Report for the French Broad River Metropolitan Planning Organization

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Transportation Planning Models

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Analysis and Comparison of 2020 and 2050 Projected Data

The French Broad River Metropolitan Planning Organization (MPO) area includes five counties in Western North Carolina making up the Asheville metropolitan area. Like many regions within the state, the area is projected to see significant growth in the coming decades. This is being considered in the creation of a mandated long range transportation plan (LRTP) for 2050. To that end, projections of 2050 socioeconomic data has been provided to the MPO to help in creating a model to more accurately project transportation patterns in the coming decades.

Figure 1. Location of French Broad River MPO in Relation to North Carolina (Graviiti, Creative Commons License)

This memo puts forward a simple analysis of the 2050 projections in comparison to 2020 data to help guide future decision making and the creation of the MPO's transportation model, which in turn will help inform the creation of an LRTP.

Population

As expected, the region is projected to see significant population growth in coming decades. The total population of the French Broad River MPO is about 47% higher in the 2050 projection than in the 2020 base year data, with a population increase of roughly 200,000 people distributed in similar patterns to the current distribution.

Table 1. Projected Change in Population

2020 Total Population	2050 Total Population	Change	Percent Increase
446,052	654,268	+208,216	46.68%

In overall numbers, most of the population increase is surrounding Asheville in the eastern part of the MPO area. Buncombe County, Madison County, Henderson County, and part of Transylvania County all are projected to see significant increases in population, while Haywood County's population remained largely the same. Similarly, the majority of the population is concentrated around the Asheville and Hendersonville areas, with little change in geographical distribution of the region's population between the base year and future year despite significant population growth.

However, as a percentage of the base year population, the western portion of the MPO, along with the areas along the region's highways, would see the largest percent increases. This is largely expected for the smaller traffic analysis zones (TAZs) along the highway corridors, which already seemed sized based on expectation of growth and included many of the area's major municipalities. Some rural areas are projected to see moderate growth, but cross-referencing with the geography, much of these areas are part of national forests or mountainous terrain otherwise unsuited for significant development. Large percentages of population growth in these areas likely are more reflective of exceptionally low base year populations than of significant development and may be indicative of a flaw in the model.

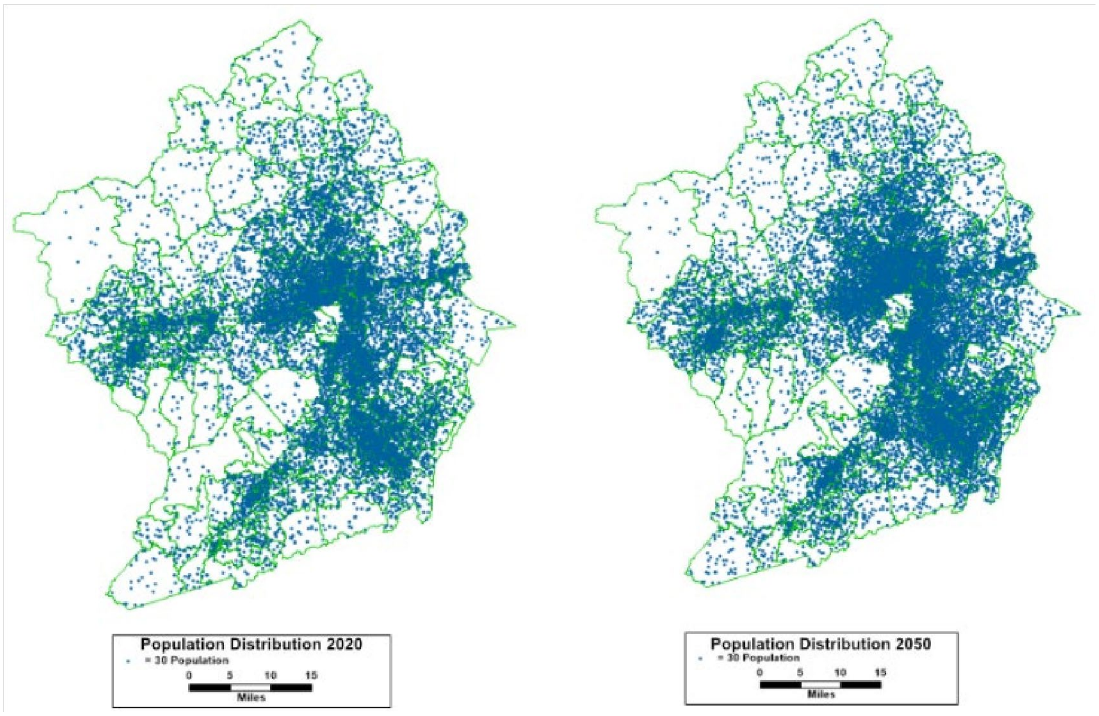

Figure 2. Existing and Projected Population Distribution throughout the French Broad River MPO

