PLAN FORWARD

Comprehensive Transportation Analysis

Executive Summary

Proposed changes to a transportation system or planned land use may require a transportation impact study. In the past, these studies primarily focused on impacts to roadway congestion, often expressed as vehicle delay at intersections around the area being studied. The study report would then recommend a set of "mitigations" intended to reduce the delay incurred by vehicles.

Mitigations to improve vehicle delay often come at the expense of those who walk, bike, or use transit. For example, increasing the capacity of a roadway often makes its crossings less safe, comfortable and convenient for a pedestrian or a bicyclist. Fairfax County Department of Transportation (FCDOT) has implemented a new way to conduct transportation assessments for zoning actions, Plan amendments, and corridor studies to better illustrate solutions-based trade-offs between different modes of travel.

The new Comprehensive Transportation Analysis (CTA) introduces a framework for the various transportation study types conducted in Fairfax County and applies a context-sensitive approach, prioritizing the travel modes that best reflect each area's unique transportation system needs. It also establishes targets for various measures of effectiveness (MOEs) that are intended to help Fairfax County meet its transportation goals and reinforce new and established objectives and policies as part of the Plan Forward Transportation Policy Plan update effort.

This paper describes the process used to identify appropriate MOEs and develop the new CTA analysis, and provides recommendations for where those may be reflected in the Policy Plan.

Background

Transportation impact studies are generally conducted when a zoning application or Plan amendment proposes a substantial change to the uses and intensities or densities of a land area. These changes may be the result of a land development proposal, such as the construction of a retail center, or a modification of the transportation system, which could include new roadway construction, an alteration of traffic operations, or a reallocation of right-of-way for different uses, such as the conversion of general-purpose travel lanes to dedicated transit lanes. The significance of a proposed change is determined by the number of new vehicle trips it is expected to generate; the Virginia Department of Transportation (VDOT) requires a study when a proposal is expected to generate more than 5,000 vehicle trips per day. The impacts are assessed in terms of vehicle delay, the ratio of vehicular volume to roadway capacity, and vehicle queue lengths at intersections, among other vehicle-focused metrics. If the results of the analysis exceed predetermined thresholds - delay at an intersection is deemed too high, for instance – mitigation is proposed.

Often the mitigation for an expected increase in traffic is to add more capacity for vehicles (e.g. wider roadway, longer turn lanes) and/or adjust traffic signal timings to allow for increased throughput. While these solutions may improve congestion, they can also have unintended consequences, such as encouraging higher speeds and inducing more vehicle demand.

Additionally, there is little to no consideration of the impact to pedestrians, bicyclists, and transit users. Increasing vehicular capacity often comes at the expense of pedestrians and bicyclists, and those trying to access transit, resulting in longer roadway crossings, and narrower, less comfortable facilities for those users. Fairfax County has recognized the challenges of the status-quo transportation assessment, and the County's first Countywide Strategic Plan, adopted in October 2021, called for a *"[Revision to] the methodology of how transportation impacts are assessed by transitioning from the automobile-focused level of service methodology to a multi-modal approach."* Over the past several years, FCDOT, in coordination with partner agencies and VDOT, has endeavored to address this strategy and shift the paradigm to a transportation system that considers the needs of all users.

Additional Measures of Effectiveness (AMOE)

Beginning in spring 2020, FCDOT staff conducted research on measures of effectiveness (MOEs), generally defined as metrics used to quantify aspects of a transportation system and assess different transportation options proposed in a plan or project. This task included identifying the MOEs that are commonly used in FCDOT's transportation studies, and determining what aspects are not measured in these studies but should be. While many FCDOT studies do include metrics for non-auto modes, such as bicycle level of traffic stress, these measures were not formally required unless noted during the scoping process for a particular study. A majority of the MOEs required to conduct a transportation study per VDOT regulations are autocentric.

Staff then researched MOEs used by other jurisdictions throughout the United States to find examples that could potentially fit the needs of Fairfax County. In total, the stakeholder group identified and categorized 35 measures by mode: pedestrians, bicyclists, transit, vehicles. While some measures do not fit neatly into these groups, such as crashes, they are still important. The ten measures that ultimately moved forward to be included in the CTA are underlined.

