

**Standard Title Page - Report on Federally Funded Project**

1. Report No. FHWA/VTRC 05-R20	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle Providing Technical Assistance in an Environment of Uncertainty: A Case Study in Coordinating Transportation and Land Use		5. Report Date February 2005	
		6. Performing Organization Code	
7. Author(s) John S. Miller and Arkopal K. Goswami		8. Performing Organization Report No. VTRC 05-R20	
9. Performing Organization and Address  Virginia Transportation Research Council 530 Edgemont Road Charlottesville, VA 22903		10. Work Unit No. (TRAIS)	
		11. Contract or Grant No. 72991	
12. Sponsoring Agencies' Name and Address  Virginia Department of Transportation      FHWA 1401 E. Broad Street                              P.O. Box 10249 Richmond, VA 23219                                Richmond, VA 23240		13. Type of Report and Period Covered Final	
		14. Sponsoring Agency Code	
15. Supplementary Notes			
16. Abstract  <p>This study examined the feasibility of just one approach to coordinating transportation and land use planning. The lack of such coordination in the United States has been the subject of much criticism. In rural areas, the locality usually controls land development decisions whereas the state generally controls transportation decisions. In Virginia, Botetourt County and the Virginia Department of Transportation (VDOT) initiated a pilot planning process to coordinate transportation and land use planning. In that process, VDOT personnel served as staff for the county, which was the client.</p> <p>The immediate goal of this effort was a scenarios analysis. Botetourt specified potential zoning scenarios for consideration, and VDOT estimated the likely impacts of each scenario on the immediate transportation network. Botetourt benefited from this relationship by having access to engineering staff who can provide a quantitative analysis of delay at key intersections, and VDOT benefited by helping to ensure that Botetourt had the opportunity to consider the transportation impacts in its zoning decisions. To support this scenarios development, three additional deliverables were developed: a data element protocol, an action plan, and a template for replicating this process with other Virginia counties.</p> <p>Seven steps comprise this template: (1) define a problem statement quickly, imperfectly, and iteratively; (2) use quick updates to resolve shortcomings; (3) maintain momentum; (4) keep everyone updated equally; (5) recognize that the county is the client; (6) dedicate staff; and (7) end the process with a tangible deliverable. Details of how these steps were accomplished are provided to facilitate the transfer of these lessons to other counties and VDOT.</p>			
17 Key Words Land use, transportation planning, Botetourt County, intergovernmental relationships, technical assistance		18. Distribution Statement No restrictions. This document is available to the public through NTIS, Springfield, VA 22161.	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 38	22. Price

**FINAL REPORT**

**PROVIDING TECHNICAL ASSISTANCE IN AN ENVIRONMENT  
OF UNCERTAINTY: A CASE STUDY IN COORDINATING TRANSPORTATION  
AND LAND USE**

**John S. Miller, Ph.D., P.E.  
Senior Research Scientist**

**Arkopal K. Goswami  
Graduate Research Assistant**

Virginia Transportation Research Council  
(A Cooperative Organization Sponsored Jointly by the  
Virginia Department of Transportation and  
the University of Virginia)

In Cooperation with the U.S. Department of Transportation  
Federal Highway Administration

Charlottesville, Virginia

February 2005  
VTRC 05-R20

## **DISCLAIMER**

The contents of this report reflect the views of the authors, who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Virginia Department of Transportation, the Commonwealth Transportation Board, or the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Copyright 2005 by the Commonwealth of Virginia.

## ABSTRACT

This study examined the feasibility of just one approach to coordinating transportation and land use planning. The lack of such coordination in the United States has been the subject of much criticism. In rural areas, the locality usually controls land development decisions whereas the state generally controls transportation decisions. In Virginia, Botetourt County and the Virginia Department of Transportation (VDOT) initiated a pilot planning process to coordinate transportation and land use planning. In that process, VDOT personnel served as staff for the county, which was the client.

The immediate goal of this effort was a scenarios analysis. Botetourt specified potential zoning scenarios for consideration, and VDOT estimated the likely impacts of each scenario on the immediate transportation network. Botetourt benefited from this relationship by having access to engineering staff who can provide a quantitative analysis of delay at key intersections, and VDOT benefited by helping to ensure that Botetourt had the opportunity to consider the transportation impacts in its zoning decisions. To support this scenarios development, three additional deliverables were developed: a data element protocol, an action plan, and a template for replicating this process with other Virginia counties.

Seven steps comprise this template: (1) define a problem statement quickly, imperfectly, and iteratively; (2) use quick updates to resolve shortcomings; (3) maintain momentum; (4) keep everyone updated equally; (5) recognize that the county is the client; (6) dedicate staff; and (7) end the process with a tangible deliverable. Details of how these steps were accomplished are provided to facilitate the transfer of these lessons to other counties and VDOT.

## **FINAL REPORT**

### **PROVIDING TECHNICAL ASSISTANCE IN AN ENVIRONMENT OF UNCERTAINTY: A CASE STUDY IN COORDINATING TRANSPORTATION AND LAND USE**

**John S. Miller, Ph.D., P.E.**  
**Senior Research Scientist**

**Arkopal K. Goswami**  
**Graduate Research Assistant**

## **INTRODUCTION**

The need for better coordination between transportation and land planning has been noted in the popular press, legislative bodies, and academic literature (U.S. General Accounting Office, 2001; Virginia General Assembly, 2003; Virginia General Assembly Legislative Information System, 2003). Proponents of coordination have cited benefits such as satisfying the demand for housing, accommodating commercial and retail developments through provision of adequate transportation infrastructure, and improving air quality. For example, in a discussion of the U.S. Route 29/I-66 interchange in Prince William County, Virginia, Risse (2003) recommended that accurate land development estimates based on market-driven zoning should be linked to demand the transportation system should accommodate. In short, few people oppose the *general concept* of coordinated transportation and land use planning.

There is also widespread agreement among practitioners that in Virginia, decisions for transportation and land development are not controlled by the same entity. Local governments control land development decisions through the county comprehensive plan that is implemented through zoning ordinances, subdivision ordinances, and site plan reviews (Jernigan, 1999; *Code of Virginia*, § 15.2-2233, 2004). In all counties except Arlington and Henrico, the state (through the Virginia Department of Transportation [VDOT] under the Commonwealth Transportation Board) controls transportation infrastructure investments for interstate, primary, and secondary road systems. This sharp division of responsibility is tempered by individual acts of coordination across the transportation and land use spheres. For example, counties prioritize secondary road projects and often voluntarily include VDOT in the site plan review process by offering VDOT a chance to comment on development proposals before approval.

Despite agreement on the benefits of improved coordination and the separation of powers in Virginia, questions arise regarding how such coordination should be accomplished within Virginia given existing legal constraints. In 2003, the Virginia General Assembly in its Budget Bill 472 directed the Secretary of Transportation to report VDOT's experience in offering technical assistance and coordination of state resources to work with local governments upon their request (Virginia General Assembly, 2003).

To fulfill this directive, technical assistance was offered to Botetourt County as a case study. Botetourt noted that a primary transportation problem facing the county was operations at Exit 150. In close proximity to this exit are two major routes (Routes 11 and 220), heavy truck traffic, and a large number of commercial access points, all of which contribute to congestion in the vicinity of the interchange. VDOT's expected redesign of the interchange as part of a series of improvements to I-81 presented the county with an opportunity to improve operations and to coordinate transportation and land use, since the redesigned interchange would generate new land uses and displace or remove existing ones. The county was interested in knowing how different types of zoning in the affected area would affect the roadway network in the vicinity of Exit 150.

## **PURPOSE AND SCOPE**

The purpose of this study was to investigate the feasibility of VDOT providing technical assistance to local governments through conducting a pilot project with Botetourt County. The project had four objectives:

1. *For the short term*, provide a scenarios analysis that illustrates the transportation demand resulting from various land development possibilities based on a preliminary estimate of the Exit 150 design.
2. *For the long term*, develop a process, or template, for how county and state officials can work together on land use/transportation coordination issues.
3. *Develop an action plan* for Botetourt based on the scenarios analysis to be used when the design for Exit 150 is finalized by VDOT.
4. *Develop a data element protocol* that helps Botetourt and VDOT manage data collection costs by prioritizing data elements and determining which may be omitted when scenario analyses are performed.

The scope of this project was limited to Botetourt County and to information available for the Exit 150 interchange for the period June 2003 through September 2004. In addition, only one potential approach to achieving coordination was considered: having VDOT staff provide technical assistance to Botetourt. In this vein, VDOT served as staff working to provide objective information to the county regarding how different land development scenarios would affect transportation demand and how such demand might be mitigated through improvements to the transportation system.

## **METHODS**

The case study approach was used where staff of the Virginia Transportation Research Council (VTRC) worked with Botetourt staff, VDOT staff, and others over a 16-month period to perform land use scenarios of interest to Botetourt and to document the process used.

Specifically, the project team included 20 persons from various functional units within Botetourt, the area’s regional planning district commission (RVARC), VDOT, and VTRC.

Because VTRC staff were actively involved in conducting the scenarios, VTRC did not play the role of detached, objective auditor. The advantage, however, of VTRC’s proximity to the process was that staff could quickly identify challenges and insights for moving the scenarios forward. This short-term goal—providing Botetourt with zoning options based on various land uses and their effect on the present road network—provided a framework through which the remaining goals could be accomplished.

Four broad tasks supported this project:

1. *Determine the increase in delay that would result at key traffic signals as a function of additional land development.* Over the period of several months, Botetourt, RVARC, and VDOT identified different zoning scenarios of interest to Botetourt. Trip generation rates corresponding to these scenarios were developed, and then Highway Capacity Software (HCS) was used to estimate resultant delay. Interim results such as those provided in Table 1 helped the team to identify the areas that needed further study. In this particular example, Botetourt eventually used this information to focus only on B2 zoning.
2. *Develop a data element protocol for determining the most critical land use and traffic engineering elements for the scenarios analysis.* Roughly three fourths of the effort expended to develop the zoning scenarios was spent collecting data. Accordingly, a sensitivity analysis was performed to determine which land use data (e.g., trip generation rates, zoning, internal capture rates) and which traffic engineering data (e.g., traffic counts, saturation flow rates, truck percentages) had the greatest effect on computed transportation performance. These results were used to identify which data must be collected and which data could be borrowed from other sources.

