*	*P*			*P*	*P*				*P*		*P*
Startup lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Ext. eff. green	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Unit Extension	*3.0*	*3.0*			*3.0*	*3.0*				*3.0*		*3.0*
Ped/Bike/RTOR Volume				*0*		*0*	*0*			*0*		*0*
Lane Width	*12.0*	*12.0*			*12.0*	*12.0*				*12.0*		*12.0*
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*			*0*	*0*				*0*		*0*
Ped timing				*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	SB Only	06	07	08
Timing	G = *7.0*	G = *30.0*	G =	G =	G = *21.3*	G =	G =	G =
	Y = *4*	Y = *4*	Y =	Y =	Y = *4*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *70.3*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*144*	*155*			*297*	*571*				*323*		*95*
PHF	*0.88*	*0.88*			*0.82*	*0.82*				*0.94*		*0.94*
Adj. Flow Rate	*164*	*176*			*362*	*696*				*344*		*101*
Lane Group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*164*	*176*			*362*	*696*				*344*		*101*
Prop. LT or RT	*0.000*	--	*0.000*	*0.000*	--	*0.000*		--			--	

Saturation Flow Rate

Base satflow	*1900*	*1900*			*1900*	*1900*				*1900*		*1900*
Num. of lanes	*1*	*2*	*0*	*0*	*2*	*1*	*0*	*0*	*0*	*1*	*0*	*1*
fW	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fHV	*0.952*	*0.952*			*0.952*	*0.952*				*0.952*		*0.952*
fg	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fp	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fbb	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fa	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fLU	*1.000*	*0.952*			*0.952*	*1.000*				*1.000*		*1.000*
fLT	*0.950*	*1.000*	--		*1.000*	--			--	*0.950*		--
Secondary fLT	*0.461*		--			--			--			--
fRT	--	*1.000*		--	*1.000*	*0.850*	--			--		*0.850*
fLpb	*1.000*	*1.000*	--		*1.000*	--			--	*1.000*		--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--			--		*1.000*
Adj. satflow	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Sec. adj. satflow	*834*		--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*164*	*176*			*362*	*696*				*344*		*101*
Satflow rate	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Green ratio	*0.58*	*0.58*			*0.43*	*0.79*				*0.30*		*0.30*
Lane group cap.	*574*	*2009*			*1470*	*1210*				*521*		*466*
v/c ratio	*0.29*	*0.09*			*0.25*	*0.58*				*0.66*		*0.22*
Flow ratio		*0.05*			*0.11*	*0.45*				*0.20*		*0.07*
Crit. lane group	*N*	*N*			*N*	*Y*		*N*		*N*	*N*	*N*
Sum flow ratios	*0.55*											
Lost time/cycle	*8.00*											
Critical v/c ratio	*0.62*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*164*	*176*			*362*	*696*				*344*		*101*
Lane group cap.	*574*	*2009*			*1470*	*1210*				*521*		*466*
v/c ratio	*0.29*	*0.09*			*0.25*	*0.58*				*0.66*		*0.22*
Green ratio	*0.58*	*0.58*			*0.43*	*0.79*				*0.30*		*0.30*
Unif. delay d1	*6.9*	*6.4*			*12.9*	*2.9*				*21.3*		*18.3*
Delay factor k	*0.50*	*0.50*			*0.50*	*0.50*				*0.50*		*0.50*
Increm. delay d2	*1.2*	*0.1*			*0.4*	*2.0*				*6.4*		*1.1*
PF factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
Control delay	*8.2*	*6.5*			*13.3*	*4.9*				*27.8*		*19.3*
Lane group LOS	*A*	*A*			*B*	*A*				*C*		*B*
Apprch. delay	*7.3*			*7.8*						*25.9*		
Approach LOS	*A*			*A*						*C*		
Intersec. delay	*12.1*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*70.3*			
Prot. phase eff. green intvl, g (s)	*7.0*			
Opposed queue eff. green intvl, g_q (s)	*4.76*			
Unopposed green intvl, g_u (s)	*29.24*			
Red time, r(s)	*29.3*			
Arrival rate, q_a (veh/s)	*0.05*			
Prot. phase departure rate, s_p (veh/s)	*0.478*			
Perm. phase departure rate, s_s (veh/s)	*0.27*			
X_{perm}	*0.20*			
X_{prot} (N/A for lagging left-turns)	*0.49*			

Uniform Queue Size and Delay Computations

Queue at start of green arrow, Q_a	*1.33*			
Queue at start of unsaturated green, Q_u	*0.22*			
Residual queue, Q_r	*0.00*			
Uniform delay, d_1	*6.9*			

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

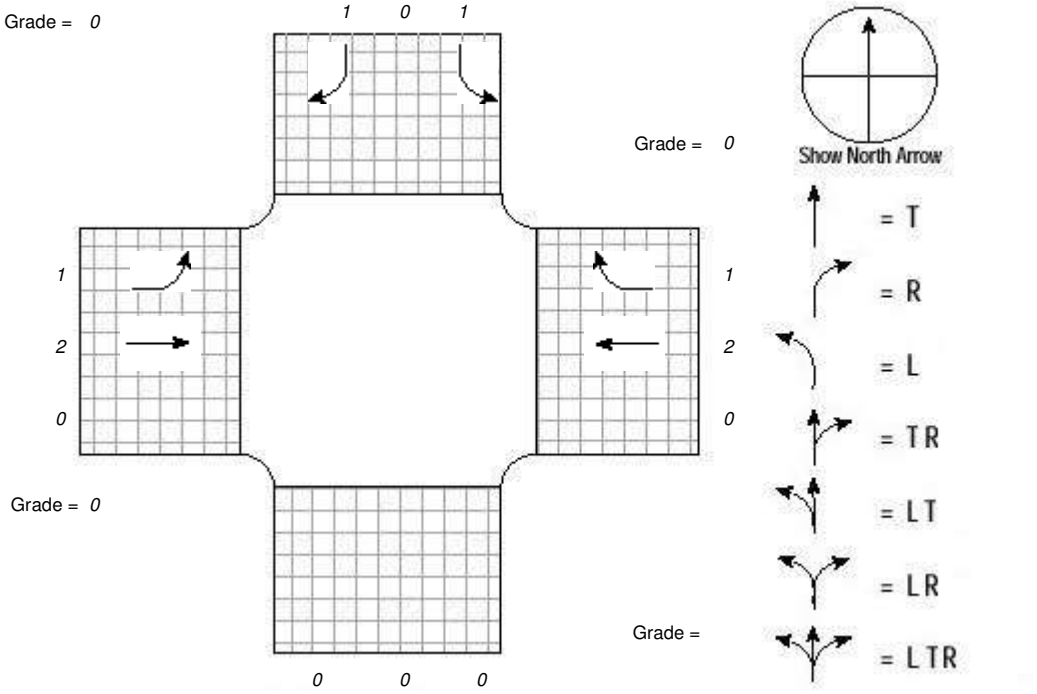
Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Init. queue/lane	*0.0*	*0.0*			*0.0*	*0.0*				*0.0*		*0.0*
Flow rate/lane	*164*	*176*			*362*	*696*				*344*		*101*
Satflow per lane	*985*	*1809*			*1809*	*1538*				*1719*		*1538*
Capacity/lane	*574*	*2009*			*1470*	*1210*				*521*		*466*
Flow ratio	*0.17*	*0.05*			*0.11*	*0.45*				*0.20*		*0.07*
v/c ratio	*0.29*	*0.09*			*0.25*	*0.58*				*0.66*		*0.22*
I factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*	*1.000*	*1.000*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Platoon ratio	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
PF factor	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
Q_1	*1.4*	*0.8*			*2.4*	*5.3*				*5.9*		*1.5*
k_B	*0.7*	*1.0*			*0.8*	*1.1*				*0.6*		*0.6*
Q_2	*0.3*	*0.1*			*0.3*	*1.5*				*1.1*		*0.2*
Q avg.	*1.6*	*0.9*			*2.6*	*6.8*				*7.0*		*1.6*
Percentile Back of Queue (95th percentile)												
$f_{B\%}$	*2.3*	*2.4*			*2.2*	*1.9*				*1.8*		*2.3*
BOQ, $Q_{\%}$	*3.8*	*2.2*			*5.8*	*12.6*				*12.9*		*3.8*
Queue Storage Ratio												
Q spacing	*25.0*	*25.0*			*25.0*	*25.0*				*25.0*		*25.0*
Q storage	*0*	*0*			*0*	*0*				*0*		*0*
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*East Main & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*2/20/2006*	Jurisdiction	*VDOT*
Time Period	*PM Peak Hour (Existing)*	Analysis Year	*2005*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*182*	*200*			*187*	*253*				*307*		*140*
% Heavy veh	*5*	*5*			*5*	*5*				*5*		*5*
PHF	*0.84*	*0.84*			*0.92*	*0.92*				*0.75*		*0.75*
Actuated (P/A)	*P*	*P*			*P*	*P*				*P*		*P*
Startup lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Ext. eff. green	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Unit Extension	*3.0*	*3.0*			*3.0*	*3.0*				*3.0*		*3.0*
Ped/Bike/RTOR Volume				*0*		*0*	*0*			*0*		*0*
Lane Width	*12.0*	*12.0*			*12.0*	*12.0*				*12.0*		*12.0*
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*			*0*	*0*				*0*		*0*
Ped timing				*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	SB Only	06	07	08
Timing	G = *15.0*	G = *12.0*	G =	G =	G = *25.2*	G =	G =	G =
	Y = *4*	Y = *4*	Y =	Y =	Y = *4*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *64.2*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*182*	*200*			*187*	*253*				*307*		*140*
PHF	*0.84*	*0.84*			*0.92*	*0.92*				*0.75*		*0.75*
Adj. Flow Rate	*217*	*238*			*203*	*275*				*409*		*187*
Lane Group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*217*	*238*			*203*	*275*				*409*		*187*
Prop. LT or RT	*0.000*	--	*0.000*	*0.000*	--	*0.000*		--			--	

Saturation Flow Rate

Base satflow	*1900*	*1900*			*1900*	*1900*				*1900*		*1900*
Num. of lanes	*1*	*2*	*0*	*0*	*2*	*1*	*0*	*0*	*0*	*1*	*0*	*1*
fW	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fHV	*0.952*	*0.952*			*0.952*	*0.952*				*0.952*		*0.952*
fg	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fp	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fbb	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fa	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fLU	*1.000*	*0.952*			*0.952*	*1.000*				*1.000*		*1.000*
fLT	*0.950*	*1.000*	--		*1.000*	--			--	*0.950*		--
Secondary fLT	*0.496*		--			--			--			--
fRT	--	*1.000*		--	*1.000*	*0.850*	--			--		*0.850*
fLpb	*1.000*	*1.000*	--		*1.000*	--			--	*1.000*		--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--			--		*1.000*
Adj. satflow	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Sec. adj. satflow	*898*		--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*217*	*238*			*203*	*275*				*409*		*187*
Satflow rate	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Green ratio	*0.48*	*0.48*			*0.19*	*0.64*				*0.39*		*0.39*
Lane group cap.	*626*	*1663*			*644*	*987*				*675*		*604*
v/c ratio	*0.35*	*0.14*			*0.32*	*0.28*				*0.61*		*0.31*
Flow ratio		*0.07*			*0.06*	*0.18*				*0.24*		*0.12*
Crit. lane group	*N*	*N*			*Y*	*N*		*N*		*Y*	*N*	*N*
Sum flow ratios	*0.42*											
Lost time/cycle	*12.00*											
Critical v/c ratio	*0.52*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*217*	*238*			*203*	*275*				*409*		*187*
Lane group cap.	*626*	*1663*			*644*	*987*				*675*		*604*
v/c ratio	*0.35*	*0.14*			*0.32*	*0.28*				*0.61*		*0.31*
Green ratio	*0.48*	*0.48*			*0.19*	*0.64*				*0.39*		*0.39*
Unif. delay d1	*9.9*	*9.2*			*22.6*	*5.0*				*15.5*		*13.5*
Delay factor k	*0.50*	*0.50*			*0.50*	*0.50*				*0.50*		*0.50*
Increm. delay d2	*1.5*	*0.2*			*1.3*	*0.7*				*4.0*		*1.3*
PF factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
Control delay	*11.4*	*9.4*			*23.8*	*5.7*				*19.6*		*14.8*
Lane group LOS	*B*	*A*			*C*	*A*				*B*		*B*
Apprch. delay	*10.4*			*13.4*						*18.1*		
Approach LOS	*B*			*B*						*B*		
Intersec. delay	*14.3*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*64.2*			
Prot. phase eff. green intvl, g (s)	*15.0*			
Opposed queue eff. green intvl, g_q (s)	*3.29*			
Unopposed green intvl, g_u (s)	*12.71*			
Red time, r(s)	*33.2*			
Arrival rate, q_a (veh/s)	*0.06*			
Prot. phase departure rate, s_p (veh/s)	*0.478*			
Perm. phase departure rate, s_s (veh/s)	*0.31*			
X_{perm}	*0.24*			
X_{prot} (N/A for lagging left-turns)	*0.41*			