Employment

The future year data projects a total increase of roughly 93,000 workers in the region's workforce between 2020 and 2050, or about a 46% increase. This is in line with the 46% expected increase in population, which is hopefully a good sign for continued employment in the region and acts as a check on the reasonableness of the data. There is no substantial change within employment sectors projected, but the model did show a small shift in distribution from industry and retail to office and service jobs (see table 2), which would seem to be in line with the expected trend nationwide as the economy moves further into a service economy.

Table 2. Employment by Sector

Sector	2020	% of Emp 2020	2050	% of Emp 2050	Change in percent of total
Industry	46,116	22.70%	60,225	20.40%	-2.30%
Retail	49,502	24.40%	60,307	20.40%	-4.00%
Office	27,536	13.60%	44,327	15.00%	+1.40%
Service	80,002	39.40%	130,987	44.30%	+4.90%
Total	203,156		295,876		

Similar to the population distribution, the employment distribution is projected to stay fairly constant, with growth in employment following existing highway corridors, municipalities, and clusters of employment.

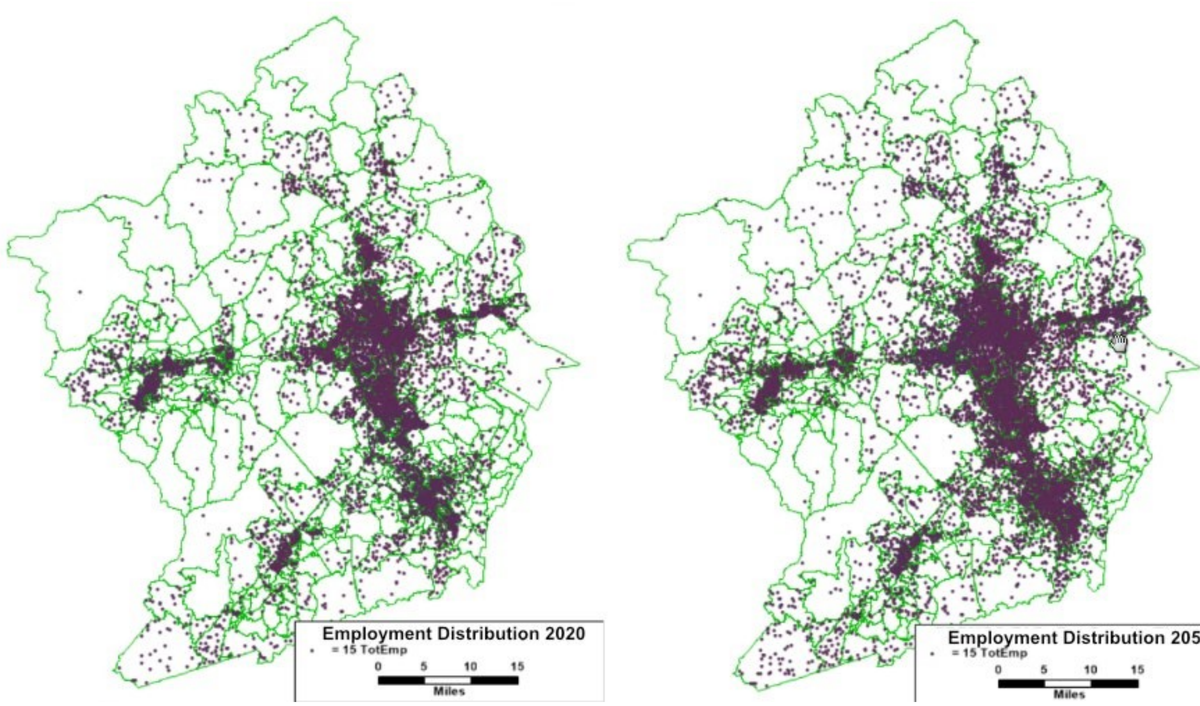

Figure 3. Existing and Expected Employment Distribution throughout the French Broad River MPO