**Table 1. Select Trip Generation Estimates for Various Botetourt Zoning Designations**

Example Land Use	Zoning Designation	Number of Vehicle Trips Per 24 Hours Per Acre		
		Minimum Rate	Average Rate	Maximum Rate
Single-family Detached Houses	(R-2)	11	24	55
Residential Condo/Townhouse	(R-3)	15	47	94
Golf Course	(PUD)	2	5	11
General Office Building	(B1)	26	110	288
Electronic Superstore	(B2)	591	788	1036
New Cars Sale	(B3)	235	563	1195
Pharmacy/ Drugstore	(M1)	1377	1531	1811
Automobile Parts Sale	(M2)	717	1053	1201
Mini Warehouse	(PIP)	222	583	970

3. *Develop a template for VDOT and other counties to use to replicate this collaborative process.* Botetourt acknowledged that this objective was more important than the specific results of the scenarios analysis. Botetourt, VDOT, and VTRC staff identified the key steps used in the Botetourt pilot and examined how they could be generalized for other land use/technical assistance efforts.

Table 2 summarizes the key steps of the Botetourt pilot.

## RESULTS

The scenarios analysis and the template for VDOT to provide technical assistance to localities are presented here. Appendices A and B illustrate the action plan for Exit 150 and the data element protocol, respectively.

### Scenarios Analysis

The scenarios of interest to Botetourt and the proposed redesign of Exit 150 are shown in Figure 1. The figure also illustrates the parcels of land (shown as **A**, **B**, **C**, **D**, and **E**) and the critical intersections ( $I_1$ ,  $I_2$ ,  $I_3$ ,  $I_4$ , and  $I_5$ ) affected by the parcels.

Because Botetourt indicated that the most critical areas are A and E and they were interested in the effects of B2 zoning for the areas, two analyses were performed for each area:

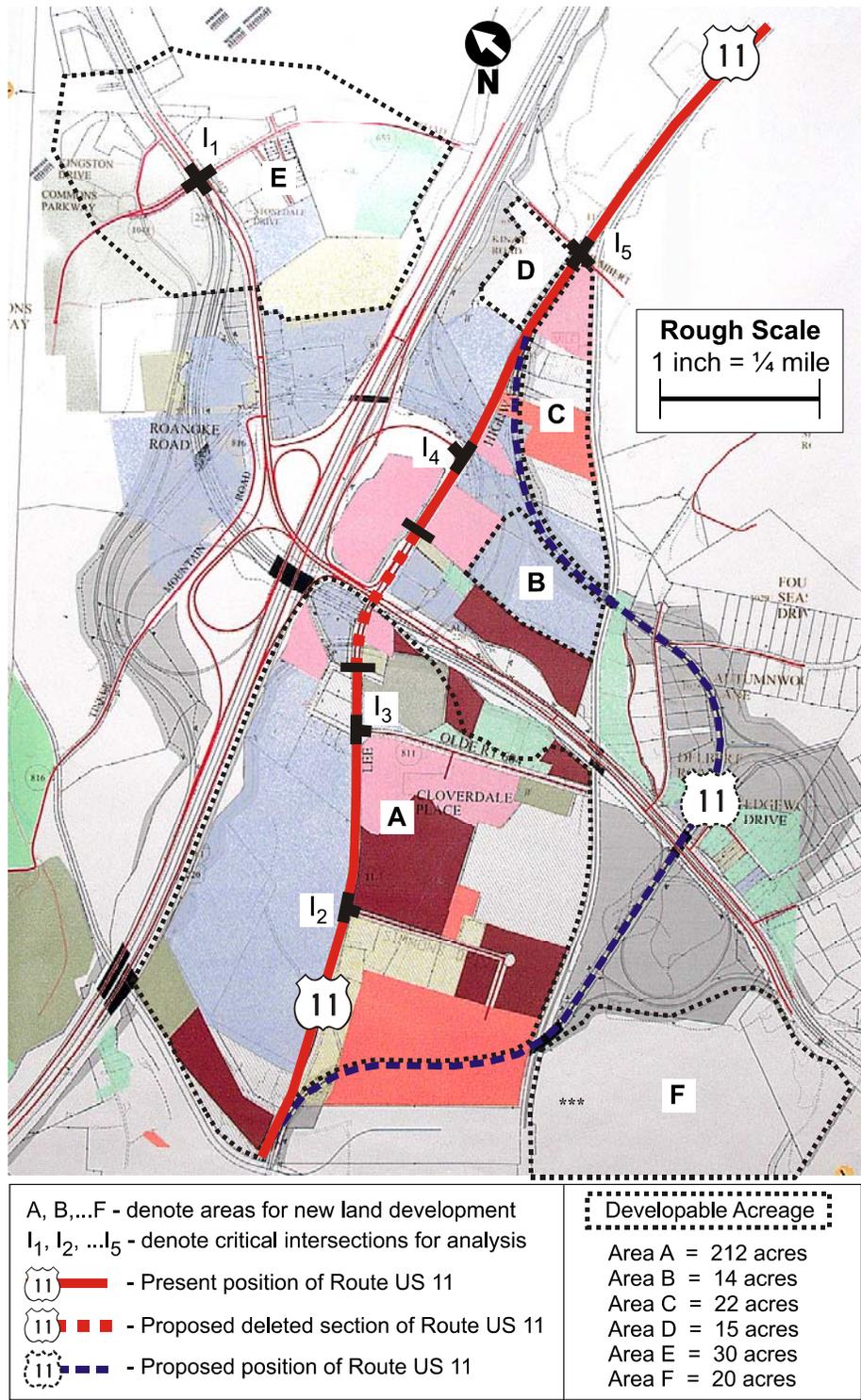
1. *The delay at the critical intersection that would result from developing a single parcel for a use permissible under B2 zoning.* This situation is analogous to a gradual development of the buildable areas once Exit 150 is constructed.
2. *The delay at the same critical intersection that would result from developing the entire area under B2 zoning.* This is analogous to a “full build-out” where all of the available land is used.

Division 10 in Chapter 25 of Botetourt’s *Code* describes a wide range of land uses permissible under B2 zoning (Botetourt County, 1985). Although not all of the uses were examined in this study, a large subset was chosen to represent the range of travel patterns such land uses could generate.

For area E, the critical intersection was U.S. 220/Wesley Road; for area A, U.S. 11 and Route 1047. For both areas, traffic counts helped determine a base intersection delay with no new development. For area E, turning volumes for the base scenario were obtained in a straightforward fashion from a previous traffic study conducted for Botetourt County (Anderson and Associates, n.d.). For area A, turning volumes were estimated using VDOT average daily traffic counts, assumptions regarding the proportion of traffic in the peak hour, the Institute of Traffic Engineers (ITE) expected directional splits (ITE, 1997) for the development found in area A, and conservation of network flows. Figures 2 and 3 show the critical intersections in areas A and E, respectively.

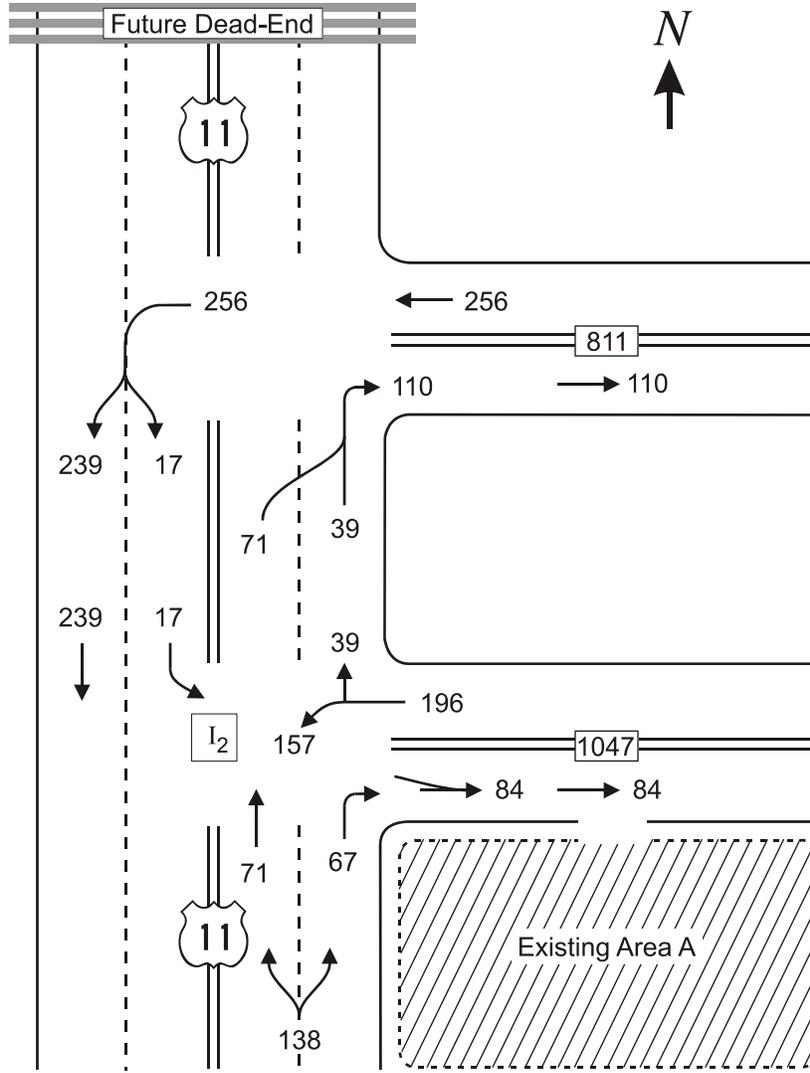
**Table 2. Summary of Key Steps in Refining Focus of Botetourt County Pilot**

<b>Month</b>	<b>Situation</b>	<b>Action</b>	<b>Resolution</b>
1-2	Botetourt and VDOT want to coordinate transport/land planning but do not have same focus. Botetourt's top concern is Exit 150; VDOT staff note uncertainty due to lack of finalized design.	Phone calls and emails lead to in-person Fincastle meeting in July 2003 to discuss scope of work.	Team agrees to short 4-page problem statement that explicitly focuses on Exit 150; sent to group after meeting.
3	Design of alignment for Exit 150 is not known, which hampers analysis of alternatives.	Team makes initial guess at which areas will likely be preserved and which will likely be affected by new interchange.	At another in-person Fincastle meeting in August, VDOT provides proposed alignments from consultant with caveat that they are not finalized.
3	How to quantify impacts of zoning is unclear.	Interim update sent to group with 24-hour trip generation rates for land uses that fall within agricultural, commercial, industrial, and residential zoning developed.	Team responds that only commercial and industrial rates should be studied and that only peak hour rates are needed.
4-5	Demonstration needed to show how to quantify transportation impacts.	In-person meeting held in Fincastle where trip generation rates and resultant delay at one intersection are computed.	Upon further examination of land uses, it is decided that study should focus on only one type of zoning: B2 impacts.
6-7	Quantities of land that would need to be rezoned as result of new alignment are unknown.	Proposed layout manually superimposed on zoning map as shown in Figure 1.	Botetourt's GIS expert and VDOT staff provided estimates of available acreage as result of proposed alignment.
8-9	How to measure traffic impacts, where to get hourly traffic data, and which geographic areas should be studied most intently are unclear.	Area broken into affected regions, and key intersections identified (Figure 1); intersection seconds of delay chosen as performance measure.	Specific areas A and E in Figure 1 targeted by county as highest priority and capacity analysis focused therein. Assumptions made regarding traffic counts (Figure 2).
10-11	Results of scenarios analysis for areas A and E presented to county (Tables 3 and 4).	Team suggested that to some extent, this had been hypothetical exercise if final alignment is not as proposed.	At Botetourt's suggestion, action plan is drafted for replicating process once new redesign formally announced (Appendix A).
11	Trip generation spreadsheet software for zoning presented also to Botetourt and VDOT	Instead of a spreadsheet, staff need a "data element protocol" specifying who should contribute which data.	Accordingly, a draft data element protocol is drafted (Appendix B).
14-15	Draft data element protocol and draft action plan sent for review	Minor changes requested for data element protocol, but major changes suggested for action plan.	Action plan revised, noting that main point of contention is staff time requirement on behalf of VDOT Lead Planner.
16	Question remains as to how much time VDOT Lead Planner can contribute and whether time requirements in action plan are accurate.	Last in-person or telephone meeting is held to resolve action plan. Expected requirements are shown, but plan made less contractual.	