Uniform Queue Size and Delay Computations

Queue at start of green arrow, Q_a	*2.00*			
Queue at start of unsaturated green, Q_u	*0.20*			
Residual queue, Q_r	*0.00*			
Uniform delay, d_1	*9.9*			

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

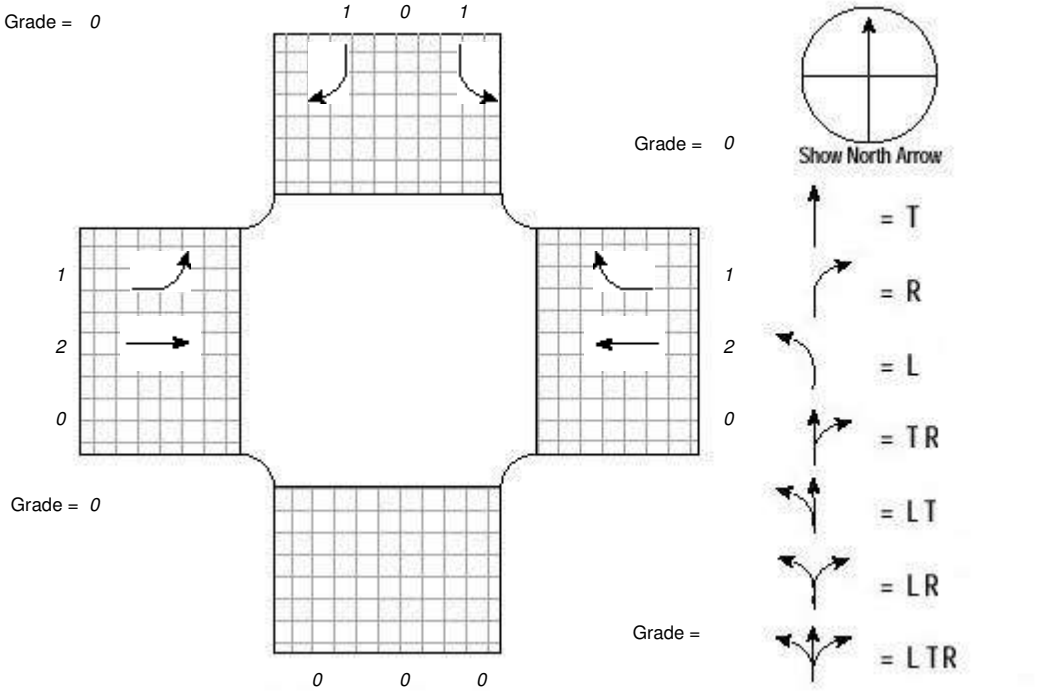
Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Init. queue/lane	*0.0*	*0.0*			*0.0*	*0.0*				*0.0*		*0.0*
Flow rate/lane	*217*	*238*			*203*	*275*				*409*		*187*
Satflow per lane	*1295*	*1809*			*1809*	*1538*				*1719*		*1538*
Capacity/lane	*626*	*1663*			*644*	*987*				*675*		*604*
Flow ratio	*0.17*	*0.07*			*0.06*	*0.18*				*0.24*		*0.12*
v/c ratio	*0.35*	*0.14*			*0.32*	*0.28*				*0.61*		*0.31*
I factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*	*1.000*	*1.000*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Platoon ratio	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
PF factor	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
Q_1	*2.2*	*1.2*			*1.6*	*2.1*				*5.8*		*2.3*
k_B	*0.6*	*0.8*			*0.4*	*0.9*				*0.7*		*0.6*
Q_2	*0.3*	*0.1*			*0.2*	*0.3*				*1.0*		*0.3*
Q avg.	*2.5*	*1.4*			*1.8*	*2.5*				*6.8*		*2.6*
Percentile Back of Queue (95th percentile)												
$f_{B\%}$	*2.2*	*2.4*			*2.3*	*2.2*				*1.9*		*2.2*
BOQ, $Q_{\%}$	*5.6*	*3.2*			*4.2*	*5.5*				*12.7*		*5.7*
Queue Storage Ratio												
Q spacing	*25.0*	*25.0*			*25.0*	*25.0*				*25.0*		*25.0*
Q storage	*0*	*0*			*0*	*0*				*0*		*0*
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*East Main & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*2/20/2006*	Jurisdiction	*VDOT*
Time Period	*PM Peak Hour (Future)*	Analysis Year	*2030*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*250*	*275*			*257*	*348*				*422*		*193*
% Heavy veh	*5*	*5*			*5*	*5*				*5*		*5*
PHF	*0.84*	*0.84*			*0.92*	*0.92*				*0.75*		*0.75*
Actuated (P/A)	*P*	*P*			*P*	*P*				*P*		*P*
Startup lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Ext. eff. green	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Unit Extension	*3.0*	*3.0*			*3.0*	*3.0*				*3.0*		*3.0*
Ped/Bike/RTOR Volume				*0*		*0*	*0*			*0*		*0*
Lane Width	*12.0*	*12.0*			*12.0*	*12.0*				*12.0*		*12.0*
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*			*0*	*0*				*0*		*0*
Ped timing				*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	SB Only	06	07	08
Timing	G = *15.0*	G = *12.0*	G =	G =	G = *25.2*	G =	G =	G =
	Y = *4*	Y = *4*	Y =	Y =	Y = *4*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *64.2*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*250*	*275*			*257*	*348*				*422*		*193*
PHF	*0.84*	*0.84*			*0.92*	*0.92*				*0.75*		*0.75*
Adj. Flow Rate	*298*	*327*			*279*	*378*				*563*		*257*
Lane Group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*298*	*327*			*279*	*378*				*563*		*257*
Prop. LT or RT	*0.000*	--	*0.000*	*0.000*	--	*0.000*		--			--	

Saturation Flow Rate

Base satflow	*1900*	*1900*			*1900*	*1900*				*1900*		*1900*
Num. of lanes	*1*	*2*	*0*	*0*	*2*	*1*	*0*	*0*	*0*	*1*	*0*	*1*
fW	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fHV	*0.952*	*0.952*			*0.952*	*0.952*				*0.952*		*0.952*
fg	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fp	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fbb	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fa	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
fLU	*1.000*	*0.952*			*0.952*	*1.000*				*1.000*		*1.000*
fLT	*0.950*	*1.000*	--		*1.000*	--			--	*0.950*		--
Secondary fLT	*0.413*		--			--			--			--
fRT	--	*1.000*		--	*1.000*	*0.850*	--			--		*0.850*
fLpb	*1.000*	*1.000*	--		*1.000*	--			--	*1.000*		--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--			--		*1.000*
Adj. satflow	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Sec. adj. satflow	*747*		--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*298*	*327*			*279*	*378*				*563*		*257*
Satflow rate	*1719*	*3445*			*3445*	*1538*				*1719*		*1538*
Lost time	*2.0*	*2.0*			*2.0*	*2.0*				*2.0*		*2.0*
Green ratio	*0.48*	*0.48*			*0.19*	*0.64*				*0.39*		*0.39*
Lane group cap.	*588*	*1663*			*644*	*987*				*675*		*604*
v/c ratio	*0.51*	*0.20*			*0.43*	*0.38*				*0.83*		*0.43*
Flow ratio		*0.09*			*0.08*	*0.25*				*0.33*		*0.17*
Crit. lane group	*N*	*N*			*Y*	*N*		*N*		*Y*	*N*	*N*
Sum flow ratios	*0.58*											
Lost time/cycle	*12.00*											
Critical v/c ratio	*0.72*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Adj. flow rate	*298*	*327*			*279*	*378*				*563*		*257*
Lane group cap.	*588*	*1663*			*644*	*987*				*675*		*604*
v/c ratio	*0.51*	*0.20*			*0.43*	*0.38*				*0.83*		*0.43*
Green ratio	*0.48*	*0.48*			*0.19*	*0.64*				*0.39*		*0.39*
Unif. delay d1	*10.6*	*9.5*			*23.1*	*5.5*				*17.6*		*14.2*
Delay factor k	*0.50*	*0.50*			*0.50*	*0.50*				*0.50*		*0.50*
Increm. delay d2	*3.1*	*0.3*			*2.1*	*1.1*				*11.6*		*2.2*
PF factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*		*1.000*
Control delay	*13.7*	*9.7*			*25.2*	*6.6*				*29.2*		*16.4*
Lane group LOS	*B*	*A*			*C*	*A*				*C*		*B*
Apprch. delay	*11.6*			*14.5*						*25.2*		
Approach LOS	*B*			*B*						*C*		
Intersec. delay	*17.8*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*64.2*			
Prot. phase eff. green intvl, g (s)	*15.0*			
Opposed queue eff. green intvl, g_q (s)	*4.63*			
Unopposed green intvl, g_u (s)	*11.37*			
Red time, r(s)	*33.2*			
Arrival rate, q_a (veh/s)	*0.08*			
Prot. phase departure rate, s_p (veh/s)	*0.478*			
Perm. phase departure rate, s_s (veh/s)	*0.29*			
X_{perm}	*0.40*			
X_{prot} (N/A for lagging left-turns)	*0.56*			

Uniform Queue Size and Delay Computations

Queue at start of green arrow, Q_a	*2.75*			
Queue at start of unsaturated green, Q_u	*0.38*			
Residual queue, Q_r	*0.00*			
Uniform delay, d_1	*10.6*			