Transit

1. Transit Access/Walkshed
2. Bus Stop Comfort/Amenities
3. Transit Load Factor
4. Transit Headway
5. Transit Hours of Service
6. Transit Speed
7. Transit Travel Time Difference
8. Transit Ridership

Pedestrian

9. Pedestrian Level of Comfort
10. Pedestrian Delay/Level of Service (LOS)
11. Pedestrian Block Length

Vehicle

12. Volume to Capacity (V/C) Ratio
13. Queuing
14. Vehicle Miles Traveled
15. Vehicle Delay/LOS
16. Travel Time Reliability
17. Transportation Demand Management
18. Sketch Trip Generation

Bicycle

19. Bike Level of Traffic Stress
20. Bike Network Density
21. Bike Intersection Connectivity

Other

22. Demographics and Needs
23. Parking Rate
24. Crashes
25. Mode Share
26. Person Throughput
27. Trip Time Modal Comparison
28. Bike/Pedestrian V/C Ratio
29. Person LOS/Delay
30. Multimodal LOS
31. Activity Density
32. Free Flow vs Posted Speed
33. Curbside Management
34. Job Access
35. Cost

Measure Selection

The following subsections discuss the metrics selected from each category, along with examples of those that did not move forward to help illustrate the AMOE group's decision-making process as they considered the benefits and disadvantages of each metric.

Transit Measures

Transit ridership was selected for the CTA and was modified to include the comfort and amenities metric to show if benches, shelters, or other facilities are provided at transit stops. Ridership data is readily available through FCDOT's Transit Services Division which can provide an understanding for how much transit is being utilized within a study area or along a corridor; it may also help in understanding how well transit users are being accommodated. Transit access is another planning-level metric which looks at the distance transit riders need to traverse to access stops within a certain radius. It compares the distance from a transit stop as-the-crow-flies to the same distance if travelled using the available pedestrian and bicycle facilities, such as sidewalks, crosswalks, and bike lanes. The metric is useful for identifying potential improvements to the walking and biking network around transit stops. This information can be conveyed through a variety of maps, such as the one shown below in *Figure 1*.

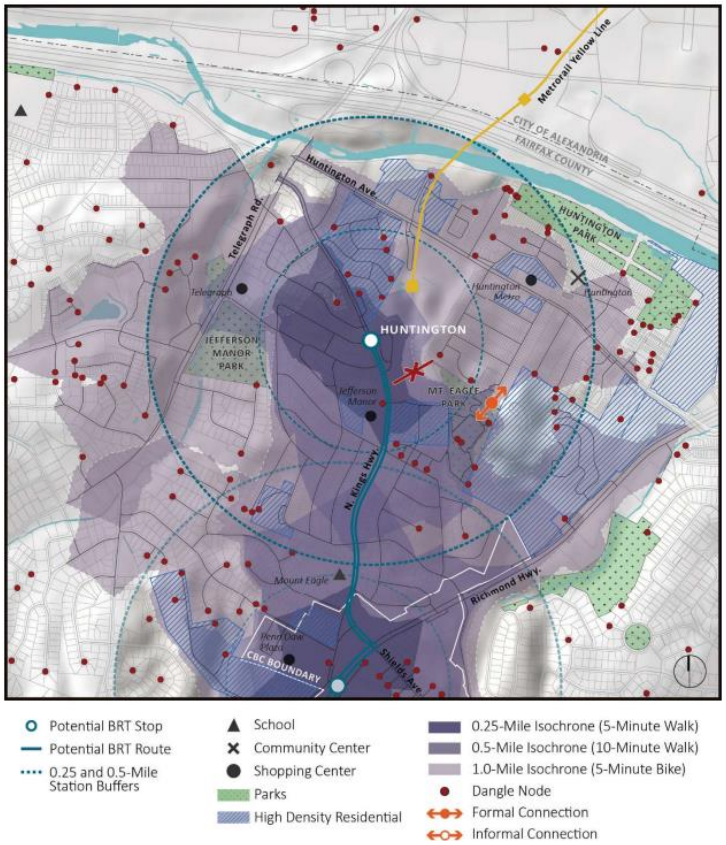

Figure 1: Huntington - Existing Conditions
Source: Richmond Highway BRT Bicycle and Pedestrian Connectivity Memo, January 2019

Other transit metrics, such as hours of service, load factor, and headways were not selected for inclusion in the CTA. Though these are important metrics that are utilized to create efficiencies in the transit system, they are best analyzed as part of route-optimization and other transit-focused planning exercises. While some zoning actions, Plan amendments, and corridor studies may involve areas with several transit stops, they are unlikely to include an entire transit route within the study area boundary, excluding corridor studies with a specific transit focus, such as those analyzing a Bus Rapid Transit (BRT) System. In other words, it would be difficult for non-transit focused studies to influence operations metrics in their study area without affecting an entire route or multiple routes.