**Figure 1. Exit 150 Study Area**

*All alignments, zoning, and acreage estimates are tentative and subject to change. Shading denotes current zoning. In the future, all areas will be rezoned B2. The “deleted” section of U.S. 11 refers to the fact that U.S. 11 will be split into two dead-end sections terminating on either side of I- 81.*



**Figure 2. Area A, Intersection  $I_2$  (U.S. 11/Route 1047): Baseline Traffic Counts**

For both areas, *existing* traffic counts were added to the *new* traffic counts that would be generated by new development following the procedure in ITE's *Trip Generation* for various land uses (ITE, 1997). Then, HCS, which is the computerized version of the *Highway Capacity Manual 2000* (Transportation Research Board [TRB], 2000), was used to estimate delay at the traffic signal for each land use based on an optimal signal phasing and cycle length. Figure 3 shows the screen captures from HCS used to derive estimates of delay at the critical intersection.

Table 3 shows the delay when a single site is constructed. Because of the nature of the intersection in area E, results vary depending on whether the parcel developed is to the east or to the west of the intersection. For example, Figure 3 shows an electronics superstore located to the west of the U.S. 220/Wesley Road intersection in area E, with the peak hour trips generated by the superstore being added to the existing trips at the intersection.

Table 4 shows how multiple developments affect the delay at these intersections.

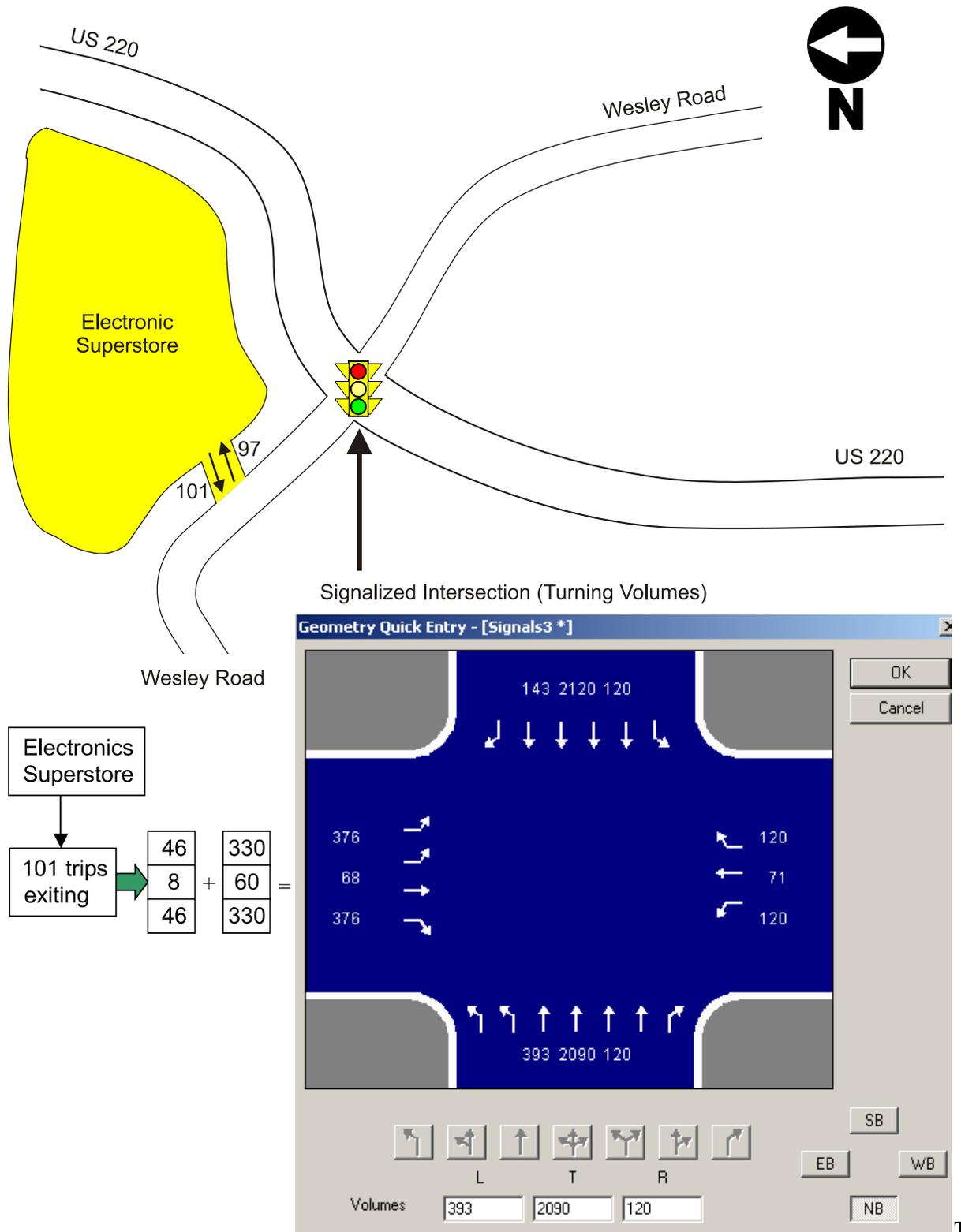


Figure 3. Area E, Intersection  $I_1$  (U.S. 220/Wesley Road): Single Use Development West of  $I_1$

**Table 3. Intersection Delay as Result of Single-Parcel Development**

Land Development	Results for Area E		Results for Area A
	Intersection Delay at $I_1$ If Parcel West of $I_1$ (sec/veh)	Intersection Delay at $I_1$ If Parcel East of $I_1$ (sec/veh)	Intersection Delay at $I_2$
	No Development	29.7	29.7
Motel	30.3	29.8	12.3
Hotel	30.5	29.9	12.3
Electronic Superstore	34.5	33.2	12.5
Apparel Store	34.0	32.4	12.5
Hospital	31.5	30.0	12.5
Nursing Home	30.2	29.7	12.2
Day Care Center	51.5	67.3	15.1
Quality Restaurant	38.4	37.4	12.7
Fast Food Restaurant with Drive-Through Window	113.3	128.2	115

Intersection 1 ( $I_1$ ) refers to the U.S. 220/Wesley Road intersection of area E, and intersection 2 ( $I_2$ ) refers to the Route 1047/Route 11 intersection of Area A.

**Table 4. Intersection Delay as Result of Multi-Use Development**

Land Development	Acreage	Intersection Delay at $I_1$ If Parcels West of $I_1$ (sec/veh)	Intersection Delay at $I_1$ If Parcels East of $I_1$ (sec/veh)	Intersection Delay at $I_2$ (sec/veh)
Office/Quality Restaurant/Electronic Superstore	6	51.8	68.5	14.7
Office/Fast Food/Apparel Store	5	46.8	62.5	14.3
Office/Fast Food/Quality restaurant	5	48.2	64.9	14.5
Office/Furniture Store/Apparel Store	7	43.7	40.3	14.2
Office/Furniture Store/Quality Restaurant	7	45.2	41.9	14.2
Office/Furniture Store/Fast Food	7	47.2	62.8	14.3
Office/Furniture Store/Electronic Superstore	7	51.3	68.2	14.6
Office/Fast Food/Electronic Superstore	6	53.0	69.8	14.8

Intersection 1 ( $I_1$ ) refers to the U.S. 220/Wesley Road intersection of area E, and intersection 2 ( $I_2$ ) refers to the Route 1047/Route 11 intersection of Area A.

For both areas, it is apparent that the number of vehicle trips will increase intersection delay, but there are three other pieces of information provided by these calculations. First, there is some variability in terms of measuring how development will affect travel demand: even within the same B2 zoning category, the development of a parcel with one type of land use may have less impact on delay than would the development of the parcel with another type of land use. Such impacts suggest that Botetourt and VDOT may find it beneficial periodically to reassess how delay at key intersections is being affected as development grows in the desired areas. This variability could extend to other zoning categories where a wide range of diverse land uses is permitted.

Second, it is apparent that there may be location benefits to developing some parcels earlier than others: developing one parcel may not be as detrimental to the network as developing another parcel. Thus, Botetourt may find it worthwhile to encourage development in some locations earlier than in others or to request mitigation measures based on anticipated demand that will result from new development.

Third, not all intersections are created equal. In retrospect, the intersection of area A was less susceptible to delay from various land uses because it was a three-way intersection with a greater capacity to accommodate the additional development. The intersection of area E is more realistic for cases where the intersection will be operating close to capacity.

When the team first produced the delay estimates shown in Tables 3 and 4, they had also included the level of service (LOS) based on the vehicle delay at the intersections. For example, the data in Table 4 suggested that the delay at intersection  $I_2$  was usually LOS B, since LOS B corresponds to delays between 10 and 20 seconds. However, because the audience for this work represented a wide range of backgrounds, the investigators chose to use the direct measure of vehicle delay. In this particular case, use of the LOS did not seem to add value to the analysis, although that does not preclude the use of LOS in other analyses.

The work presented in Tables 3 and 4 is similar to that performed in a traffic impact study, in “the transportation needs and traffic impacts of development on the surrounding road net” are assessed (ITE, 1999). Such studies include an analysis of trips that will be generated by future land uses and are often done as part of a rezoning application. In fact, the only salient difference between a typical impact analysis and that presented in Tables 3 and 4 is that the latter uses zoning instead of a specific land use. Because zoning may encompass a range of possible land uses, it is necessary to analyze impacts based on this range of possible land uses rather than a single definitive land use that is typically provided for a site impact analysis.