Household Size

There was consistent growth among households of all sizes. Households of three grew the most at 45.11%, and households of four or more grew the least at 38.36%. Interestingly, there was no change in proportion of household sizes. Each household type made up the same percentage of total households in 2020 and 2050, give or take a couple tenths of a percent. Figure 4 shows the percent change in total households for each TAZ in the FBR region. As shown, most of the growth occurred in the southeastern section of the region. However, the changes in each particular TAZ are very small, so the map required a high scale to be able to see any changes. Only six TAZs grew by more than 10%.

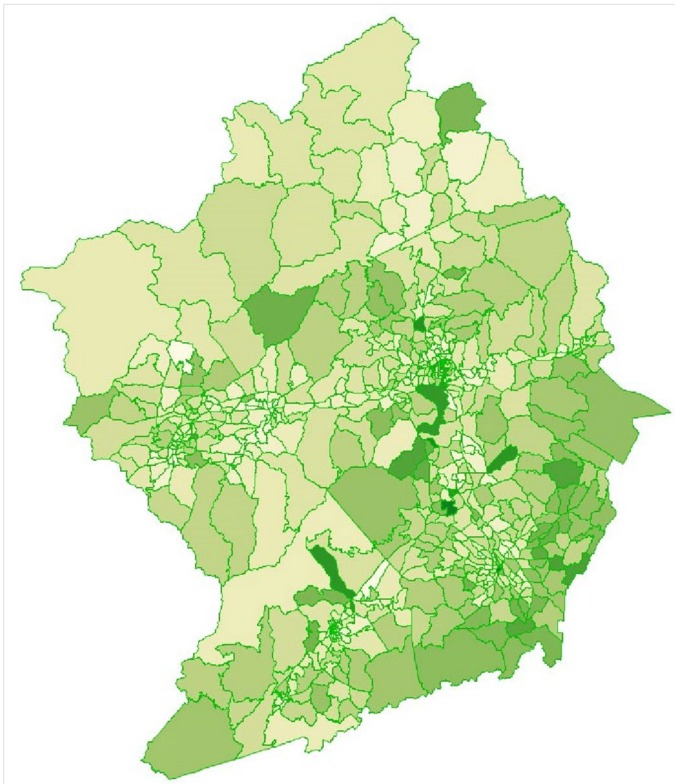

Figure 4. Percent Growth of Households by TAZ

The overwhelming majority of TAZs experienced 1.2% population growth or less. There were no readily apparent flaws in this dataset.

Table 3. Household Size

Household Size	2020	2050	Percent Increase	% of total 2020	% of total 2050
1 Person	61,450	86,322	40.47%	31.83%	31.62%
2 Person	68,887	97,898	42.12%	35.68%	35.86%
3 Person	29,836	43,295	45.11%	15.45%	15.86%
4+ Person	32,891	45,503	38.36%	17.04%	16.67%
Total	193,064	273,018	41.41%	100.00%	100.00%

Auto Ownership

There was consistent growth among number of cars per household. Households with three or more cars grew the most at 47.17%, and households with zero cars grew the least at 32.71%. Interestingly, there was no change in proportion of number of households with a specific number of cars. Number of cars per household made up the same percentage of total households in 2020 and 2050, give or take a couple tenths of a percent.

The same method was used to create a map for auto ownership as was used to create Figure 4. Change in auto ownership is in-line with change in households to the extent that the auto ownership map is near identical to the households map. Similar to household size, there were no readily apparent flaws within this data. The overall expected growth among households and car ownership underscores the need for a transportation network that is capable of handling an increasing volume of vehicles as the region continues to grow in coming years.