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

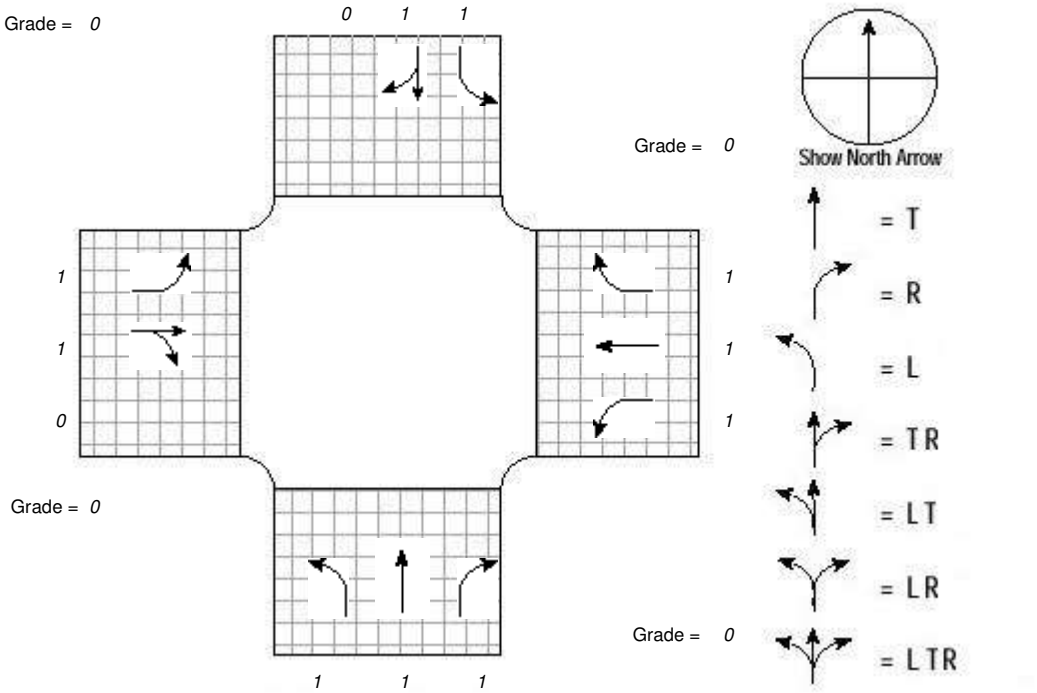
Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*T*			*T*	*R*				*L*		*R*
Init. queue/lane	*0.0*	*0.0*			*0.0*	*0.0*				*0.0*		*0.0*
Flow rate/lane	*298*	*327*			*279*	*378*				*563*		*257*
Satflow per lane	*1217*	*1809*			*1809*	*1538*				*1719*		*1538*
Capacity/lane	*588*	*1663*			*644*	*987*				*675*		*604*
Flow ratio	*0.24*	*0.09*			*0.08*	*0.25*				*0.33*		*0.17*
v/c ratio	*0.51*	*0.20*			*0.43*	*0.38*				*0.83*		*0.43*
I factor	*1.000*	*1.000*			*1.000*	*1.000*				*1.000*	*1.000*	*1.000*
Arrival type	*3*	*3*			*3*	*3*				*3*		*3*
Platoon ratio	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
PF factor	*1.00*	*1.00*			*1.00*	*1.00*				*1.00*		*1.00*
Q_1	*3.1*	*1.7*			*2.3*	*3.2*				*9.1*		*3.3*
k_B	*0.6*	*0.8*			*0.4*	*0.9*				*0.7*		*0.6*
Q_2	*0.6*	*0.2*			*0.3*	*0.6*				*2.9*		*0.5*
Q avg.	*3.7*	*1.9*			*2.6*	*3.8*				*11.9*		*3.8*
Percentile Back of Queue (95th percentile)												
$f_{B\%}$	*2.1*	*2.3*			*2.2*	*2.1*				*1.7*		*2.1*
BOQ, $Q_{\%}$	*7.8*	*4.4*			*5.7*	*7.8*				*20.2*		*7.9*
Queue Storage Ratio												
Q spacing	*25.0*	*25.0*			*25.0*	*25.0*				*25.0*		*25.0*
Q storage	*0*	*0*			*0*	*0*				*0*		*0*
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*Forest & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*3/21/2006*	Jurisdiction	*VDOT*
Time Period	*AM Peak Hour (Existing)*	Analysis Year	*2005*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*176*	*135*	*124*	*104*	*170*	*10*	*100*	*182*	*123*	*8*	*136*	*3*
% Heavy veh	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
PHF	*0.84*	*0.84*	*0.84*	*0.80*	*0.80*	*0.80*	*0.82*	*0.82*	*0.82*	*0.77*	*0.77*	*0.77*
Actuated (P/A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Startup lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Ext. eff. green	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Unit Extension	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Ped/Bike/RTOR Volume	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane Width	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Ped timing	*3.2*			*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	NS Perm	06	07	08
Timing	G = *12.0*	G = *16.6*	G =	G =	G = *16.4*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *60.0*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*176*	*135*	*124*	*104*	*170*	*10*	*100*	*182*	*123*	*8*	*136*	*3*
PHF	*0.84*	*0.84*	*0.84*	*0.80*	*0.80*	*0.80*	*0.82*	*0.82*	*0.82*	*0.77*	*0.77*	*0.77*
Adj. Flow Rate	*210*	*161*	*148*	*130*	*212*	*12*	*122*	*222*	*150*	*10*	*177*	*4*
Lane Group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*210*	*309*		*130*	*212*	*12*	*122*	*222*	*150*	*10*	*181*	
Prop. LT or RT	*0.000*	--	*0.479*	*0.000*	--	*0.000*	*0.000*	--	*0.000*	*0.000*	--	*0.022*

Saturation Flow Rate

Base satflow	*1900*	*1900*		*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	
Num. of lanes	*1*	*1*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*
fW	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fHV	*0.952*	*0.952*		*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	
fg	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fp	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fbb	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fa	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLU	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLT	*0.950*	*1.000*	--	*0.572*	*1.000*	--	*0.643*	*1.000*	--	*0.577*	*1.000*	--
Secondary fLT			--			--			--			--
fRT	--	*0.928*		--	*1.000*	*0.850*	--	*1.000*	*0.850*	--	*0.997*	
fLpb	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	
Adj. satflow	*1719*	*1680*		*1036*	*1810*	*1538*	*1164*	*1810*	*1538*	*1044*	*1804*	
Sec. adj. satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*210*	*309*		*130*	*212*	*12*	*122*	*222*	*150*	*10*	*181*	
Satflow rate	*1719*	*1680*		*1036*	*1810*	*1538*	*1164*	*1810*	*1538*	*1044*	*1804*	
Lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Green ratio	*0.20*	*0.56*		*0.28*	*0.28*	*0.28*	*0.27*	*0.27*	*0.27*	*0.27*	*0.27*	
Lane group cap.	*344*	*941*		*287*	*501*	*426*	*318*	*495*	*420*	*285*	*493*	
v/c ratio	*0.61*	*0.33*		*0.45*	*0.42*	*0.03*	*0.38*	*0.45*	*0.36*	*0.04*	*0.37*	
Flow ratio	*0.12*	*0.18*		*0.13*	*0.12*	*0.01*	*0.10*	*0.12*	*0.10*	*0.01*	*0.10*	
Crit. lane group	*Y*	*N*		*Y*	*N*	*N*	*N*	*Y*	*N*	*N*	*N*	
Sum flow ratios	*0.37*											
Lost time/cycle	*15.00*											
Critical v/c ratio	*0.49*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*210*	*309*		*130*	*212*	*12*	*122*	*222*	*150*	*10*	*181*	
Lane group cap.	*344*	*941*		*287*	*501*	*426*	*318*	*495*	*420*	*285*	*493*	
v/c ratio	*0.61*	*0.33*		*0.45*	*0.42*	*0.03*	*0.38*	*0.45*	*0.36*	*0.04*	*0.37*	
Green ratio	*0.20*	*0.56*		*0.28*	*0.28*	*0.28*	*0.27*	*0.27*	*0.27*	*0.27*	*0.27*	
Unif. delay d1	*21.9*	*7.1*		*17.9*	*17.8*	*15.8*	*17.7*	*18.1*	*17.6*	*16.0*	*17.6*	
Delay factor k	*0.50*	*0.50*		*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	
Increm. delay d2	*7.8*	*0.9*		*5.1*	*2.6*	*0.1*	*3.5*	*2.9*	*2.4*	*0.2*	*2.1*	
PF factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Control delay	*29.7*	*8.0*		*23.0*	*20.4*	*15.9*	*21.2*	*21.0*	*19.9*	*16.2*	*19.7*	
Lane group LOS	*C*	*A*		*C*	*C*	*B*	*C*	*C*	*B*	*B*	*B*	
Apprch. delay	*16.8*			*21.2*			*20.7*			*19.5*		
Approach LOS	*B*			*C*			*C*			*B*		
Intersec. delay	*19.4*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*60.0*			
Prot. phase eff. green intvl, g (s)				
Opposed queue eff. green intvl, g_q (s)				
Unopposed green intvl, g_u (s)				
Red time, r(s)				
Arrival rate, q_a (veh/s)				
Prot. phase departure rate, s_p (veh/s)				
Perm. phase departure rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for lagging left-turns)				

Uniform Queue Size and Delay Computations

Queue at start of green arrow, Q_a				
Queue at start of unsaturated green, Q_u				
Residual queue, Q_r				
Uniform delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Init. queue/lane	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Flow rate/lane	*210*	*309*		*130*	*212*	*12*	*122*	*222*	*150*	*10*	*181*	
Satflow per lane	*1719*	*1680*		*1036*	*1810*	*1538*	*1164*	*1810*	*1538*	*1044*	*1804*	
Capacity/lane	*344*	*941*		*287*	*501*	*426*	*318*	*495*	*420*	*285*	*493*	
Flow ratio	*0.12*	*0.18*		*0.13*	*0.12*	*0.01*	*0.10*	*0.12*	*0.10*	*0.01*	0.10	
v/c ratio	*0.61*	*0.33*		*0.45*	*0.42*	*0.03*	*0.38*	*0.45*	*0.36*	*0.04*	*0.37*	
I factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Platoon ratio	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
PF factor	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
Q_1	*3.2*	*2.8*		*1.8*	*2.9*	*0.1*	*1.7*	*3.1*	*2.0*	*0.1*	*2.4*	
k_B	*0.4*	*0.8*		*0.4*	*0.5*	*0.5*	*0.4*	*0.5*	*0.5*	*0.4*	*0.5*	
Q_2	*0.6*	*0.4*		*0.3*	*0.4*	*0.0*	*0.2*	*0.4*	*0.3*	*0.0*	*0.3*	
Q avg.	*3.8*	*3.2*		*2.1*	*3.3*	*0.2*	*1.9*	*3.5*	*2.3*	*0.1*	*2.7*	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	*2.1*	*2.1*		*2.3*	*2.1*	*2.6*	*2.3*	*2.1*	*2.2*	*2.6*	*2.2*	
BOQ, $Q_{\%}$	*7.9*	*6.8*		*4.7*	*6.9*	*0.4*	*4.3*	*7.3*	*5.1*	*0.3*	*6.0*	