### **Technical Assistance Template**

Although the short-term goal for this effort was the preceding scenarios analysis, the long-term goal was to develop a process, or template, that could guide VDOT in future technical assistance endeavors with Botetourt and other counties.

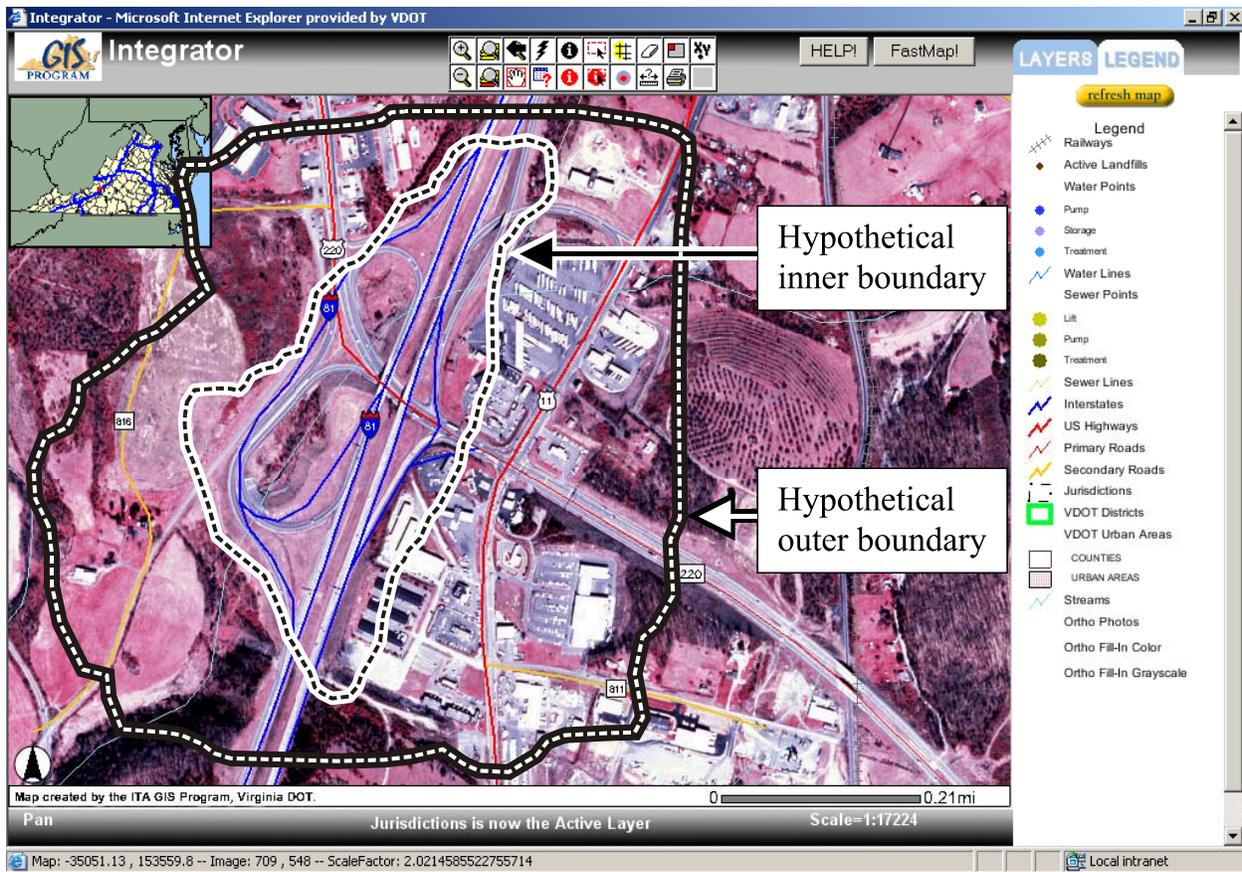
Seven steps helped the project team translate a general desire to coordinate transport/land planning into a specific set of deliverables.

1. Define a problem statement quickly, imperfectly, and iteratively.
2. Use quick updates to resolve shortcomings and identify data needs.
3. Maintain momentum by realizing there is always something that can be done.
4. Keep everyone updated equally.
5. Recognize that the county, not VDOT, is the client.
6. Dedicate staff.
7. Produce something tangible, and have a definitive end to the process.

## 1. Define a Problem Statement Quickly, Imperfectly, and Iteratively

The approach used with the Botetourt was to listen to the county representatives and then develop a draft problem statement based on the conversations, rather than attempting to develop the perfect problem statement from “scratch.” For example, the team knew a relationship between Botetourt County zoning and trip generation rates would need to be developed (e.g., how the trip generation rates would be affected if the zoning was changed from agricultural to high-intensity commercial). Yet it was unclear which trip generation rates to study since Botetourt did not have an estimate of how the road would be designed. Therefore, a sample set of trip generation rates was created, as shown in Table 1. Subsequently, Botetourt narrowed the focus to the B2 designation. Thus the question of which zoning types merited study was resolved through a gradual piecemeal discussion rather than through the county being required to state them definitively at the outset.

A second example was the estimation of land that would be taken by the new interchange. At an initial meeting, no maps of the alignment were available, so a rough sketch of the areas that could be affected by the interchange was done based on the discussion, as shown in Figure 4. This map conveyed what the team was trying to accomplish—quantify the amount of



**Figure 4. Exit 150 and Current Land Uses. Courtesy of VDOT GIS Integrator.**

(Area between boundary lines shows some newly developable land that could be created by the interchange.)

land available for development—even though it was so inaccurate it could be used only for order-of-magnitude purposes. In response, VDOT’s Salem District Location & Design Section obtained permission to share a proposed alignment (Figure 2) with the group. Although Figure 2 was much more accurate, Figure 4 at least provided a starting point for further work.

## **2. Use Quick Updates to Resolve Shortcomings and Identify Data Needs**

Results were provided by email every few weeks to all participants, with most emails being no more than eight pages long. The short updates helped Botetourt and VDOT staff identify errors in VTRC’s calculations and hone the project. They also helped the team ask for the right data rather than all the data. Even if an educated guess was “wrong,” it demonstrated more clearly why better data were needed, thereby helping to make the case for the extra effort.

For example, initially 24-hour trip rates were used, but upon review, the team suggested that P.M. peak hour rates be used. Another example is in the presentation of the capacity analysis results: it was agreed that impacts on the transportation network would be determined by looking at delay per vehicle at critical intersections.

## **3. Maintain Momentum by Realizing There Is Always Something to Be Done**

There is often enthusiasm for a project at the beginning when many possibilities are being explored and at the end when the results are presented to decision makers. In the interim, however, it is easy for other duties to become a priority. One strategy that helped the project keep moving forward was to realize there was always a particular task that could be better performed.

As an example, at one point during the project, delays were expected because proposed detailed zoning information was not yet available. However, it was still possible to generate dummy trip generation scenarios using high, medium, and low values for various land development types represented within the zoning categories following the procedure outlined by ITE (1997). Examples of interim deliverables that took more time than anticipated and that could be undertaken even with imperfect information are:

- superimposing the proposed roadway alignment on existing zoning
- obtaining a list of the affected intersections and streets of greatest interest to Botetourt
- developing techniques to relate broad zoning categories to specific land uses
- determining potential roadway data sources
- performing example trip generation and delay calculations for a sample scenario.

Each could be done while the team was waiting for more feedback. For example, the team could propose how traffic volumes would be obtained for the intersection delay computations or which intersections should be analyzed.

#### **4. Keep Everyone Updated Equally**

Email, telephone calls, and in-person meetings were necessary, as is the case with many collaborative projects. Yet there was a special issue regarding the availability of information for the Exit 150 project: both VDOT and Botetourt potentially had data that the other agency would need but that might not necessarily be publicly available. To ensure that all parties received the full information available, updates were sent to all participants at the same time. That is, even though VDOT staff were doing the calculations, for this particular project, VDOT was not given an opportunity to review material before it was sent to Botetourt (or vice-versa). This material included quantitative calculations, proposed approaches for completion of next steps, syntheses of meeting notes, and iterations of the final report. For the purposes of the project, all participants were considered internal agency members.

In retrospect, it probably would have been preferable to establish another in-person Botetourt meeting about 6 months after the project started. Although having meetings just for the sake of having meetings is not desirable, there is some value to having face-to-face interactions just to keep the process moving forward.

#### **5. Recognize That the County, Not VDOT, Is the Client**

The test of “who is the client” occurred at the initial meeting of Botetourt, VDOT, planning district commission, and VTRC representatives. Botetourt staff clearly expressed that their interest was the redesign of Exit 150—which was the most significant land development issue facing the county. VDOT staff preferred to focus on another part of the county.

VDOT’s concern was that the plans for redesigning Exit 150 were not finalized: the consultant has not completed the design for the interchange and two proposals submitted under the Public-Private Transportation Act for I-81 were under consideration by VDOT. As a result, it was not known with certainty which tracts of land would be available for development and, thus, VDOT’s credibility was at risk should it incorrectly indicate the extent of land taken for the interchange. Botetourt faced a similar risk for potentially not making the right call about how future zoning would change. Time, however, forced the issue: since Botetourt was continually faced with rezoning requests, the county needed some basis on which to make decisions.

The meeting showed that the uncertainty associated with Exit 150 was not going to disappear, and in fact such uncertainty was common with many transport/land use projects. As a result, at that meeting, Botetourt and VDOT agreed to focus on Exit 150, taking steps to mitigate the uncertainty where possible.

#### **6. Dedicate Staff and Organizational Time**

Definitive time commitments were required in terms of breadth and depth. The breadth of staff appears feasible within VDOT’s existing organizational structure, but depth appears more challenging because it is more difficult to find a few people who can devote substantial amounts of time to these efforts. In particular, Botetourt noted that the scenarios process should

be separate from the comprehensive planning process. Given the energy that goes into updating the county comprehensive plan, the scenarios analysis should be conducted at a separate time.

- *Breadth of staff involvement was necessary for review work.* From the county, the pilot required the active involvement of the county executive director, the county’s deputy administrator, two county planners with strong zoning knowledge, the county’s Geographic Information System (GIS) specialist, and two planning commission members. From VDOT, participation on behalf of district location and design staff, the acting district planner, the local residency representative, and the central office was needed. Although all of these staff had other duties, they were able to devote sufficient concentration to the project to provide guidance at critical points, such as determining the scope, reviewing the computational methods, and identifying how to implement key findings.
- *Depth of staff was needed for the actual computations for the land development scenarios.* Two VTRC staff were charged with pulling together the necessary data from the different sources, presenting results, and keeping the group notified of results. They were not required to “have all the answers”—their role was to perform as much work as could be done between meetings so that key problems could be posed in a cogent manner. It was estimated that about 1,500 hours of support staff time were needed for producing the scenarios, with about one fourth of those hours spent doing analytical computations and the bulk of the time spent collecting data, synthesizing information, and disseminating results.