Pedestrian Measures

Level of Comfort
1 = Very Comfortable
2 = Comfortable
3 = Somewhat Comfortable
4 = Uncomfortable
5 = No Pathway

Table 1: Pedestrian Level of Comfort scale

Source: Pedestrian Levels of Comfort

Pedestrian delay was selected as it serves as a counterpoint to vehicle delay and can be calculated with a simple equation using signal timing. The metric relates the average delay in seconds a pedestrian must wait at a signalized intersection and provides the likelihood of non-compliance – crossing without a "walk" signal – for different ranges of delay. The assumption is that the longer a pedestrian must wait to cross, the more likely they may cross without a "walk" signal. Pedestrian level of comfort (PLOC) is useful in rating sidewalks and pathways based on a combination of factors that can contribute to or detract from one's perceived level of comfort. For example, a wider sidewalk along a tree-lined road with a low posted speed limit is more comfortable than a narrow sidewalk without a buffer along a road with a high posted speed limit. The data inputs for PLOC, include the posted speed limit, presence of streetscape and roadway features, and facility dimension; data can be gathered from online maps and verified through a site visit.

Vehicle Measures

Vehicle delay, queuing, and volume to capacity ratio are commonly used in transportation studies and will continue to be assessed through the CTA. The methodologies for these measures largely remain unchanged from past studies, though in some instances the way in which their outputs are communicated have been updated to align with the CTA's more balanced, multimodal approach. For example, the CTA will avoid using level of service (LOS) letter grades for vehicle delay as they may carry negative connotations for traffic conditions which may be otherwise acceptable when balanced with other measures. Volume to capacity ratio, which traditionally highlights roadway segments that are over capacity, can also be used to identify areas with excess capacity, which could therefore be repurposed for other uses such as bicycle lanes or a road diet. Some vehicle measures, such as travel time reliability, did not move forward as requirements for the CTA, but may still be used in certain studies, especially corridor studies.

Vehicle miles travelled (VMT) is a metric less commonly used in FCDOT's studies but was selected to be included in large area studies and corridor studies to show the difference in total miles travelled between alternatives, or the difference in per capita VMT. This may help with decisions on where to locate community resources or active transportation facilities. For example, creating a more direct walking and biking route to a grocery store in a dense neighborhood could encourage the per capita VMT to decrease. Eventually, VMT could be used to measure progress toward Fairfax County's environmental goals, which include reduction in carbon dioxide ($CO^{2)}$ emissions due to lower VMT. Some parts of the US, most notably in California, have identified VMT as the de rigueur transportation decision-making metric over vehicle delay. Fairfax County will need to more thoroughly test its application and outcomes before making such a judgement.

Bicycle Measures

The stakeholder group selected bicycle level of traffic stress (BLTS) for the CTA as the metric is easy to understand and requires minimal data collection. Like PLOC, this metric combines several factors to produce a score for a given roadway segment or crossing. In 2012 the Mineta Transportation Institute published a report titled Low-Stress Bicycling and Network Connectivity which included methodology used to determine traffic stress imposed on bicyclists. The report indicates that stress is based on a roadway's prevailing speed, number of lanes, average daily

traffic (for roadways without a dedicated bicycle facility), and bicycle lane width; other variables may also be considered, such as parking lane width and separation (e.g. flexpost, curb). Scores range from LTS 1, which is suitable for all ages and abilities, to LTS 4, which is acceptable only to a small minority of experienced bicyclists. The scoring table for mixed traffic criteria (bicyclists sharing a lane with vehicles) is shown in *Table 2*.

Mixed traffic criteria

Number of lanes	Effective ADT*	Prevailing Speed						
		≤ 20 mph	25 mph	30 mph	35 mph	40 mph	45 mph	50+mph
Unlaned 2-way street (no centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 1	LTS 1	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 2	LTS 2	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
1 thru lane per direction (1-way, 1-lane street or 2-way street with centerline)	0-750	LTS 1	LTS 1	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3
	751-1500	LTS 2	LTS 2	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4
	1501-3000	LTS 2	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	3000+	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
2 thru lanes per direction	0-8000	LTS 3	LTS 3	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4
	8001+	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4
3+ thru lanes per direction	any ADT	LTS 3	LTS 3	LTS 4	LTS 4	LTS 4	LTS 4	LTS 4

* Effective ADT = ADT for two-way roads; Effective ADT = 1.5*ADT for one-way roads

Table 2: Bicycle Level of Traffic Stress - mixed traffic criteria
Source: Bicycle Level of Traffic Stress Methodology

While the stakeholder group found merit in other bicycle metrics, such as bicycle network density and bicycle intersection connectivity, it was concluded that they would not be useful for much of Fairfax County. Network density, for instance, is best applied in locations with a street grid and a built-up bike network, and both metrics lack other important considerations, such as facility quality and design.