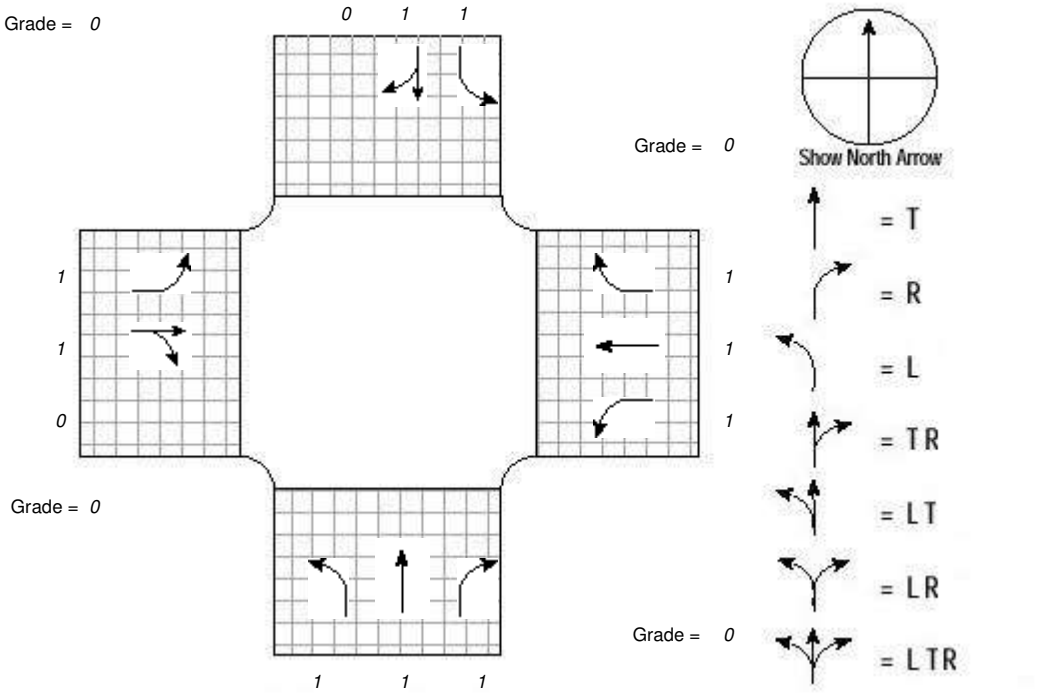
Queue Storage Ratio

Q spacing	*25.0*	*25.0*		*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	
Q storage	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*Forest & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*3/21/2006*	Jurisdiction	*VDOT*
Time Period	*AM Peak Hour (Future)*	Analysis Year	*2030*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*242*	*186*	*171*	*143*	*234*	*14*	*138*	*250*	*169*	*11*	*187*	*4*
% Heavy veh	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
PHF	*0.84*	*0.84*	*0.84*	*0.80*	*0.80*	*0.80*	*0.82*	*0.82*	*0.82*	*0.77*	*0.77*	*0.77*
Actuated (P/A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Startup lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Ext. eff. green	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Unit Extension	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Ped/Bike/RTOR Volume	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane Width	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Ped timing	*3.2*			*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	NS Perm	06	07	08
Timing	G = *12.3*	G = *16.8*	G =	G =	G = *15.9*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *60.0*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*242*	*186*	*171*	*143*	*234*	*14*	*138*	*250*	*169*	*11*	*187*	*4*
PHF	*0.84*	*0.84*	*0.84*	*0.80*	*0.80*	*0.80*	*0.82*	*0.82*	*0.82*	*0.77*	*0.77*	*0.77*
Adj. Flow Rate	*288*	*221*	*204*	*179*	*292*	*17*	*168*	*305*	*206*	*14*	*243*	*5*
Lane Group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*288*	*425*		*179*	*292*	*17*	*168*	*305*	*206*	*14*	*248*	
Prop. LT or RT	*0.000*	--	*0.480*	*0.000*	--	*0.000*	*0.000*	--	*0.000*	*0.000*	--	*0.020*

Saturation Flow Rate

Base satflow	*1900*	*1900*		*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	
Num. of lanes	*1*	*1*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*
fW	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fHV	*0.952*	*0.952*		*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	
fg	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fp	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fbb	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fa	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLU	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLT	*0.950*	*1.000*	--	*0.515*	*1.000*	--	*0.527*	*1.000*	--	*0.430*	*1.000*	--
Secondary fLT			--			--			--			--
fRT	--	*0.928*		--	*1.000*	*0.850*	--	*1.000*	*0.850*	--	*0.997*	
fLpb	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	
Adj. satflow	*1719*	*1679*		*931*	*1810*	*1538*	*954*	*1810*	*1538*	*778*	*1804*	
Sec. adj. satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*288*	*425*		*179*	*292*	*17*	*168*	*305*	*206*	*14*	*248*	
Satflow rate	*1719*	*1679*		*931*	*1810*	*1538*	*954*	*1810*	*1538*	*778*	*1804*	
Lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Green ratio	*0.20*	*0.57*		*0.28*	*0.28*	*0.28*	*0.26*	*0.26*	*0.26*	*0.26*	*0.26*	
Lane group cap.	*352*	*954*		*261*	*507*	*431*	*253*	*480*	*408*	*206*	*478*	
v/c ratio	*0.82*	*0.45*		*0.69*	*0.58*	*0.04*	*0.66*	*0.64*	*0.50*	*0.07*	*0.52*	
Flow ratio	*0.17*	*0.25*		*0.19*	*0.16*	*0.01*	*0.18*	*0.17*	*0.13*	*0.02*	*0.14*	
Crit. lane group	*Y*	*N*		*Y*	*N*	*N*	*Y*	*N*	*N*	*N*	*N*	
Sum flow ratios	*0.54*											
Lost time/cycle	*15.00*											
Critical v/c ratio	*0.71*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*288*	*425*		*179*	*292*	*17*	*168*	*305*	*206*	*14*	*248*	
Lane group cap.	*352*	*954*		*261*	*507*	*431*	*253*	*480*	*408*	*206*	*478*	
v/c ratio	*0.82*	*0.45*		*0.69*	*0.58*	*0.04*	*0.66*	*0.64*	*0.50*	*0.07*	*0.52*	
Green ratio	*0.20*	*0.57*		*0.28*	*0.28*	*0.28*	*0.26*	*0.26*	*0.26*	*0.26*	*0.26*	
Unif. delay d1	*22.8*	*7.5*		*19.2*	*18.5*	*15.7*	*19.7*	*19.5*	*18.7*	*16.5*	*18.8*	
Delay factor k	*0.50*	*0.50*		*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	
Increm. delay d2	*18.7*	*1.5*		*13.7*	*4.7*	*0.2*	*13.0*	*6.3*	*4.4*	*0.6*	*4.0*	
PF factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Control delay	*41.5*	*9.0*		*33.0*	*23.2*	*15.9*	*32.6*	*25.8*	*23.1*	*17.1*	*22.8*	
Lane group LOS	*D*	*A*		*C*	*C*	*B*	*C*	*C*	*C*	*B*	*C*	
Apprch. delay	*22.1*			*26.6*			*26.7*			*22.5*		
Approach LOS	*C*			*C*			*C*			*C*		
Intersec. delay	*24.6*			Intersection LOS						*C*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*60.0*			
Prot. phase eff. green intvl, g (s)				
Opposed queue eff. green intvl, g_q (s)				
Unopposed green intvl, g_u (s)				
Red time, r(s)				
Arrival rate, q_a (veh/s)				
Prot. phase departure rate, s_p (veh/s)				
Perm. phase departure rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for lagging left-turns)				

Uniform Queue Size and Delay Computations

	EB	WB	NB	SB
Queue at start of green arrow, Q_a				
Queue at start of unsaturated green, Q_u				
Residual queue, Q_r				
Uniform delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Init. queue/lane	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Flow rate/lane	*288*	*425*		*179*	*292*	*17*	*168*	*305*	*206*	*14*	*248*	
Satflow per lane	*1719*	*1679*		*931*	*1810*	*1538*	*954*	*1810*	*1538*	*778*	*1804*	
Capacity/lane	*352*	*954*		*261*	*507*	*431*	*253*	*480*	*408*	*206*	*478*	
Flow ratio	*0.17*	*0.25*		*0.19*	*0.16*	*0.01*	*0.18*	*0.17*	*0.13*	*0.02*	0.14	
v/c ratio	*0.82*	*0.45*		*0.69*	*0.58*	*0.04*	*0.66*	*0.64*	*0.50*	*0.07*	*0.52*	
I factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Platoon ratio	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
PF factor	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
Q_1	*4.6*	*4.1*		*2.7*	*4.2*	*0.2*	*2.5*	*4.5*	*2.9*	*0.2*	*3.5*	
k_B	*0.4*	*0.8*		*0.3*	*0.5*	*0.5*	*0.3*	*0.5*	*0.5*	*0.3*	*0.5*	
Q_2	*1.6*	*0.7*		*0.7*	*0.7*	*0.0*	*0.6*	*0.9*	*0.5*	*0.0*	*0.5*	
Q avg.	*6.1*	*4.8*		*3.3*	*4.9*	*0.2*	*3.1*	*5.4*	*3.4*	*0.2*	*4.1*	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	*1.9*	*2.0*		*2.1*	*2.0*	*2.6*	*2.1*	*1.9*	*2.1*	*2.6*	*2.0*	
BOQ, $Q_{\%}$	*11.6*	*9.4*		*7.1*	*9.7*	*0.6*	*6.6*	*10.4*	*7.1*	*0.5*	*8.3*	

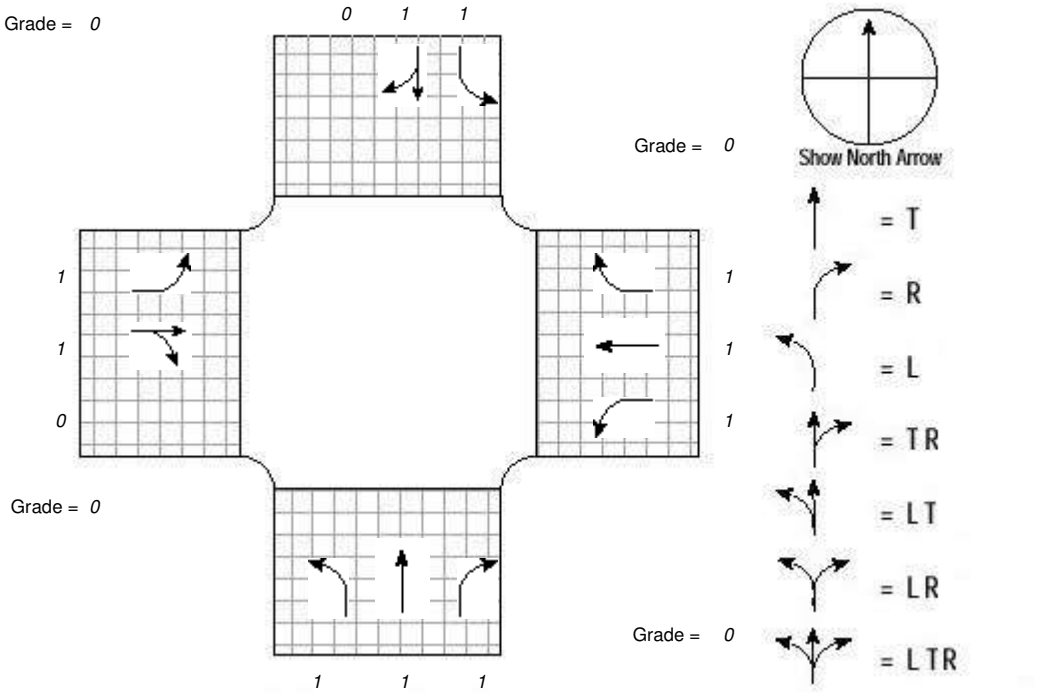
Queue Storage Ratio

Q spacing	*25.0*	*25.0*		*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	
Q storage	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*Forest & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*3/21/2006*	Jurisdiction	*VDOT*
Time Period	*PM Peak Hour (Existing)*	Analysis Year	*2005*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*185*	*251*	*175*	*140*	*219*	*10*	*167*	*134*	*145*	*10*	*84*	*6*
% Heavy veh	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
PHF	*0.89*	*0.89*	*0.89*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.93*	*0.93*	*0.93*
Actuated (P/A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Startup lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Ext. eff. green	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Unit Extension	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Ped/Bike/RTOR Volume	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane Width	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Ped timing	*3.2*			*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	NS Perm	06	07	08
Timing	G = *10.5*	G = *17.8*	G =	G =	G = *16.7*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *60.0*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*185*	*251*	*175*	*140*	*219*	*10*	*167*	*134*	*145*	*10*	*84*	*6*
PHF	*0.89*	*0.89*	*0.89*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.93*	*0.93*	*0.93*
Adj. Flow Rate	*208*	*282*	*197*	*154*	*241*	*11*	*184*	*147*	*159*	*11*	*90*	*6*
Lane Group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*208*	*479*		*154*	*241*	*11*	*184*	*147*	*159*	*11*	*96*	
Prop. LT or RT	*0.000*	--	*0.411*	*0.000*	--	*0.000*	*0.000*	--	*0.000*	*0.000*	--	*0.063*