## **7. Producing Something Tangible and Having a Definitive End to the Process**

The VDOT district location and design engineer noted that by not tackling the transportation and land use paradigm for the entire county but instead by working on a specific effort, i.e., trips generated by roadway designs at the Exit 150 interchange, the project became much more feasible. The team started with a relatively simple site plan analysis that has been used for several decades: estimate trips that will be generated by new development and then compute the effect on the transport network (ITE, 2001). Part of this product comprises Tables 3 and 4, where for various land uses the resultant delays at key intersections are shown. Yet by the end of the project, the team had achieved several deliverables, some of which went beyond the scope of a traditional site plan review: identification of feasible zoning scenarios; an action plan, requested by the county, for determining the scenarios in more detail once VDOT’s plans for the interchange were finalized (Appendix A); and a data element protocol for replicating the approach in other counties (Appendix B).

Concluding the project does not mean ending the relationship but simply reflects that with limitations on the time of parties involved, it is appropriate to bring each project to a conclusion and then be ready to start fresh on future efforts. Botetourt County representatives pointed out that making headway on developing a more collaborative and productive process for working with VDOT was significantly more important than the particular details of the land use scenarios at Exit 150. Keeping a few goals in mind kept the process productive.

## DISCUSSION

Close to the end of the project in the 10th month, another meeting was held in Fincastle to discuss the scenarios and template that had been developed. As a result of conversations during that meeting and thereafter, Botetourt and VDOT staff noted two conditions that should be set for any future collaborative efforts between counties and VDOT.

1. *The county and VDOT must recognize each other's statutory authority.* The county controls the land development and is responsible for maintaining a tax base that supports essential local services. VDOT controls and operates the roadway, including access to that network. Although these facts are known, explicitly stating them may make discussions over contentious issues more productive.
2. *The county must recognize that a partnership with VDOT must be formed, with both parties making the commitment to resolve jointly the key issues under discussion.* This partnership may result in either or both parties changing existing procedures. (Botetourt suggested an example in which a county and VDOT found that the time required to perform a scenarios analysis averaged 90 days. If the county's rezoning ordinances state that the county will give a response within 60 days, it may be necessary to rewrite the ordinance to provide sufficient time to obtain an accurate analysis.)

The single most controversial aspect of this project arose not in the course of the scenarios analysis but rather with regard to a time commitment, i.e., that a definitive commitment of VDOT staff time would be made for future Exit 150 work. Based on the Botetourt experience, approximately 1,500 hours total were required from two staff to provide the major deliverables—the scenarios analysis, the action plan, and the data element protocol—for the first pilot. However, in the process of drafting and revising the action plan, concerns arose regarding how VDOT could provide such a commitment in the future should multiple localities request assistance and should the assistance require a comparable effort. House Bill 2259 and Senate Bill 869 authorized the Commonwealth Transportation Board to “offer technical assistance and coordinate state resources to work with local governments, upon their request, in developing sound transportation components for their local comprehensive plans” (Virginia General Assembly Legislative Information Systems, 2003). Thus, a situation comprising multiple requests from counties for assistance is a real possibility.

For that reason, VDOT faces a difficult decision regarding how much staff time will be allocated to providing technical assistance to localities. To some extent, these time requirements may be reduced through careful consideration by the county and VDOT regarding the type of assistance needed, and in that vein, details such as those provided in Appendix A may be useful. Further, a staff member suggested that the particular Botetourt tasks could have been achieved in 468 hours rather than 1,500, as shown in Table 5. The results of this scenarios analysis, however, suggest that even with excellent communication between the county and VDOT, providing this technical assistance *might* require a substantial time commitment from at least one VDOT employee who is representing VDOT for a particular project. Future technical assistance

efforts may have a different scope; thus, the hours shown in Table 5 may not be necessary for such efforts: they are simply noted as a distinct possibility.

**Table 5. Estimates of Number of Hours Required to Provide his Technical Assistance**

<b>Task</b>	<b>VTRC Estimate</b>	<b>VDOT Estimate</b>
Collect data: obtain traffic counts, estimate quantities of developable land, pinpoint types of development for each zoning category	600	148
Perform computations with trip generation and HCS	300	120
Document and share results of the scenarios analysis	300	80
Perform follow-up work with the action plan, data element protocol, and draft spreadsheet for internal capture rates	300	120
<b>Total</b>	<b>1,500</b>	<b>468</b>

### LIMITATIONS

There were two chief initiations to this study. The first limitation pertains to the narrow definition of *technical assistance* provided in this study. The meaning of “coordinated transportation and land use” has been widely discussed but less frequently agreed upon. Quantification of intersection delay as development increases under various zoning scenarios was the goal of this project. Yet the range of possible goals is wide. Other goals include, but are not limited to, (1) creating an environment that provides better pedestrian mobility, (2) maximizing local revenue streams from development gained or lost, (3) minimizing the environmental footprint of new development, (4) preservation of vehicle mobility as development increases, and (5) considering ways to improve air quality as noted in the comprehensive plan (Botetourt County, 2004). This project’s focus on zoning scenarios does not preclude technical assistance in these other areas.

The second limitation is that an “ideal” approach to transportation and land use planning was not investigated as part of this study. The study did not consider, for example, whether additional expertise or resources in land development should ideally be situated within the VDOT district, the planning district commission, or the county. Similarly the study did not evaluate whether the process for designing the Exit 150 interchange or the realignments of Routes 11 and 220 was ideal. Instead, the study took the existing design and allocation of personnel among state and local agencies as a given and sought to develop a prototype collaborative process within those constraints.

### CONCLUSIONS

- *This type of collaborative effort is feasible provided adequate staff resources are dedicated.* Time commitments came from three major sources: county staff who provided input, data, and maps; VDOT planning and engineering staff who also provided input, data, and corrections; and VTRC staff who performed analysis.

- *VDOT staff have the skills necessary to provide this type of technical assistance.* VDOT staff provided corrections and demonstrated an understanding of the trip generation steps required; further, the steps in the developed template are comparable to those undertaken in a conventional traffic impact analysis. The difference was the large number of assumptions that needed to be made given uncertainty with the data. Those assumptions entailed not knowing the specific types of development that would be constructed under a general zoning category (as shown by the range of land uses under B2 zoning in Table 3) and interpolating with existing data (as was done with turning volumes in Figure 2).
- *The biggest challenge is maintaining momentum, especially when staff have other duties.* The template shows how some challenges can be overcome: for example, to prevent uncertainty from stopping a project, VDOT staff can present a sample solution giving participants something tangible to discuss, as illustrated in the step 1 of the template. However, there is no substitute for having one or more VDOT staff involved in a project where they are responsible for providing a clearly defined technical assistance product.
- *This project did not resolve how VDOT would deliver assistance on this scale if requests came from multiple counties.* This project required about 1,500 hours from VTRC staff—a role that in future efforts would be played by VDOT staff.

## RECOMMENDATIONS

1. *The VDOT technical planning staff providing assistance should update the template as new technical assistance efforts are undertaken.* There are limitations to this template, such as its focus on one type of assistance when counties may desire other types of collaboration. One way to do this might be to present the template for discussion in counties where collaborative efforts between VDOT and the county are underway. For example, in rural areas, this template might be discussed as part of VDOT’s Rural Transportation Planning Assistance Program.
2. *The VDOT technical planning staff providing assistance should update the data element protocol in Appendix B based on experiences with other counties.* Collecting data comprised a substantial portion of the time for this effort; thus, experiences with other counties that reduce this time requirement should be noted.
3. *Because of VDOT concerns about being able to provide sufficient staff time, the VDOT technical planning staff providing assistance should perform the following tracking on future technical assistance efforts when the county and VDOT are undertaking a collaborative effort for the first time.*
  - *Allocate a specific amount of staff time from a specific person to provide assistance for a particular county.* For example, even a commitment such as “district planner X can devote 200 hours to this project in 2005” gives the county and VDOT an understanding as to resources available.

- *Aim for a concrete deliverable.* Every situation is different, and there will be occasions where it is appropriate to take a substantial risk and create something new: such occasions should not be eliminated by this recommendation. Because, however, a failed project can potentially be damaging, risk can be managed by first delivering something simple and then by addressing more ambitious goals.
  - *Document what it took to realize the project.* The last step of the plan in Appendix A suggests questions that should be answered for a particular effort, and knowing similar information for future pilots would also be of interest.
4. *VDOT's leadership should consider using this report as a justification for increased VDOT planning staff who are focused on providing technical assistance to localities.* Providing assistance for a single interchange could require a substantial portion of an employee's time and is logically a cause for concern given existing VDOT staffing levels. Yet, the Botetourt experience suggests types of questions that counties may legitimately ask of VDOT if given the opportunity under House Bill 2259 and Senate Bill 869. These questions may go beyond requests for information that can be answered easily. Multidisciplinary skills for such staff include traffic engineering, transportation planning, and geometric design (or the ability to use such skills when working with specialists in those areas). Given that Table 3 and the data element protocol suggest that how counties develop land will affect the demand placed on the transportation system, it may well be in VDOT's best interest to allocate staff to help counties as land development moves forward.

## **ACKNOWLEDGMENTS**

The Botetourt pilot project was a joint effort among staff in Botetourt County, the Roanoke Valley-Alleghany Regional Commission, and the Virginia Department of Transportation. This pilot could not have been undertaken without their support. These staff include Jerry Burgess, Rob Cary, Jeff Echols, Michael Gray, Herman Hollins, Mark Jordan, Jeff Kessler, James Laughlin, Ken Lantz, Ned McElwaine, Mark McCaskill, Randall Phillips, Walter Pribble, Jeff Southard, Chuck Supan, Spencer Suter, Eddie Wells, Wendy Wingo, and Don Witt. Insights and comments were also received from Randy Combs, Wayne Ferguson, Marsha Fiol, Ryan Hartman, Chad Tucker, and Don Wells.

## **REFERENCES**

- Anderson and Associates for the County of Botetourt. *I-81 Traffic Development and Analysis: Milepost 135.9-152.4*. Blacksburg, n.d.
- Botetourt County. *Code of the County of Botetourt, Virginia*. Fincastle, Va., 1985. Accessed [http://co.botetourt.va.us/government/municipal\\_code.php](http://co.botetourt.va.us/government/municipal_code.php), December 6, 2004.
- Botetourt County. *Envision Botetourt: Botetourt County Comprehensive Plan (Draft 3)*. Fincastle, Va., April 6, 2004.

Institute of Transportation Engineers. *Transportation Planning Handbook*. Washington, D.C., 1999.