Other Measures

There were several metrics or data types researched that did not fall into a specific modal category. Of those, crashes – including vehicle, pedestrian, and bicycle involved crashes – was selected as having the most relevance to the goals of the CTA. While a five-year crash history is typically collected for studies, there was a desire from the stakeholder group to be more proactive in planning for safer streets. Therefore, CTAs for corridor studies will require a predictive crash analysis to estimate how many crashes could occur at a given intersection or roadway segment. Studies may also apply a hot spot analysis, which creates a crash profile for areas with high crash frequency or crashes that resulted in a serious injury or fatality and compares the profile to areas with similar attributes along a corridor.

With the ten MOEs selected, the project moved into its next phase to develop a framework for applying the measures and create a process for conducting the CTA.

Creating the CTA Framework and Process

When developing the CTA framework, it was acknowledging that a one-size-fits-all approach would not work in Fairfax County as the County includes a variety of land uses with different transportation needs. For example, the Tysons Urban Center does not have the same needs as a suburban neighborhood like Burke. Using the Concept for Future Development's Land Classification Map (https://www.fairfaxcounty.gov/planning-development/comprehensive-

plan/special-planning-areas) as a base, similar land uses were first grouped, and modal priority was applied to each area type. The modal priority highlights modes which should be prioritized when mitigation strategies are proposed and evaluated, as noted in *Figure 2*. While vehicles are the dominant mode of travel in area types one and two, the Comprehensive Plan already includes guidance on improving multimodal transportation in many of these areas and updates to the Transportation Element should be directed toward balancing the needs of all modes.

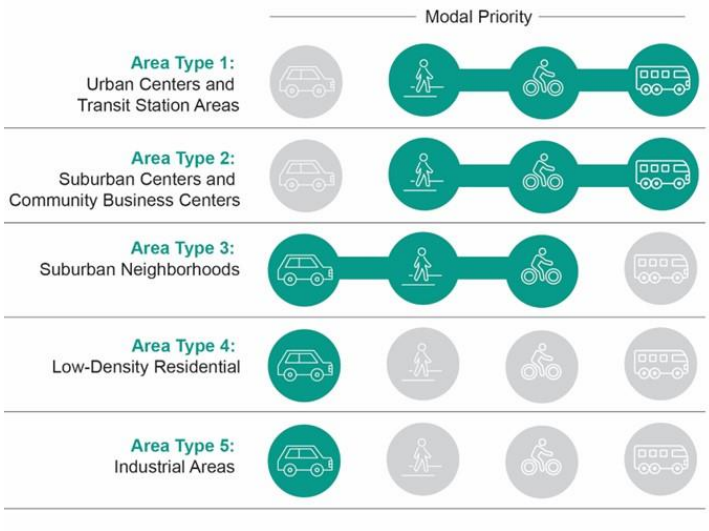

Figure 2: Area Type Structure and Modal Emphasis

Source:
https://www.fairfaxcounty.gov/transportation/sites/transportation/files/Assets/Documents/PDF/transportation%20projects%2C%20studies%20and%20plans/cta/CTA-Users-Guide_Fall-2024.pdf

Next, there are a variety of transportation studies used for different purposes. Broadly, the three study types are 1) zoning action studies 2) Comprehensive Planning studies (Plan amendments), and 3) corridor studies. Comprehensive Planning studies range from Site Specific Plan Amendments (SSPAs) which include one or several land parcels, to large area studies encompassing several square miles. All ten measures selected will not necessarily be required for each study type (Figure 3), and the measures listed are the minimum required; there may be additional MOEs included in a study as determined at scoping. Corridor studies will often include others, such as travel speeds and travel time reliability.

Measure	Comprehensive Planning	Zoning Action	Corridor Studies
Transit			
Transit Access/Walkshed	✓	✓	✗
Stop-Level Transit Ridership	✓	✓	✓
Pedestrian			
Pedestrian Level of Comfort/Gap Analysis	✓	✓	✓
Pedestrian Delay	✓	✓	✓
Vehicle			
V/C Ratio	✓	✗	✓
Motorist Queuing	✗	✓	✓
Vehicle Miles Traveled*	✓	✗	✓
Vehicle Delay	✓	✓	✓
Bicycle			
Bicycle Level of Traffic Stress/Gap Analysis	✓	✓	✓
Multimodal Safety			
Crashes	✗	✗	✓

*For comprehensive planning projects, the VMT measure only applies to area studies.