Saturation Flow Rate

Base satflow	*1900*	*1900*		*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	
Num. of lanes	*1*	*1*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*
fW	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fHV	*0.952*	*0.952*		*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	
fg	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fp	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fbb	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fa	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLU	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLT	*0.950*	*1.000*	--	*0.490*	*1.000*	--	*0.695*	*1.000*	--	*0.663*	*1.000*	--
Secondary fLT			--			--			--			--
fRT	--	*0.938*		--	*1.000*	*0.850*	--	*1.000*	*0.850*	--	*0.991*	
fLpb	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	
Adj. satflow	*1719*	*1698*		*886*	*1810*	*1538*	*1257*	*1810*	*1538*	*1200*	*1793*	
Sec. adj. satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*208*	*479*		*154*	*241*	*11*	*184*	*147*	*159*	*11*	*96*	
Satflow rate	*1719*	*1698*		*886*	*1810*	*1538*	*1257*	*1810*	*1538*	*1200*	*1793*	
Lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Green ratio	*0.17*	*0.56*		*0.30*	*0.30*	*0.30*	*0.28*	*0.28*	*0.28*	*0.28*	*0.28*	
Lane group cap.	*301*	*942*		*263*	*537*	*456*	*350*	*504*	*428*	*334*	*499*	
v/c ratio	*0.69*	*0.51*		*0.59*	*0.45*	*0.02*	*0.53*	*0.29*	*0.37*	*0.03*	*0.19*	
Flow ratio	*0.12*	*0.28*		*0.17*	*0.13*	*0.01*	*0.15*	*0.08*	*0.10*	*0.01*	*0.05*	
Crit. lane group	*Y*	*N*		*Y*	*N*	*N*	*Y*	*N*	*N*	*N*	*N*	
Sum flow ratios	*0.44*											
Lost time/cycle	*15.00*											
Critical v/c ratio	*0.59*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*208*	*479*		*154*	*241*	*11*	*184*	*147*	*159*	*11*	*96*	
Lane group cap.	*301*	*942*		*263*	*537*	*456*	*350*	*504*	*428*	*334*	*499*	
v/c ratio	*0.69*	*0.51*		*0.59*	*0.45*	*0.02*	*0.53*	*0.29*	*0.37*	*0.03*	*0.19*	
Green ratio	*0.17*	*0.56*		*0.30*	*0.30*	*0.30*	*0.28*	*0.28*	*0.28*	*0.28*	*0.28*	
Unif. delay d1	*23.2*	*8.3*		*18.0*	*17.1*	*14.9*	*18.3*	*17.0*	*17.4*	*15.8*	*16.5*	
Delay factor k	*0.50*	*0.50*		*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	
Increm. delay d2	*12.3*	*2.0*		*9.2*	*2.7*	*0.1*	*5.6*	*1.5*	*2.5*	*0.2*	*0.9*	
PF factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Control delay	*35.5*	*10.2*		*27.2*	*19.8*	*15.0*	*23.9*	*18.5*	*19.9*	*16.0*	*17.4*	
Lane group LOS	*D*	*B*		*C*	*B*	*B*	*C*	*B*	*B*	*B*	*B*	
Apprch. delay	*17.9*			*22.5*			*21.0*			*17.2*		
Approach LOS	*B*			*C*			*C*			*B*		
Intersec. delay	*19.8*			Intersection LOS						*B*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*60.0*			
Prot. phase eff. green intvl, g (s)				
Opposed queue eff. green intvl, g_q (s)				
Unopposed green intvl, g_u (s)				
Red time, r(s)				
Arrival rate, q_a (veh/s)				
Prot. phase departure rate, s_p (veh/s)				
Perm. phase departure rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for lagging left-turns)				

Uniform Queue Size and Delay Computations

Queue at start of green arrow, Q_a				
Queue at start of unsaturated green, Q_u				
Residual queue, Q_r				
Uniform delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Existing (Comm # 2541)*

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Init. queue/lane	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Flow rate/lane	*208*	*479*		*154*	*241*	*11*	*184*	*147*	*159*	*11*	*96*	
Satflow per lane	*1719*	*1698*		*886*	*1810*	*1538*	*1257*	*1810*	*1538*	*1200*	*1793*	
Capacity/lane	*301*	*942*		*263*	*537*	*456*	*350*	*504*	*428*	*334*	*499*	
Flow ratio	*0.12*	*0.28*		*0.17*	*0.13*	*0.01*	*0.15*	*0.08*	*0.10*	*0.01*	0.05	
v/c ratio	*0.69*	*0.51*		*0.59*	*0.45*	*0.02*	*0.53*	*0.29*	*0.37*	*0.03*	*0.19*	
I factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Platoon ratio	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
PF factor	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
Q_1	*3.3*	*4.9*		*2.2*	*3.3*	*0.1*	*2.6*	*1.9*	*2.1*	*0.1*	*1.2*	
k_B	*0.4*	*0.8*		*0.3*	*0.6*	*0.5*	*0.4*	*0.5*	*0.5*	*0.4*	*0.5*	
Q_2	*0.8*	*0.8*		*0.5*	*0.4*	*0.0*	*0.4*	*0.2*	*0.3*	*0.0*	*0.1*	
Q avg.	*4.0*	*5.8*		*2.6*	*3.7*	*0.1*	*3.0*	*2.1*	*2.4*	*0.1*	*1.3*	

Percentile Back of Queue (95th percentile)

$f_{B\%}$	*2.0*	*1.9*		*2.2*	*2.1*	*2.6*	*2.1*	*2.3*	*2.2*	*2.6*	*2.4*	
BOQ, $Q_{\%}$	*8.2*	*11.1*		*5.8*	*7.7*	*0.4*	*6.5*	*4.8*	*5.3*	*0.4*	*3.2*	

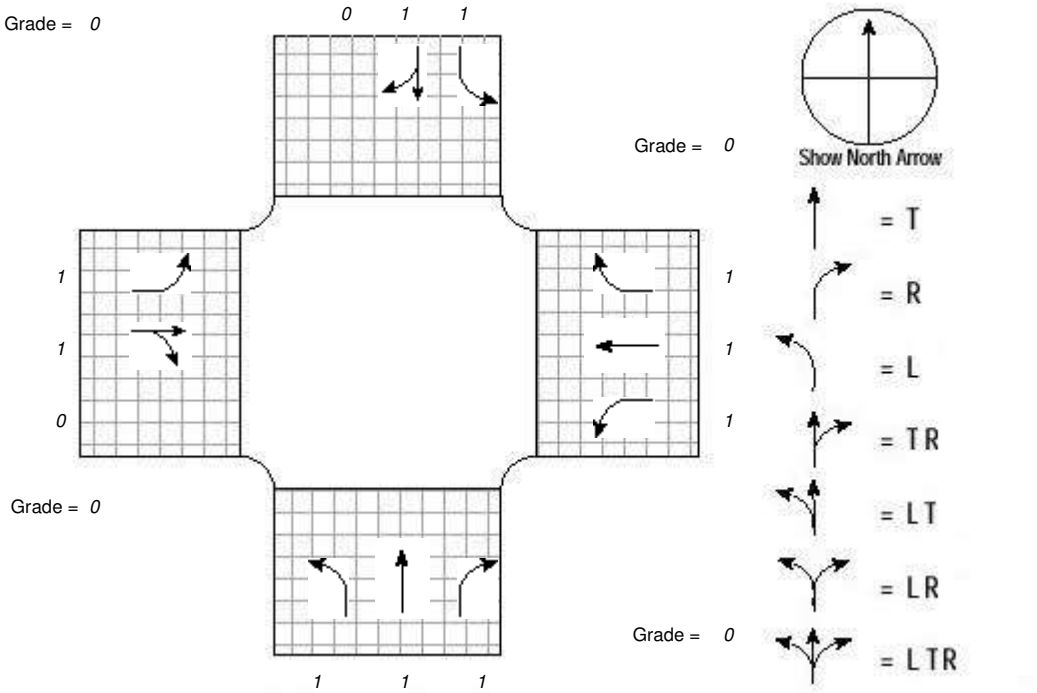
Queue Storage Ratio

Q spacing	*25.0*	*25.0*		*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	
Q storage	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Avg. R_Q												
95% $R_{Q\%}$												

LONG REPORT

General Information		Site Information	
Analyst	*Ken Putnam*	Intersection	*Forest & Independence*
Agency or Co.	*Mattern & Craig*	Area Type	*All other areas*
Date Performed	*3/21/2006*	Jurisdiction	*VDOT*
Time Period	*PM Peak Hour (Future)*	Analysis Year	*2030*

Intersection Geometry



Volume and Timing Input

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume (vph)	*254*	*345*	*241*	*193*	*301*	*14*	*230*	*184*	*199*	*14*	*116*	*8*
% Heavy veh	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*	*5*
PHF	*0.89*	*0.89*	*0.89*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.93*	*0.93*	*0.93*
Actuated (P/A)	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*	*P*
Startup lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Ext. eff. green	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Unit Extension	*3.0*	*3.0*		*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	*3.0*	
Ped/Bike/RTOR Volume	*0*		*0*	*0*		*0*	*0*		*0*	*0*		*0*
Lane Width	*12.0*	*12.0*		*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	*12.0*	
Parking (Y or N)	*N*		*N*	*N*		*N*	*N*		*N*	*N*		*N*
Parking/hr												
Bus stops/hr	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Ped timing	*3.2*			*3.2*			*3.2*			*3.2*		

	EB Only	EW Perm	03	04	NS Perm	06	07	08
Timing	G = *10.5*	G = *18.6*	G =	G =	G = *15.9*	G =	G =	G =
	Y = *5*	Y = *5*	Y =	Y =	Y = *5*	Y =	Y =	Y =

Duration of Analysis (hrs) = *0.25*

Cycle Length C = *60.0*

VOLUME ADJUSTMENT AND SATURATION FLOW RATE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Volume Adjustment

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Volume	*254*	*345*	*241*	*193*	*301*	*14*	*230*	*184*	*199*	*14*	*116*	*8*
PHF	*0.89*	*0.89*	*0.89*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.91*	*0.93*	*0.93*	*0.93*
Adj. Flow Rate	*285*	*388*	*271*	*212*	*331*	*15*	*253*	*202*	*219*	*15*	*125*	*9*
Lane Group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*285*	*659*		*212*	*331*	*15*	*253*	*202*	*219*	*15*	*134*	
Prop. LT or RT	*0.000*	--	*0.411*	*0.000*	--	*0.000*	*0.000*	--	*0.000*	*0.000*	--	*0.067*

Saturation Flow Rate

Base satflow	*1900*	*1900*		*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	*1900*	
Num. of lanes	*1*	*1*	*0*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*1*	*0*
fW	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fHV	*0.952*	*0.952*		*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	*0.952*	
fg	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fp	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fbb	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fa	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLU	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
fLT	*0.950*	*1.000*	--	*0.414*	*1.000*	--	*0.671*	*1.000*	--	*0.608*	*1.000*	--
Secondary fLT			--			--			--			--
fRT	--	*0.938*		--	*1.000*	*0.850*	--	*1.000*	*0.850*	--	*0.990*	
fLpb	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	*1.000*	--
fRpb	--	*1.000*		--	*1.000*	*1.000*	--	*1.000*	*1.000*	--	*1.000*	
Adj. satflow	*1719*	*1698*		*750*	*1810*	*1538*	*1215*	*1810*	*1538*	*1101*	*1791*	
Sec. adj. satflow			--			--			--			--