Institute of Transportation Engineers. *Trip Generation*, 6th ed. Washington, D.C., 1997.

Institute of Transportation Engineers. *Trip Generation Handbook: An ITE Recommended Practice*. Washington, D.C., 2001.

Jernigan, J. *Briefing Paper: Local Land Use Management and State Transportation Policy: State of the Art and Practice*. Virginia Transportation Research Council, Charlottesville, 1999.

Risse, E.M. *Anatomy of a Bottleneck: The U.S. Route 29/Interstate 66 Interchange at Gainesville, Virginia; Bacon's Rebellion, June 16, 2003*. Accessed [http://www.baconsrebellion.com/Wonks\\_Risse\\_bottleneck.html](http://www.baconsrebellion.com/Wonks_Risse_bottleneck.html), September 13, 2004.

Transportation Research Board. *Highway Capacity Manual*. Washington, D.C., 2000.

U.S. General Accounting Office. *Environmental Protection: Federal Incentives Could Help Promote Land Use That Protects Air and Water Quality*. U.S. General Accounting Office, Washington, D.C., 2001. Accessed <http://www.gao.gov/new.items/d0212.pdf>.

Virginia General Assembly. *2003 Virginia Acts of Assembly*, Chapter 1042, Item 472G. Richmond, 2003, p. 476.

Virginia General Assembly Legislative Information Systems. *2003 Session*. Richmond, 2003. Accessed <http://leg1.state.va.us/031/lis.htm>.



## **APPENDIX A**

### **REVISED ACTION PLAN FOR COORDINATING TRANSPORTATION AND LAND DEVELOPMENT AT THE EXIT 150 INTERCHANGE**

#### **Introduction**

Botetourt County, the Roanoke-Valley Alleghany Regional Commission (RVARC), and the Virginia Department of Transportation (VDOT) recognize that the pending redesign of the I-81 interchange at Exit 150 provides an excellent opportunity to coordinate transportation and land development at the vicinity of the interchange. Botetourt, RVARC, and VDOT resolve to achieve this coordination through the timely sharing of information, the use of qualified staff from each agency for which this coordination is a priority, and explicit consideration of the interaction between transportation and land use.

Given that a design for the Exit 150 interchange has not been selected, and is likely several years away, dedicated staff to do the work outlined in this action plan have not been identified. When the action plan is implemented and the project is scoped, each agency will need to determine what staff they can dedicate to the project. Potential sources of staff from VDOT include the Salem District Planning Section, the Salem District Location & Design Section, and the Central Office Transportation & Mobility Planning Division (TMPD).

The remainder of this plan presumes that when the alignment of Exit 150 is announced, VDOT, Botetourt County, and RVARC will work together and use this document as a starting point for determining how best to analyze and address the transportation and land use impacts of the new alignment. The success of this technical project will be contingent upon the full participation of all three organizations.

#### **Recent Planning Efforts in the Vicinity of Exit 150**

For the past 5 years, Botetourt and VDOT have recognized that the current integration of transportation and land use at Exit 150 presents a challenge. Route 220 and Route 11 have a large number of commercial access points in the immediate vicinity of the interchange, which causes excessive queuing at area traffic signals and stop-and-go traffic movement. Heavy trucks do not have good access from the interchange to the truck stop, which may have adverse economic consequences for the movement of freight; further, these truck movements adversely affect vehicle mobility in the area. Pedestrian access is also hampered; indeed, the adjacent Appalachian Trail crossing no longer provides hikers with the intended “wilderness experience” but rather places them on a busy arterial facility.

In the summer of 2003, Botetourt, RVARC, VDOT, and VTRC used an anticipated redesign of Exit 150 to brainstorm how transportation and land use could be better coordinated. Staff from the three agencies computed the number of vehicle trips that different types of developments under the B2 zoning category would generate and then examined how these additional trips would increase delays at adjacent intersections. By the end of that 1-year period,

the group had developed a rough set of deliverables that showed how different amounts and types of development could affect delay. Yet that pilot exercise was hypothetical, for three reasons:

1. *The proposed alignment of the new interchange is a guess.* Environmental factors, cost, the role of firms under the Public-Private Transportation Act (PPTA), or decisions by the CTB could alter the chosen alignment from what was supposed.
2. *The methods and data used were approximate.* The computational methods chosen—ITE trip generation rates and the *Highway Capacity Manual*—yield only order-of-magnitude estimates of delay. Additional data are needed to calibrate the models, such as how many access points will be placed along realigned Route 11 and which parcels will be developed.
3. *The land use and transportation problem addressed in the pilot study are not now the most critical issue facing Botetourt.* At the time of the study, determining the right zoning was critical; now, the issue is more related to access management.

The exercise was beneficial, however, for two main reasons. First, it showed how staff from different agencies could work together to produce, with finite resources, a desired outcome. It illustrated the breadth of staff from three agencies needed for the project, and the results of that pilot study suggested that this collaboration could be done at least for this single pilot without overloading the three agencies, depending on other duties. Second, a data element protocol was devised that provided information about the type, format, and sources of the data obtained. This protocol does not suggest that counties or VDOT must provide a complete dataset in order to perform some what-if scenarios; instead, it presents data requirements as a continuum. With a small amount of data and good assumptions, some order-of-magnitude estimates can be made, and with more complete data, more precise answers can be obtained.

The preliminary project-scoping meeting for the design of the interchange should include representatives from Botetourt County, VDOT, and RVARC. This meeting will be an opportunity to update the seven steps listed in the section that follows. Because it is continually receiving inquiries from businesses regarding the feasibility of new development, Botetourt needs to respond to rezoning requests in a relatively short time frame; thus, information from such scoping meetings could be of significant value.

A memorandum of understanding (MOU) among the three agencies may be appropriate at the same time as the kickoff meeting. The reason for the memo is the discovery of three facts that were critical to the success of the previous pilot: (1) cooperation between local, regional, and state government is essential; (2) staff time must be dedicated on behalf of these local, regional, and state agencies; and (3) a tangible contribution of hours from support staff is needed, which for the previous coordination effort was 1,500 hours. However, such a memo for a *future* coordination effort may be developed as details become clearer about (1) the interchange design, (2) the time requirements for the future coordination effort (which may be different than that required for the previous pilot), and (3) the availability of support staff from the three agencies. Thus, this action plan suggests that the MOU be developed in tandem with the step 1 to ensure

that all three agencies can take advantage of this opportunity to coordinate transportation and land use.

### **Seven Steps for Coordinating Transportation and Land Use Once the Exit 150 Interchange Design Is Formally Announced**

Botetourt, RVARC, and VDOT resolve to follow these seven steps once the new location and design of Exit 150 are announced.

1. *As soon as the new approved roadway alignment is announced:*
  - VDOT will provide the roadway alignment in an electronic format (AutoCAD, Microstation, or other) to Botetourt and RVARC for inclusion in their GIS platforms. It is expected that Salem District location and design staff would provide the new alignment to Botetourt's mapping unit.
  - Botetourt will provide to VDOT and RVARC the proposed alignment overlaid on existing zoning. This will give all three agencies a perspective on the Exit 150 corridor as it stands.
  - Botetourt, RVARC, and VDOT's Salem District will each designate a lead person from their agency who is accountable for their agency's decisions regarding the implementation of the project. These persons will coordinate their agency's involvement, including how data and technical assistance will be provided.
  
2. *At an in-person meeting to be chaired by the Botetourt County Administrator in Fincastle, representatives from Botetourt, RVARC, and VDOT will determine four things: (1) what is known about the interchange design, (2) the goal of coordinating transportation and land use at the interchange, (3) the type and level of technical assistance that each agency should provide, and (4) who needs to be kept involved in the technical assistance effort.*
  - *What is known about the interchange design.* The representative from VDOT's Salem District Location & Design Section will summarize what is not known about the interchange and the expected source of that information. Although Chapter 1D of VDOT's *Road Design Manual* summarizes the project development process, there will likely be characteristics unique to the Exit 150 redesign of interest to Botetourt. For example, relocation information for utilities will probably not be known until 12 to 18 months after the roadway alignment has been chosen. Although such design work is VDOT's responsibility, there may be opportunities for the agencies to provide input that can better integrate how land is developed. (See Chapter 1d of that manual at <http://www.extranet.vdot.state.va.us/locdes/Electronic%20Pubs/Rdm/ROADMAN/CHAP-1D/CONT-1D.PDF>.)

- *The goal of coordinating transportation and land use at the interchange.* Although goals are important, they should not dominate the meeting. Goals may be straightforward (e.g., to minimize takings of existing parcels), multifaceted (e.g., to preserve mobility through pedestrian improvements and better engineering), or general (e.g., improve air quality).
- *The type and level of technical assistance that each agency should provide.* The emphasis of the meeting will be on the specific elements on which Botetourt, RVARC, and VDOT need to collaborate to realize the goal. For example, if the goal had been to protect the corridor such that new development could be supported, Botetourt would have needed to provide zoning information and VDOT would have needed to provide detailed roadway information, including policies on the granting of access points. A detailed staffing plan may be appropriate at this point representing the contributions of the three agencies.
- *Who needs to be kept involved in the technical assistance effort.* At a minimum, the following work units will be represented at the initial meeting:
  - Botetourt County Administration (to articulate Botetourt’s goals at the site)
  - Botetourt County Planning and Zoning (to provide zoning and land use data)
  - Botetourt County Engineering (to provide water, sewer, and utility locations)
  - RVARC (to keep the Roanoke Valley Area Metropolitan Planning Organization apprised and to ensure compatibility with regional planning efforts in air quality conformity, freight movement, rural ITS, and bicycle/pedestrian planning efforts)
  - VDOT’s Salem District Location & Design (for information on the design and construction process)
  - VDOT’s Salem Residency (for any additional traffic data needed at the site and the access permits the residency expects to grant)
  - PPTA representative (assuming I-81 goes forward as a PPTA project)
  - VDOT’s Salem District planner (to provide coordination and technical assistance)
  - VDOT’s TMPD (to provide technical assistance at the discretion of the VDOT lead planner).

Other work units may need to be involved. Depending on the details included in the initial announcement of the redesigned interchange, VDOT’s Location and Design Division or Salem District Right of Way & Utilities may need to be included. Similarly, VDOT’s Local Assistance Division may have a role.

3. *Following that meeting, the VDOT lead planner, working with the lead persons designated by Botetourt and RVARC, will craft a problem statement that specifies the overall goal of the team and how the team intends to approach this project. This statement should include a technical methodology, a project schedule, and expected deliverables. This statement will be developed as a working document and will be updated as needed throughout the life of the study.*

A draft goal that has been reviewed and agreed upon by the agencies involved is as follows:

To coordinate land use and transportation planning so as to expeditiously provide appropriate zoning, access, and required infrastructure to developable land areas adjoining the revised Exit 150 interchange. This will allow new or relocated businesses to locate in the developable land areas as soon as possible so as to offset Botetourt County's loss of employment and tax base resulting from businesses taken for the interchange reconfiguration; and, so as to ensure that VDOT's ultimate Exit 150 alignment is not compromised by unplanned access management decisions.