Figure 3: Required CTA Measures of Effectiveness by Project Type; Source:
https://www.fairfaxcounty.gov/transportation/sites/transportation/files/Assets/Documents/PDF/transportation%20projects%2C%20studies%20and%20plans/cta/CTA-Users-Guide_Fall-2024.pdf

Before scoping a study, it must be determined whether the proposal meets the need for a study and, if so, what components of the CTA are required. The CTA determination is based on site- or project-generated vehicle trip generation, expressed as average daily vehicle trips (ADT). Proposals expected to generate less than 1,000 net new ADT require a Transportation Statement, which does not include the CTA requirements, but provides supplemental transportation information, such as a trip generation table and a description of vehicular and pedestrian access. A CTA is triggered for proposals which are expected to generate 1,000 or more net new ADT. Additional study intersections may be added for proposals with 3,000 or more net new ADT, and a VDOT transportation study is required for 5,000 or more net new ADT. During scoping, the area types and modal emphases will be identified, along with the relevant measures based on the type of study being conducted. Acceptable targets (i.e. how many seconds of delay, what level of traffic stress) for each of the measures will also be communicated by FCDOT staff at this stage.

After the initial analysis is completed, solutions should be recommended by the transportation engineer for any of the MOE targets that have not been met. A study's modal priority may be helpful in guiding the decision-making process regarding the acceptability of proposed solutions. For instance, adding an additional travel lane to reduce vehicular delay to an acceptable target may not be an acceptable solution in an area that intends to prioritize pedestrian travel. Therein lies the primary goal of the CTA, which is to make more informed transportation decisions based on the collection of relevant data and a clear understanding of the trade-offs expected from proposed solutions.

Another major goal of the CTA is to set expectations by providing clear guidance. To achieve this goal, the CTA process and framework are documented in a User's Manual and Quick Guide. While the documents provide clear guidance on how to conduct a study, neither prescribes what mitigations should be proposed if targets are not met. Project outcomes should always be a result of close coordination with the stakeholders in the area being studied.

Policy Recommendations

The Comprehensive Transportation Analysis (CTA) will evolve with new knowledge and as the County continues to develop. Some of the metrics introduced may be unfamiliar to practitioners, and some may be assessed using different methodologies in other jurisdictions. FCDOT staff will closely observe and track the outcomes and data gleaned from each study and ask: Are the metrics providing useful data? Are the targets for each metric being met? Are the solutions proposed meeting the goals of Fairfax County? It is imperative that transportation studies used as tools in the decision-making process highlight the anticipated tradeoffs between the modes for people using the transportation network.

The measures and methodologies in the current CTA may change over time as new information becomes available and travel trends change. Through the Plan Forward effort, FCDOT is reviewing and updating the Transportation Element of the Policy Plan which currently contains objectives and policies related to MOEs. Objective 3, Policy b states, *"At a minimum, level of service D should be provided, except where a lower level of service has been determined acceptable."* Other measures are included more generally, with references to evaluating roadway capacity (Objectives 4 and 10) and facilitating access by transit (Objective 11). Targets established for MOEs in the CTA may help create new objectives and policies or reinforce existing ones.

- Current objectives and policies related to improving non-motorized travel and access to transit (e.g., Objective1 policy e and Objective 2 policy h) could be further clarified by including targets for pedestrian level of comfort (PLOC) and bicycle level of traffic stress (BLTS).
- Policies related to vehicle levels of service (e.g., Objective 3 policy b and Objective 11 policy b) should include consideration for the impacts to pedestrian delay and other measures that could be affected by improvements to the former.
- While the CTA does not include a specific goal for VMT, reduction of per capita VMT could be an effective policy toward environmental objectives and should be considered.
- Finally, safety objectives and policies should specifically mention reducing crashes and establishing a more proactive approach to addressing crash hot spots, as mentioned in the CTA.

Ultimately, the MOEs and associated targets in the CTA may be referenced for greater specificity in transportation policies, and new policies in turn may complement CTA documents. Both the Policy Plan and the CTA should promote the enhancement of Fairfax County's transportation system for the benefit of all people, regardless of their mode of choice, and with a focus on safety, sustainability, and mobility. Staff will continue to coordinate with County agencies and applicable stakeholders to develop policies to address topics listed in this paper, as well as any additional policies that are appropriate for incorporation into the Comprehensive Plan's Policy Plan.