CAPACITY AND LOS WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Capacity Analysis

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*285*	*659*		*212*	*331*	*15*	*253*	*202*	*219*	*15*	*134*	
Satflow rate	*1719*	*1698*		*750*	*1810*	*1538*	*1215*	*1810*	*1538*	*1101*	*1791*	
Lost time	*2.0*	*2.0*		*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	*2.0*	
Green ratio	*0.17*	*0.57*		*0.31*	*0.31*	*0.31*	*0.26*	*0.26*	*0.26*	*0.26*	*0.26*	
Lane group cap.	*301*	*965*		*233*	*561*	*477*	*322*	*480*	*408*	*292*	*475*	
v/c ratio	*0.95*	*0.68*		*0.91*	*0.59*	*0.03*	*0.79*	*0.42*	*0.54*	*0.05*	*0.28*	
Flow ratio	*0.17*	*0.39*		*0.28*	*0.18*	*0.01*	*0.21*	*0.11*	*0.14*	*0.01*	*0.07*	
Crit. lane group	*Y*	*N*		*Y*	*N*	*N*	*Y*	*N*	*N*	*N*	*N*	
Sum flow ratios	*0.66*											
Lost time/cycle	*15.00*											
Critical v/c ratio	*0.88*											

Lane Group Capacity, Control Delay, and LOS Determination

	EB			WB			NB			SB		
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Adj. flow rate	*285*	*659*		*212*	*331*	*15*	*253*	*202*	*219*	*15*	*134*	
Lane group cap.	*301*	*965*		*233*	*561*	*477*	*322*	*480*	*408*	*292*	*475*	
v/c ratio	*0.95*	*0.68*		*0.91*	*0.59*	*0.03*	*0.79*	*0.42*	*0.54*	*0.05*	*0.28*	
Green ratio	*0.17*	*0.57*		*0.31*	*0.31*	*0.31*	*0.26*	*0.26*	*0.26*	*0.26*	*0.26*	
Unif. delay d1	*24.5*	*9.1*		*19.9*	*17.5*	*14.4*	*20.5*	*18.2*	*18.9*	*16.4*	*17.5*	
Delay factor k	*0.50*	*0.50*		*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	*0.50*	
Increm. delay d2	*39.9*	*3.9*		*39.5*	*4.5*	*0.1*	*17.4*	*2.7*	*5.0*	*0.3*	*1.5*	
PF factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Control delay	*64.4*	*13.0*		*59.4*	*22.0*	*14.5*	*37.8*	*20.9*	*23.9*	*16.8*	*19.0*	
Lane group LOS	*E*	*B*		*E*	*C*	*B*	*D*	*C*	*C*	*B*	*B*	
Apprch. delay	*28.5*			*36.0*			*28.2*			*18.8*		
Approach LOS	*C*			*D*			*C*			*B*		
Intersec. delay	*29.6*			Intersection LOS						*C*		

SUPPLEMENTAL UNIFORM DELAY WORKSHEET FOR LEFT TURNS FROM EXCLUSIVE LANES WITH PROTECTED AND PERMITTED PHASES

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

v/c Ratio Computation

	EB	WB	NB	SB
Cycle length, C (s)	*60.0*			
Prot. phase eff. green intvl, g (s)				
Opposed queue eff. green intvl, g_q (s)				
Unopposed green intvl, g_u (s)				
Red time, r(s)				
Arrival rate, q_a (veh/s)				
Prot. phase departure rate, s_p (veh/s)				
Perm. phase departure rate, s_s (veh/s)				
X_{perm}				
X_{prot} (N/A for lagging left-turns)				

Uniform Queue Size and Delay Computations

	EB	WB	NB	SB
Queue at start of green arrow, Q_a				
Queue at start of unsaturated green, Q_u				
Residual queue, Q_r				
Uniform delay, d_1				

Uniform Queue Size and Delay Equations

	Case	Q_a	Q_u	Q_r	d_1
If X_{perm} <= 1.0 & X_{prot} <= 1.0	1	$q_a r$	$q_a g_q$	0	$[0.5/(q_a C)][rQ_a + Q_a^{2/(s_p - q_s)} + g_q Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} <= 1.0 & X_{prot} > 1.0	2	$q_a r$	$Q_r + q_a g_q$	$Q_a - g(s_p - q_a)$	$[0.5/(q_a C)][rQ_a + g(Q_a + Q_r) + g_q (Q_r + Q_u) + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 & X_{prot} <= 1.0	3	$Q_r + q_a r$	$q_a g_q$	$Q_u - g_u(s_s - q_a)$	$[0.5/(q_a C)][g_q Q_u + g_u(Q_a + Q_r) + r(Q_r + Q_a) + Q_a^{2/(s_p - q_a)}$
If X_{perm} <= 1.0 (lagging lefts)	4	0	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + Q_u^{2/(s_s - q_a)}$
If X_{perm} > 1.0 (lagging lefts)	5	$Q_u - g_u(s_s - q_a)$	$q_a(r + g_q)$	0	$[0.5/(q_a C)][r + g_q)Q_u + g_u(Q_u + Q_a) + Q_a^{2/(s_p - q_a)}$

BACK-OF-QUEUE WORKSHEET

General Information

Project Description *Independence Blvd Corridor Study - Future (Comm # 2541)*

Average Back of Queue

	EB			WB			NB			SB		
	LT	TH	RT	LT	TH	RT	LT	TH	RT	LT	TH	RT
Lane group	*L*	*TR*		*L*	*T*	*R*	*L*	*T*	*R*	*L*	*TR*	
Init. queue/lane	*0.0*	*0.0*		*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	*0.0*	
Flow rate/lane	*285*	*659*		*212*	*331*	*15*	*253*	*202*	*219*	*15*	*134*	
Satflow per lane	*1719*	*1698*		*750*	*1810*	*1538*	*1215*	*1810*	*1538*	*1101*	*1791*	
Capacity/lane	*301*	*965*		*233*	*561*	*477*	*322*	*480*	*408*	*292*	*475*	
Flow ratio	*0.17*	*0.39*		*0.28*	*0.18*	*0.01*	*0.21*	*0.11*	*0.14*	*0.01*	0.07	
v/c ratio	*0.95*	*0.68*		*0.91*	*0.59*	*0.03*	*0.79*	*0.42*	*0.54*	*0.05*	*0.28*	
I factor	*1.000*	*1.000*		*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	*1.000*	
Arrival type	*3*	*3*		*3*	*3*	*3*	*3*	*3*	*3*	*3*	*3*	
Platoon ratio	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
PF factor	*1.00*	*1.00*		*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	*1.00*	
Q_1	*4.7*	*7.7*		*3.4*	*4.7*	*0.2*	*3.9*	*2.8*	*3.1*	*0.2*	*1.8*	
k_B	*0.4*	*0.8*		*0.3*	*0.6*	*0.5*	*0.4*	*0.5*	*0.5*	*0.4*	*0.5*	
Q_2	*2.8*	*1.7*		*1.8*	*0.8*	*0.0*	*1.2*	*0.4*	*0.5*	*0.0*	*0.2*	
Q avg.	*7.5*	*9.5*		*5.2*	*5.5*	*0.2*	*5.2*	*3.2*	*3.6*	*0.2*	*2.0*	

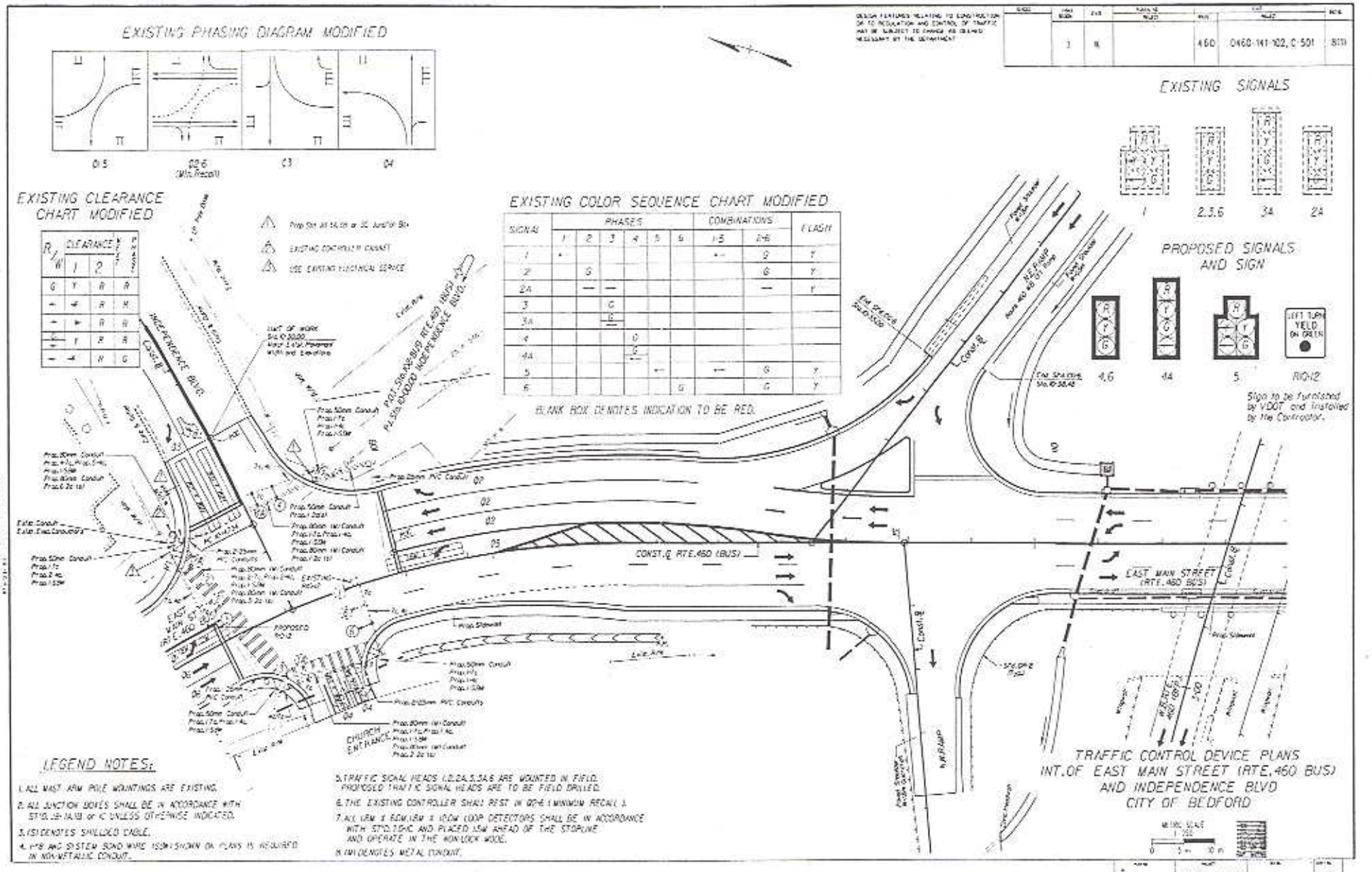
Percentile Back of Queue (95th percentile)

$f_{B\%}$	*1.8*	*1.8*		*2.0*	*1.9*	*2.6*	*2.0*	*2.1*	*2.1*	*2.6*	*2.3*	
BOQ, $Q_{\%}$	*13.6*	*16.6*		*10.2*	*10.6*	*0.5*	*10.1*	*6.7*	*7.6*	*0.5*	*4.5*	