4. *To make the project productive, Botetourt, RVARC, and VDOT will contribute the following over the life of the project:*

- VDOT will ensure that sufficient staff time, whether from the Salem District or TMPD, is contributed to the project. The VDOT lead planner will offer a single voice for VDOT, actively coordinating information from other sections. Because of potential private sector involvement in the design, it may be the case that the VDOT lead planner will work to represent the interests of VDOT and Botetourt on a number of technical issues.
- Botetourt will contribute staff from its zoning, engineering, administration, and mapping units to provide critical comments and data and keep the board of supervisors and/or the planning commission advised of progress. The Botetourt County administrator will offer a single voice for the county.
- RVARC will identify a staff person who will coordinate its involvement as described in the problem statement. (It is understood that RVARC's ability to perform this function will depend on getting the project into its work program in advance.) The RVARC planner will offer a single voice from the planning district commission and the affiliated Roanoke Valley Area MPO.

5. *To ensure that adequate progress is made during the life of the project, the following will occur after the initial meeting unless the study team deems them unnecessary.*

- Botetourt, RVARC, and VDOT will meet at least four times in person at Fincastle to review project progress.
- Each party—Botetourt, RVARC, and VDOT—will provide progress updates at significant points during the project. The updates will be relatively frequent to facilitate quick feedback.
- The VDOT lead planner will indicate, based on comments from the PPTA representative (if applicable), Location & Design, Right of Way & Utilities, other district sections, and the Salem Residency, how uncertainty in design affects the particular project. For example, the granting of access permits is ultimately a residency function, but the number of access points may not be known early in the

project. Similarly the Botetourt representative will need to convey any uncertainties that result from rezoning.

6. *The technical assistance work will be done in an open, transparent manner that can be reviewed by all stakeholders who may also have an interest in the project (positive or negative).*
  - To minimize unnecessary data collection but to obtain good data where necessary, an approach comparable to the data element protocol will be used. In other words, when data are sought, the tradeoff between data collection cost and the quality will be given. (In some cases, it may be that only easily collected data should be used; in other cases, it may be worthwhile to spend substantial time gathering data.)
  - Any spreadsheets, simulation files, or other software data files used for the project will be shared among the agencies involved so that any one agency may continue the project after the conclusion of the project. Although VDOT is not responsible for purchasing proprietary software for Botetourt or RVARC, if the purchase of such software would greatly facilitate further implementation, VDOT will consider how such software could be acquired.
7. *At the end of the project, Botetourt, RVARC, and VDOT will summarize the results and lessons learned from this coordination effort.* Although Botetourt, RVARC, and VDOT recognize each other's statutory authority, the following will be documented by the VDOT lead planner for VDOT to consider when replicating this process elsewhere:
  - what product actually was
  - the information from the effort that Botetourt was able to use or not use
  - the information from the effort that VDOT was able to use or not use
  - the extent to which design uncertainties prevented progress on the project
  - the specific time commitments needed from all agencies involved to complete the project.

Table A1 illustrates the answers that would have been given based on the previous Botetourt pilot effort. (The answers for the future Botetourt effort may be different.)

**Table A1. Example Answers Based on Previous Botetourt Pilot Effort**

<b>Question from Action Plan</b>	<b>Answer</b>
What was the product?	A scenarios analysis showing how delay would be increased at two intersections as a result of B2 zoning and a data element protocol
What information could Botetourt use?	The data element protocol but not the delay estimates
What information could VDOT use?	The methodology for determining the delay estimates but not the numbers themselves
To what extent did design uncertainties prevent progress on the project?	The design uncertainty that prevented progress was the configuration of the Exit 150 interchange
What time commitments were needed from all agencies involved to complete the project?	1,500 hours from VTRC and substantial participation time from Botetourt, VDOT, and RVARC



## APPENDIX B

### DATA ELEMENT PROTOCOL FOR ZONING SCENARIOS ANALYSIS

The *scenarios analysis* reported in the results section of this report determined how different land development alternatives would affect resultant transportation demand. For example, if an electronics superstore instead of a hotel was built on a parcel, what would be the impact on delay at key intersections serving the parcel?

Based on the Botetourt experience, roughly three quarters of the effort expended to develop these scenarios was spent collecting data. The computations themselves, which were the application of trip generation rates and the estimation of delay at key intersections, comprised a comparatively small task. For VDOT or county staff to replicate these types of land development scenarios for other counties, it would be helpful if the amount of time spent collecting data could be reduced.

Accordingly, Botetourt suggested that VDOT develop a list of data elements that a county should provide to VDOT if zoning scenarios are desired. That list should specify the types of data, the format of the various data elements, and the level of detail required. Because obtaining particular types of data may be quite time-consuming, that list should also explain how additional data would improve the quality of the analysis. For example, if truck volumes are obtained in addition to total traffic counts, it can be explained how the precision of delay estimates at affected intersections could be improved. This comprehensive list of data elements and their applicability to zoning scenarios is called the *data element protocol*.

Tables B1 through B3 summarize the data elements ideally available for a preliminary scenarios analysis. Table B1 denotes the zoning data provided by a county, Table B2 describes transportation data jointly provided by the county and VDOT, and Table B3 describes the data VDOT should provide. For each data element, an example, the level of effort required to obtain the element, and the expected data source are given. These tables should not be viewed as a minimum requirement because thoughtful consideration of assumptions can often substitute for missing data. Instead, they can be given to county or VDOT staff as an indicator of what data are needed to perform a scenarios analysis.

Three levels of data collection effort are shown: low, medium, and high.

1. *Low-effort level data are those that any county or VDOT can obtain with a minimal time investment, such as the current zoning of a parcel or the 24 hour traffic count. With only these data available, an order-of-magnitude comparison can be done for different zoning scenarios, as was done for Botetourt. For example, there could be a variety of developments, from a 5,000 square foot apparel store to a 44,000 square foot fast food restaurant, thus causing a mean delay at the nearby intersection, which would range from 30 seconds per vehicle to 128 seconds per vehicle.*
2. *Medium-effort level data require more time to obtain but can give more precise predictions. For example, for a given parcel, the mean delay at the nearby*

**Table B1. Data Element Protocol for County Supplied Zoning and Land Use Data**

<b>Data Element</b>	<b>Example</b>	<b>Effort level</b>	<b>Data Source</b>
Zoning according to county ordinance	Business District B2, which allows community shopping and service businesses	Low	Data come directly from zoning ordinance
Maximum floor area ratio (FAR) <sup>a</sup>	0.40	Low	Data come directly from zoning ordinance
Maximum allowable density <sup>b</sup>	17,500 ft <sup>2</sup> /acre	Low	Data either come directly from the zoning ordinance or are calculated from FAR
Net acreage land encompassed by parcel	30 acres	Medium	Data may be visually estimated or precisely determined from tax maps or GIS
Developable acreage as opposed to net acreage	12 acres	Medium	Data may be estimated from FAR, but detailed study of site may give more accurate number
Specific land uses to be built on parcel, such that they are compatible with ITE Land Use Codes	Office building, furniture store, and electronic superstore	High	Requires that the county either (1) be considering a specific proposal or (2) has looked at other similarly zoned parcels to determine the most likely specific land uses
Size of development to be constructed on parcel <sup>c</sup>	30,000 ft <sup>2</sup> of office space, 30,000 ft <sup>2</sup> for furniture store, and 20,000 ft <sup>2</sup> for electronic superstore	High	Same as above
Local trip generation rates for the land uses	Although national data suggest average rate of 9.6 trips per dwelling unit, county x data suggest rate of 8.3	Very high	Trip generation studies conducted by county, VDOT, or private consultant for land uses similar to the one studied and in close proximity

**Data Formatting Notes**

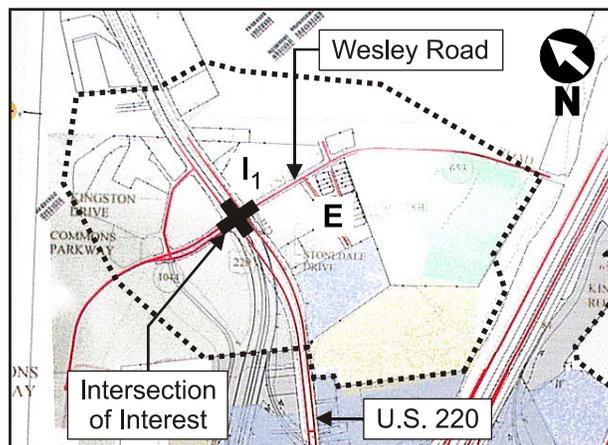
<sup>a</sup>The FAR is the ratio of square footage of development to square footage of open land. For example, an FAR of 0.40 means that 1 acre of land (43,560 ft<sup>2</sup>) may have no more than 17,424 ft<sup>2</sup> of development, since 0.40 x 43,560 = 17,424. If there is other guidance in the ordinance that affects the permitted density of development, this should be included.

<sup>b</sup>Indicate any other restrictions that affect what can be constructed at that location (besides those given in the zoning ordinance). For example, if there are significant setback requirements that are likely to keep density even lower than what is specified in the FAR, these should be noted.

<sup>c</sup>Include any commercially driven criteria that are known for a given parcel, because they will help pinpoint trip generation rates. For example, although the square footage of a retail outlet is helpful, the known number of employees of the outlet can provide a better estimate of the trips generated.