Table 4. Cars per Household

Cars per Household	2020	2050	Percent Increase	% of total 2020	% of total 2050
0	10,281	13,642	32.71%	5.33%	5.00%
1	62,079	85,089	37.06%	32.15%	31.17%
2	76,535	109,283	42.79%	39.64%	40.03%
3+	44,169	65,004	47.17%	22.88%	23.81%
Total	193,064	273,018	41.1%	100.00%	100.00%

Conclusion

Over the next thirty years, the French Broad River region is expected to increase in population by approximately 50%. This is part of the reason for the French Broad River Metropolitan Planning Organization's (FBRMPO) long term transportation plan. This memo was created to assist in that endeavor. The memo uses 2020 socioeconomic data, such as population, employment, household size, and automobile ownership and projected socioeconomic data for 2050. These data are analyzed and compared, and shown via maps and tables in order to further inform the FBRMPO decision-making processes for the long-range transportation plan.

Household Survey Data Analysis

Which trip purpose contributes the highest number of trips to the region? Does this seem reasonable?

Home-based other (HBO) contributes the most trips to the region, making up 45% of trips. While perhaps a bit surprising, it seems within reason, and these numbers act as a reminder that there is a significant amount of travel beyond work and school commutes that we cannot afford to overlook in transportation planning and modeling for the area. A lot of such planning, especially in public transit planning, often focuses heavily on work-based trips to the extent that important trips to shopping, recreation, socialization, etc are not adequately accommodated for in the transportation network.

Table 5. Total Trips by Purpose

	HBW	HBO	HBSC	NHB
Walk	8,434	28,392	214	24,334
Bike	1,381	5,488	0	4,889
Auto/Van/Truck (driver)	103,301	335,780	2,652	357,686
Auto/Van/Truck (passenger)	6,405	93,392	20,947	77,261
Public transit	926	1,971	0	4,383
School bus	995	3,073	7,705	2,381
Motorcycle/Moped	195	1,393	100	2,542
Private Shuttle/Bus	0	69	0	0
Carpool	954	588	1,598	1,091
Don't travel to work	79	149	130	0
Don't travel to school	0	522	0	1,926
Something else	104,903	158,773	28,883	15,666
Total:	227,574	629,591	62,229	492,059

Which trip purpose shows the highest share of "Driver" mode trips and which purpose the highest share of "Passenger" trips? What is the reason for the difference?

The data seemed off when including "something else" and "don't travel options" but excluding all "something else" and "don't travel to work/don't travel to school", Home-based work trips (HBW) make up the highest share of "driver" mode trips. Meanwhile, Home-based school (HBSC) had the highest share of "passenger" mode trips. This likely corresponds to the fact that unlike many workers, elementary, middle, and most high school students lack the ability to drive themselves and would be reliant on school buses or being dropped off/picked up from school.

Which are the top two trip purposes for public transit? How might this information inform model development and/or plan development?

Non-home based (NHB) and Homebased work (HBW) were the two top trip purposes for public transit usage, at 0.9% and 0.4% respectively. For the former, it would imply a need for identifying the major destinations people were using public transit between, and for the latter it would imply the need to understand home-to-work commute patterns. Notably, the fact that non-home based trips made up the largest share points to the importance of the transit system for trips beyond just work commutes, which should be reflected in routing and planning.

Which purpose shows the highest percentage of non-motorized (walk and bicycle) trips? Does this seem reasonable? How is this information beneficial?

Non-home based (NHB) trips made up the highest percentage of walking and bicycle trips, followed closely by home-based other trips (HBO). This seems reasonable in indicating walking or biking from destination to destination and potentially to/for trips like shopping, recreation, or social visits. A better understanding of where this is happening will be helpful. In a mountain city like Asheville known for tourism and outdoor recreation, some of those trips may be situations such as walking/biking from place to place in walkable areas like downtown or recreational runs/bike rides.

Table 6. Percentages by Purpose and Mode

	HBW	HBO	HBSC	NHB
Walk	3.7%	4.5%	0.3%	4.9%
Bike	0.6%	0.9%	0.0%	1.0%
Auto/Van/Truck (driver)	45.4%	53.3%	4.3%	72.7%
Auto/Van/Truck (passenger)	2.8%	14.8%	33.7%	15.7%
Public transit	0.4%	0.3%	0.0%	0.9%
School bus	0.4%	0.5%	12.4%	0.5%
Motorcycle/Moped	0.1%	0.2%	0.2%	0.5%
Private Shuttle/Bus	0.0%	0.0%	0.0%	0.0%
Carpool	0.4%	0.1%	2.6%	0.2%
Don't travel to work	0.0%	0.0%	0.2%	0.0%
Don't travel to school	0.0%	0.1%	0.0%	0.4%
Something else	46.1%	25.2%	46.4%	3.2%

Model Estimation

Cross Classification

We chose workers as a variable based on thinking that workers would have less time and ability to make as many HBO trips. This seemed to be an accurate trend. Higher number of workers in household loosely appeared correlated with lower numbers of HBO trips.