Queue Storage Ratio

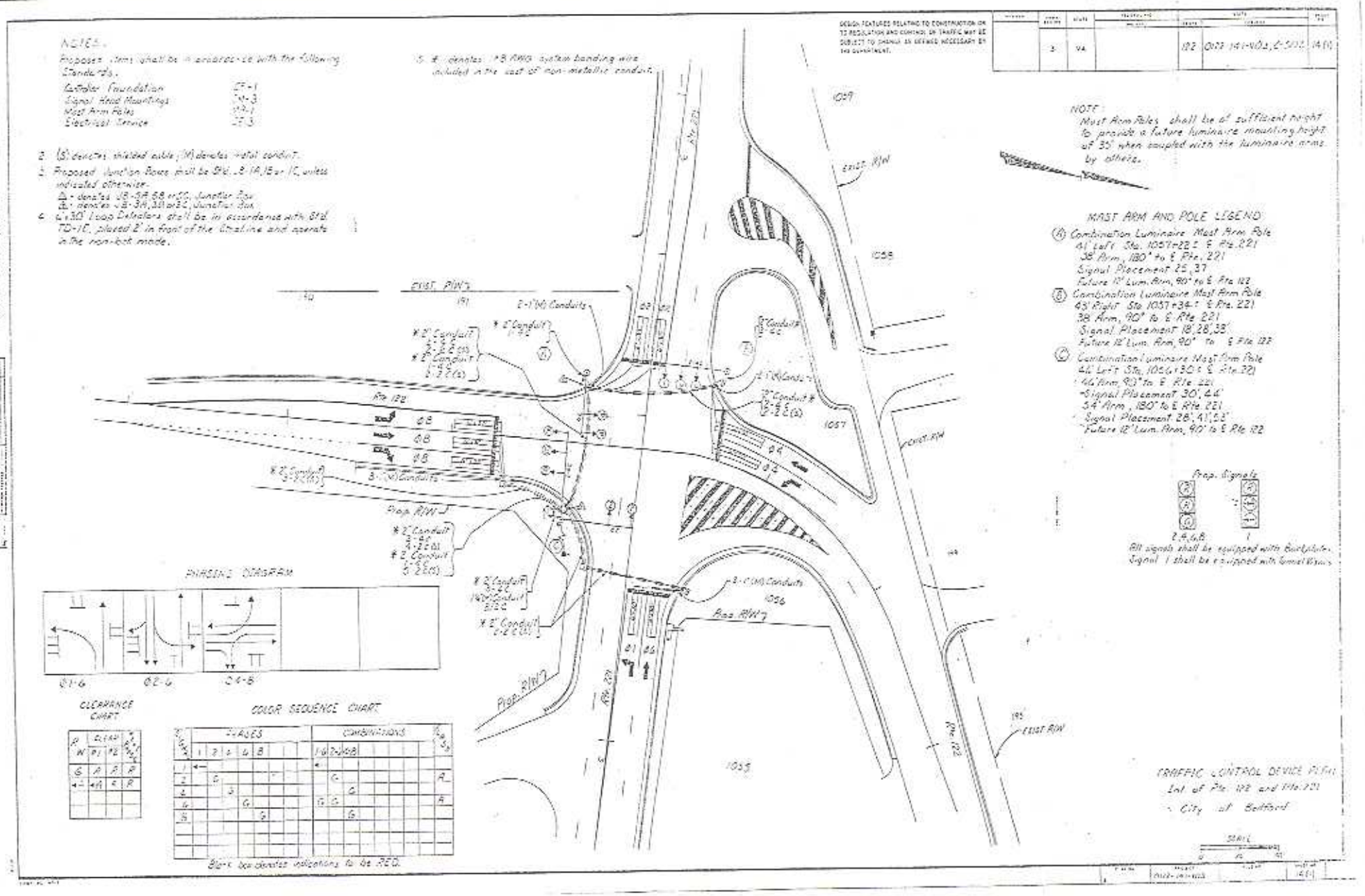
Q spacing	*25.0*	*25.0*		*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	*25.0*	
Q storage	*0*	*0*		*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	
Avg. R_Q												
95% $R_{Q\%}$												

APPENDIX D

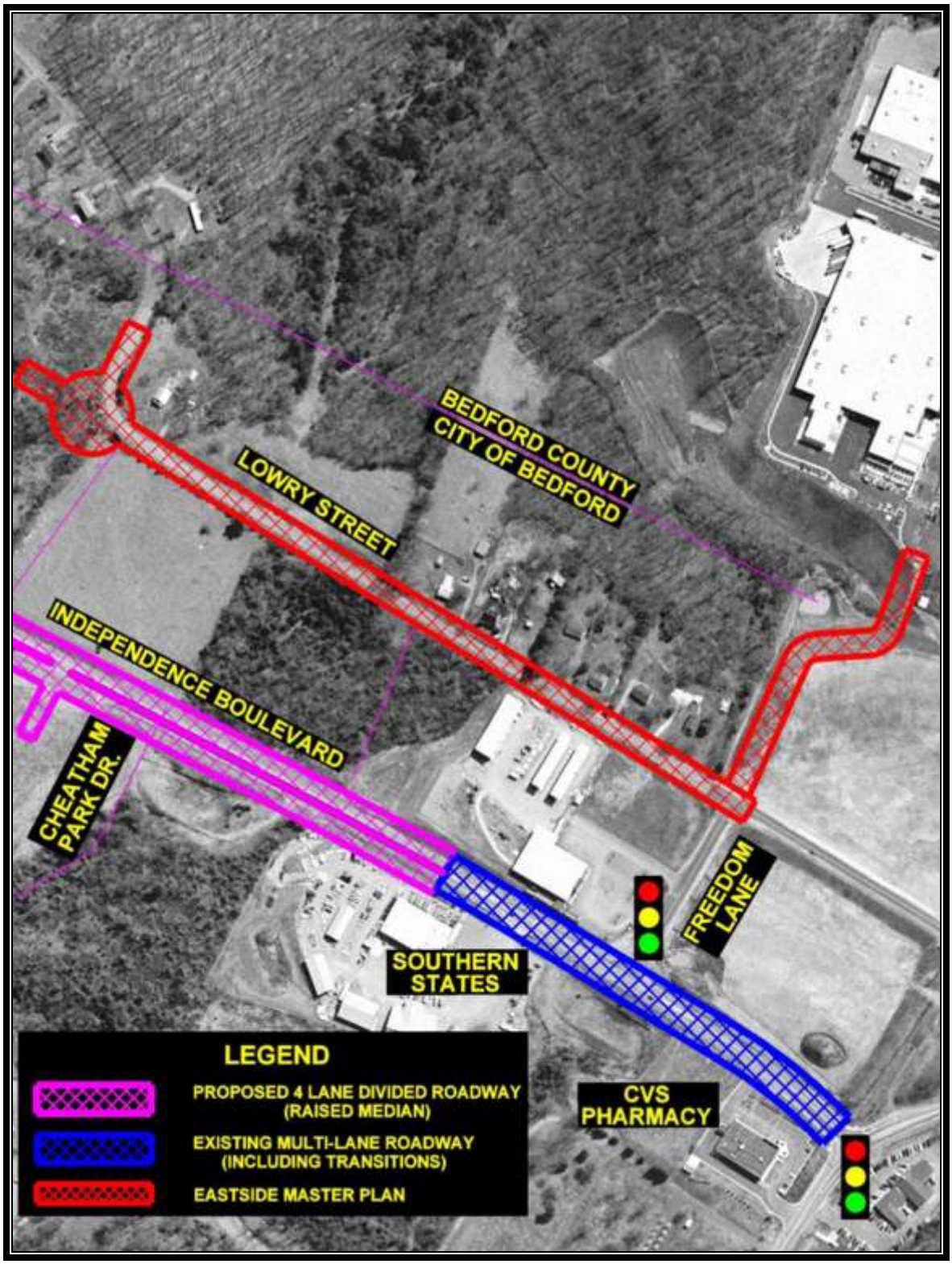


LEGEND NOTES:

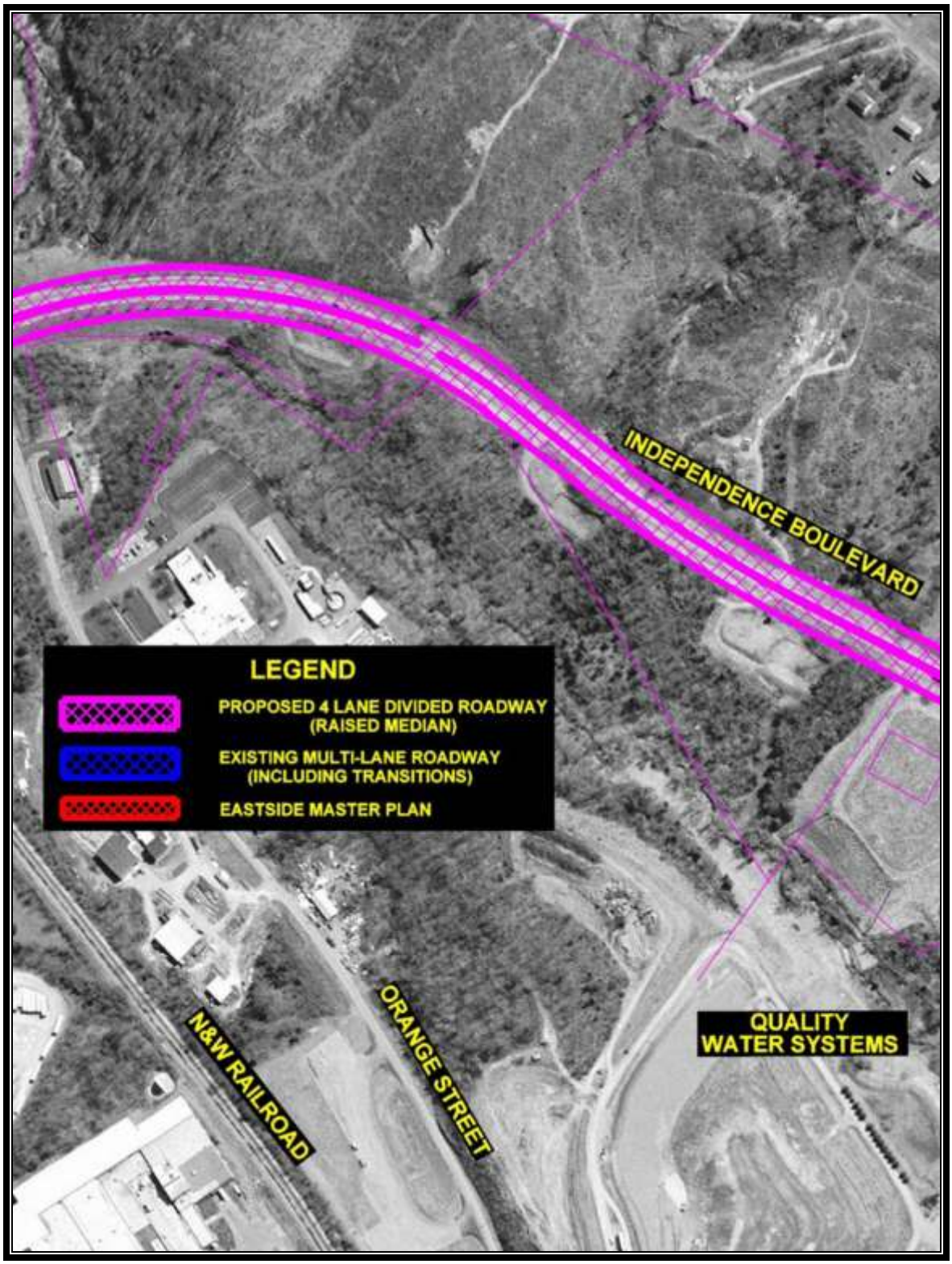
1. ALL MAST ARM POLE MOUNTINGS ARE EXISTING.
2. ALL JUNCTION BOXES SHALL BE IN ACCORDANCE WITH STD. JB-1A/18 or 4C UNLESS OTHERWISE INDICATED.
3. (S) DENOTES SHIELDED CABLE.
4. #8 AWG SYSTEM BOND WIRE (SBW) SHOWN ON PLANS IS REQUIRED IN NON-METALLIC CONDUIT.
5. TRAFFIC SIGNAL HEADS 1,0,2A,3,3A,6 ARE MOUNTED IN FIELD. PROPOSED TRAFFIC SIGNAL HEADS ARE TO BE FIELD DRILLED.
6. THE EXISTING CONTROLLER SHALL REST IN Ø2& 6 MINIMUM RECALL.
7. ALL 1.8M X 1.8M (6'X6') & 1.0M X 1.0M (3'X3') LOOP DETECTORS SHALL BE IN ACCORDANCE WITH STD. TS-1C AND PLACED 1.5M AHEAD OF THE STOPLINE AND OPERATE IN THE NON-LOCK MODE.
8. (M) DENOTES METAL CONDUIT.