**Table B2. Data Element Protocol for Transportation Data Jointly Supplied by County and VDOT**

Data Element	Example	Effort Level	Data Source
List of affected street names and route numbers	Wesley Road (Rt. 653): see Figure B1 U.S. 220 from I-81 to points north of Daleville Tinker Mountain Drive (Rt. 1070) Cedar Ridge Drive (Rt. 1071)	Low	County planners and VDOT staff can determine in brainstorming session
List of affected intersections	U.S. 220 and Wesley Road (Rt. 653) U.S. 220 and Tinker Mountain Drive (Rt. 1070)	Low	Same
List of affected walkways and bikeways	Appalachian Trail crossing in what is now urban area	Low	Same
Very rough sketch of area	See Figure B1: by naming key streets, intersections, and walkways, it becomes easier to ensure problem is well understood (sketch need not be perfect!)	Low	Combination of maps and electronic data sources
Traveler characteristics (basic)	Walking: Visual observation suggests that most persons in the area are currently drivers, although there is some pedestrian activity Biking: None observed Transit: No fixed-route public transportation currently serves area	Low	Observations
Traveler characteristics (advanced)	Walking: Pedestrian counts of 20/hr on U.S. 220 Biking: 5 crossings/hr at intersection of U.S. 220 and Wesley Road Transit: No fixed route public transportation, but potential for future service exists as result of <i>x</i> industries	High	Other studies performed by locality or VDOT



**Figure B1. Example Sketch of Area of Interest**

**Table B3. Data Element Protocol for Roadway Data Supplied by VDOT**

<b>Data Element</b>	<b>Example</b>	<b>Effort Level<sup>a</sup></b>	<b>Data Source</b>
Number of through lanes <sup>b</sup>	4 total (2 in each direction)	Low	Observation
Posted speed limit and operating speeds	Speed limit of 45 mph, operating speed of 50 mph	Low	Observation
Roadway functional classification	U.S. 220 is urban other principal arterial	Low	VDOT Mobility Management's Online Road Database ( <a href="http://tedweb/tms/jsp/">http://tedweb/tms/jsp/</a> )
24-hour volumes (Average Daily Traffic, or ADT)	U.S. 220 has 21,897 veh/day between I-81 and Route 779 North of Daleville (both directions)	Low	Same, plus Mapquest and GIS Integrator ( <a href="http://coweb/ita/gisintegrator.htm">http://coweb/ita/gisintegrator.htm</a> )
Peak hour directional volumes <sup>c</sup>	U.S. 220 AM Peak = 605 veh/hr NB and 1,237 veh/hr SB; PM peak = 1,264 veh/hr NB and 995 veh/hr SB	Medium	Same
Truck volumes	U.S. 220 AM Peak NB: 7.4% U.S. 220 AM Peak SB: 3.2% U.S. 220 AM Peak NB: 2.3% U.S. 220 AM Peak SB: 4.8%	Medium	Same, with additional calculations required
Turning lanes and length of turning bay	U.S. 220/Wesley Road intersection has dedicated left and right turns at all 4 approaches; bays are 150 feet long	Medium	Traffic study or observations
Peak hour turning movements and cycle lengths of new signals	For Wesley Road (Rt. 653) and U.S. 220, turning movements are not directly available; only 653 veh/day used Wesley Road between U.S. 220 and Rt. 1071 (Cedar Ridge Road)	High	Special studies, data from traffic signal counters, or manual calculation with different counts

**Data Formatting Notes**

<sup>a</sup>Some of the “medium” and “high” effort level categories may actually require less effort in some locations. For example, Synchro/SimTraffic files for the signals in the Northern Virginia District can provide detailed timing data, rendering the last row of Table B3 as a “low” effort category for those locations. Similarly the GIS Integrator may make other types of data easier to obtain.

<sup>b</sup>Include route numbers with street names. Not all databases are of equal quality, and some databases (such as those maintained by VDOT) have all route numbers but not all route names.

<sup>c</sup>When in doubt, give units, e.g., for traffic counts, axles, vehicles, or passenger-car equivalents; for coverage, per lane, per direction, or both directions; for duration, per 15-min/interval, per hour, per day.

intersection might be forecast to be between 30 and 67 seconds per vehicle based on data that require a medium effort level.

3. *High-effort level* data are quite time-consuming to obtain and are often available only when specific development proposals are being considered. They are included in this document, however, because there may be instances where a county or VDOT deems the extra precision to justify the cost. For example, if the exact size and the type of development are known, the range of the mean delay could be narrowed down to between 52 and 53 seconds per vehicle.

The exact format needed for these data depends on the specific software being used. For example, for analyzing traffic operations such as signal delay, different VDOT districts use different software packages such as Highway Capacity Software, Synchro/SimTraffic, CORSIM, and VISSIM. Regardless of the package chosen, however, there are some data formatting steps that can make analysis easier to perform as shown in the footnotes to each table.

Tables B4 and B5 show how increasing levels of land use and development data detail can improve the quality of the analysis. For example, obtaining the general zoning category (a low level of detail) yields results that may easily vary by an order of magnitude. In the example shown in Table B4, the estimated number of peak hour trips ranges from 2 to 700, depending on whether a furniture store is built or a combination of office, retail, and restaurant uses is chosen. (It is expected that the zoning ordinances of other Virginia counties have a similar range of permissible land uses within particular zoning categories.)

Similarly, Tables B6 and B7 show how better transportation data can tighten the range of the analysis. In particular, Table B6 shows that with the same intersection, low levels of transportation data yield an estimate of delay that could be as low as 24 seconds or as high as 292 seconds—an incredibly large range. By collecting more precise roadway data where fewer assumptions were required, however, the delay estimate tightens somewhat—a low of 30 seconds to a high of 140 seconds. In this particular case, the increased level of data did not yield a dramatic tightening of the range. However, Table B7 shows the same analysis for another intersection, where the extra data did lower the variability of the estimate. Thus, presentation of delay with a range of values, from low to high, is one way to convey the effect of uncertainty in the data or in the computations.

The estimates of *mean* delay shown in Tables B4 through B7 came from using ITE trip generation rates and Highway Capacity Analysis software, both of which are deterministic, i.e., have no random component to the analysis. Even if the high level data were perfect, however, additional variation in the delay would be observed if these intersections were examined daily. This day-to-day variation (which would also be evident in simulation runs) is not captured in Tables B4 through B7. In short, the tables capture only the range in mean delay that results from imperfect data, not the variation in individual delay values attributable to random variation. The data available for scenarios analysis may be highly variable. For some locations, only basic data elements may be available, and for others, more detailed data may be feasible. Generally, more detailed data may provide a more specific result, provided the data are not in error. However, to what extent will more detailed data provide this specificity?

Tables B4 and B5 illustrate how obtaining more specific land data elements improves the answer by using a single parcel of land as a case study. This parcel is located to the west of the U.S. 220/Wesley Road intersection in Botetourt County that has B2 zoning. The county is interested in estimating the delay at the intersection that will result from new development on the unbuilt parcel. The tables show a subset of the data available and the resultant delays that are estimated as more detailed data are obtained; the salient feature of the tables is that the estimated delays become more precise with more precise data. The lessons are twofold: better data give better results, and even with very limited data, some useful analyses are feasible. Note that the results may be presented as a range of impacts corresponding to light or intense development.

**Table B4. Impacts of Better Land Use Data for Peak Hour Intersection Delay Estimates  
(Example with U.S. 220/Wesley Road)**

<b>Data Extent</b>	<b>Low Effort</b>	<b>Medium Effort</b>	<b>High Effort</b>
Data elements	B2 zoning; parcel size 1 to 3 acres	Developable land in parcel will be 1.25 acres; with FAR of 0.40, maximum size of parcel will be 22,000 ft <sup>2</sup>	There will be 216,000 ft <sup>2</sup> of office space, 9,000 ft <sup>2</sup> for quality restaurant, and 37,000 ft <sup>2</sup> electronic superstore
Reason for uncertainty	B2 zoning permits wide range of land uses, e.g., motel, bank, restaurant, office building, school; mean trip generation rates range from 0.5 to 55 trips per 1,000 ft <sup>2</sup> and size unknown	Maximum size of parcel is 22,000 ft <sup>2</sup> , but size unknown (building size may or may not be smaller than 22,000 ft <sup>2</sup> )	Exact sizes of parcel known
Range of values for trips generated	On all 3 acres, could have 5,000 ft <sup>2</sup> furniture store that generates 2.25 trips or 13,000 ft <sup>2</sup> drive-in bank that generates 700 trips	Could have 5,000 ft <sup>2</sup> furniture store that generates 2.25 trips or 22,000 ft <sup>2</sup> furniture store that generates 9.9 trips	This combination of office, restaurant, and retail uses will generate 518 to 556 trips
Range of delay intersection delay estimates at intersection.	Accordingly, mean delay varies from 29.5 to 128.2 sec/vehicle	Accordingly, mean delay varies from 29.7 to 67.3 sec/vehicle	Accordingly, mean delay varies from 51.9 to 53.1 sec/vehicle

FAR = floor area ratio.

**Table B5. Impacts of Better Development Data for Peak Hour Intersection Delay Estimates  
(Example with U.S. 220/Wesley Road)**

<b>Data Extent</b>	<b>Low Effort</b>	<b>Medium Effort</b>	<b>High Effort</b>
Reason for uncertainty	Location of development with respect to intersection and directional split of entering/exiting trips unknown	Location of development known, but directional split unknown	Location and directional split known.
Range of delay intersection delay estimates at intersection	Accordingly, mean delay varies from 29.3 to 40.0 sec/vehicle	Accordingly, the mean delay varies from 29.3 to seconds per vehicle.	Accordingly, mean delay varies from 30.4 to 37.6 sec/vehicle

Tables B6 and B7 show the impact of increased precision with better roadway data. The delay range at the U.S. 220/Wesley Road intersection was 24 to 292 seconds based on low-level data elements and 30 to 104 seconds based on high-level data, which was not a marked improvement. However, the same type of analysis at the U.S. 11/Route 1047 intersection showed a dramatic improvement: from 12 to 123 seconds to 12 to 25 seconds.

**Table B6. Impacts of Better Transportation Data for Peak Hour Intersection Delay Estimates  
(Example with U.S. 220/Wesley Road Intersection)**

<b>Data Extent</b>	<b>Low Effort</b>	<b>Medium Effort</b>	<b>High Effort</b>
Reason for uncertainty	Unknown cycle length, PHF, % heavy vehicles, or saturation flow rate	Unknown % heavy vehicles but known cycle length, PHF, and saturation flow rate	Exact cycle length, PHF, % heavy vehicles, and saturation flow rate
Range of delay intersection delay estimates at intersection	Accordingly, mean delay varies from 23.5 to 291.5 sec/vehicle	Accordingly, mean delay varies from 27.7 to 146.3 sec/vehicle	Accordingly, mean delay varies from 29.5 to 103.6 sec/vehicle

PHF = peak hour factor.

**Table B7. Impacts of Better Transportation Data for Peak Hour Intersection Delay Estimates  
(Example with U.S. 11/Rt. 1047 Intersection)**

<b>Data Extent</b>	<b>Low Effort</b>	<b>Medium Effort</b>	<b>High Effort</b>
Reason for uncertainty	Unknown cycle length, PHF, % heavy vehicles, or saturation flow rate	Unknown % heavy vehicles but known cycle length, PHF, and saturation flow rate	Exact cycle length, PHF, % heavy vehicles, and saturation flow rate
Range of delay intersection delay estimates at intersection	Accordingly, mean delay varies from 11.9 to 122.9 sec/vehicle	Accordingly, mean delay varies from 12.1 to 42.9 sec/vehicle	Accordingly, mean delay varies from 12.2 to 25.4 sec/vehicle

PHF = peak hour factor.