NOTES.
Proposed items shall be in accordance with the following Standards.
Controller Foundation TF-1
Signal Head Mountings M-3
Mast Arm Poles M-1
Electrical Service TE-3
2. (S) denotes shielded cable; (M) denotes metal conduit.
3. Proposed Junction Boxes shall be Std. No. 14, 15 or 17, unless indicated otherwise.
△ - denotes No. 3A, 6B or 6C, Junction Box
△ - denotes No. 3A, 3B or 3C, Junction Box
4. 6'x30' Loop Detectors shall be in accordance with Std. TD-1C, placed 2' in front of the stopline and operate in the non-lock mode.
5. # denotes #8 AWG system bonding wire included in the east 2" non-metallic conduit.
DESIGN FEATURES RELATING TO CONSTRUCTION OR TO REGULATION AND CONTROL OF TRAFFIC MAY BE SUBJECT TO CHANGE AS DEEMED NECESSARY BY THE DEPARTMENT.
NOTE
Mast Arm Poles shall be of sufficient height to provide a future luminaire mounting height of 35' when coupled with the luminaire arms by others.
MAST ARM AND POLE LEGEND
(A) Combination Luminaire Mast Arm Pole
41' Left Sta. 1057+22.2 ℄ Pte. 221
38' Arm, 180° to ℄ Pte. 221
Signal Placement 25', 37'
Future 17' Lum. Arm, 90° to ℄ Pte 122
(B) Combination Luminaire Mast Arm Pole
43' Right Sta. 1057+34.7 ℄ Pte. 221
38' Arm, 90° to ℄ Pte 221
Signal Placement (8', 28', 38'
Future 12' Lum. Arm, 90° to ℄ Pte 122
(C) Combination Luminaire Mast Arm Pole
40' Left (Sta. 1056+30.6 ℄ Pte. 22)
44' Arm, 90° to ℄ Pte 221
-Signal Placement 30', 44'
54' Arm, 180° to ℄ Pte 221
Signal Placement 28', 41', 53'
Future 12' Lum. Arm, 90° to ℄ Pte 122
Prop. Signals
2, 4, 6, 8
1
All signals shall be equipped with Backplates. Signal 1 shall be equipped with Louvered Visors
PHASING DIAGRAM
Ø1-6
Ø2-6
Ø4-8
CLEARANCE CHART
COLOR SEQUENCE CHART
PHASES
COMBINATIONS
Black box denotes indications to be RED.
EXIST. R/W
PROP. R/W
EXIST. P/W's
Rte 121
Rte 122
Rte 221
1-1"(M) Conduits
3-1"(M) Conduits
1055
1056
1057
1059
TRAFFIC CONTROL DEVICE PLAN
Int of Pte. 122 and Pte. 221
City of Bedford
SCALE
0 20 40

APPENDIX E



Independence Boulevard Corridor (Sheet 1 of 4)



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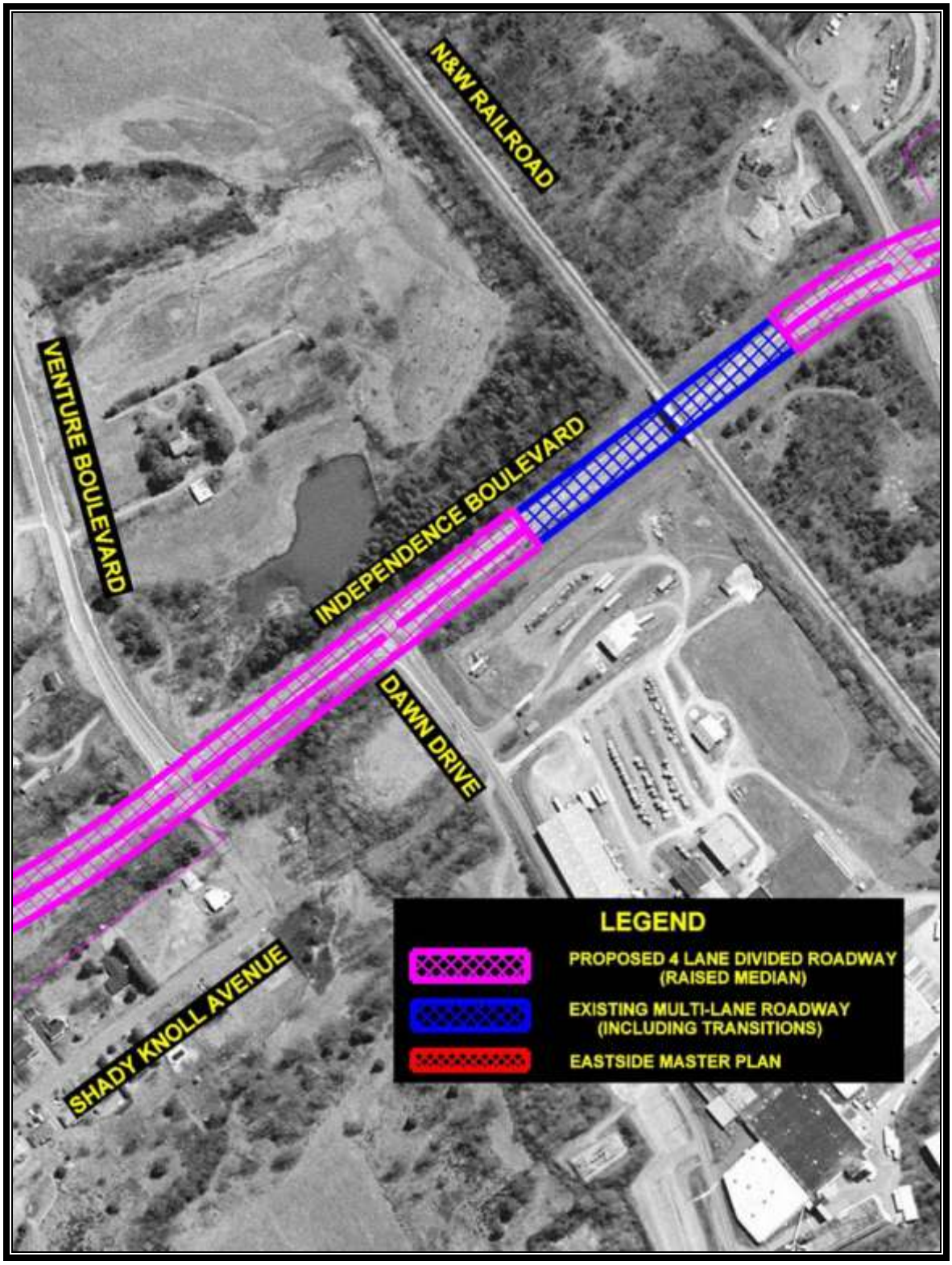

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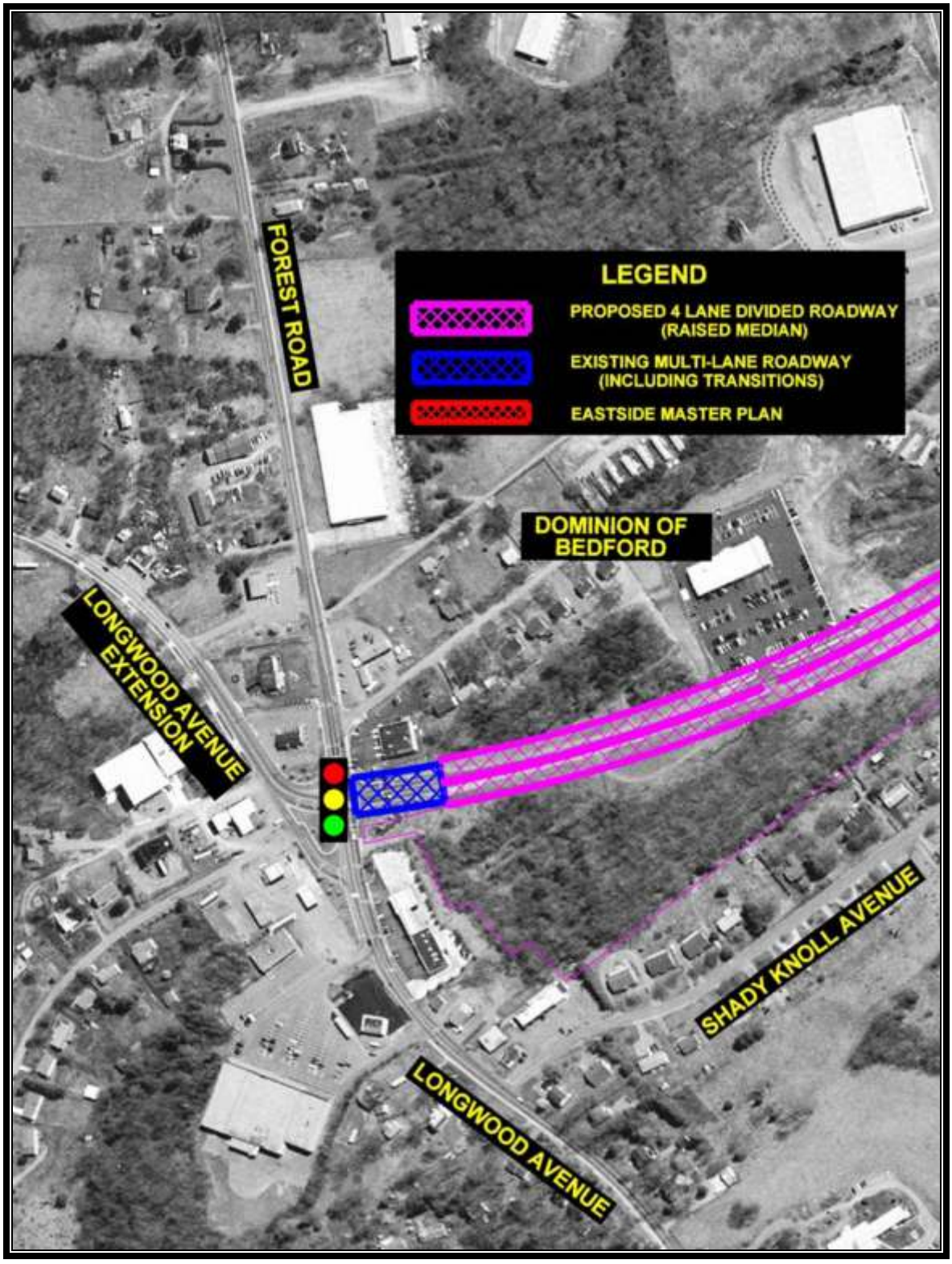

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