Our next variable was students. Households with less students tended to make less HBO trips.

The highest numbers of trips and highest numbers of students/workers acted as outliers, and thus made it harder to clearly see a trend. However, by looking at the highest nonzero "number of trips" of each "number of students/workers" column and how they compared to each other helped spot implied trends.

Table 7. Number and Percent of Trips by Mode

	Number of Trips	Percent of Trips
Walk	61,375	4.3%
Bike	11,758	0.8%
Auto/Van/Truck (driver)	799,419	56.6%
Auto/Van/Truck (passenger)	19,805	14.0%
Public transit	7,180	0.5%
School bus	14,154	1.0%
Motorcycle/Moped	4,230	0.3%
Private Shuttle/Bus	69	0.0%
Carpool	4,232	0.3%
Don't travel towork	358	0.0%
Don't travel toschool	2,448	0.2%
Something else	308,226	21.8%
Total	1,411,453	

Regression

Even though we were looking at Home-based other trips, we thought it was worth seeing if/how the number of employees in a district correlated with the number of HBO trips. To try to see the strongest link to the "other" in HBO, retail employees and service employees were chosen as the two variables.

A basic regression analysis found a moderate positive correlation between the number of retail employees and number of HBO trips, indicated by an

Table 8. Number and Percent of Trips by Purpose

	Number of Trips	Percent of Trips
HBW	227,574	16%
HBO	629,591	45%
HBSC	62,229	4%
NHB	492,059	35%
Total	1,411,453	100%

R^2 of 0.5978 along the trendline of y = 13.532x - 135381. This is below the preferred 0.6-0.7 range, but comes close enough to make a valid correlation. The significance factor of 3.43E-07 indicates a less than 1% chance that the correlation is by chance, which provides confidence in the validity of the correlation.

Similarly, regression analysis showed a moderate positive correlation between the number of service employees and number of HBO trips, indicated by an R^2 of 0.5903 along the trendline of y = 17.719x - 181485. The significance factor of 4.49E-07 again indicates a less than 1% of the correlation being by chance.

There is a chance that these correlations mostly just reflect population generally (more workers potentially trending with more total population and thus more trips), and there's not enough data to indicate causation. However, the regression model does show that the correlations are significant.

Appendix

Table 9. Workers per Household vs. Number of HBO Trips

Number of Home-Based Trips (HBO) Mdae	Number of Workers per Household				
	0	1	2	3	Total:
0	73	121	87	7	288
1	75	128	72	2	277
2	221	115	89	6	431
3	65	77	79	3	224
4	201	82	103	8	394
5	15	23	29	5	72
6	84	25	30	1	140
7	13	12	10	3	38
8	39	15	19	3	76
9	9	8	5	5	27
10	42	2	5	1	50
11	2	7	7	1	17
12	17	2	2	0	21
13	4	3	0	0	7
14	1	2	2	1	6
15	2	0	0	0	2
16	0	0	1	0	1
17	0	4	0	0	4
20	0	0	0	1	1
Total:	863	626	540	47	2076

Table 10. Students per Household vs. Number of HBO Trips

Number of Home-Based Trips (HBO)	Number of Students per Household						
	0	1	2	3	4	5	Total:
0	235	32	20	1	0	0	288
1	247	23	5	1	0	1	277
2	349	70	10	0	1	1	431
3	166	43	13	2	0	0	224
4	308	60	17	5	0	4	394
5	46	13	12	1	0	0	72
6	95	34	8	3	0	0	140
7	24	8	6	0	0	0	38
8	61	14	1	0	0	0	76
9	7	4	11	4	1	0	27
10	36	5	8	0	1	0	50
11	8	4	4	1	0	0	17
12	14	7	0	0	0	0	21
13	5	2	0	0	0	0	7
14	2	0	3	0	1	0	6
15	1	0	1	0	0	0	2
16	0	1	0	0	0	0	1
17	0	0	0	0	4	0	4
20	0	0	1	0	0	0	1
Total:	1604	320	120	18	8	6	2076

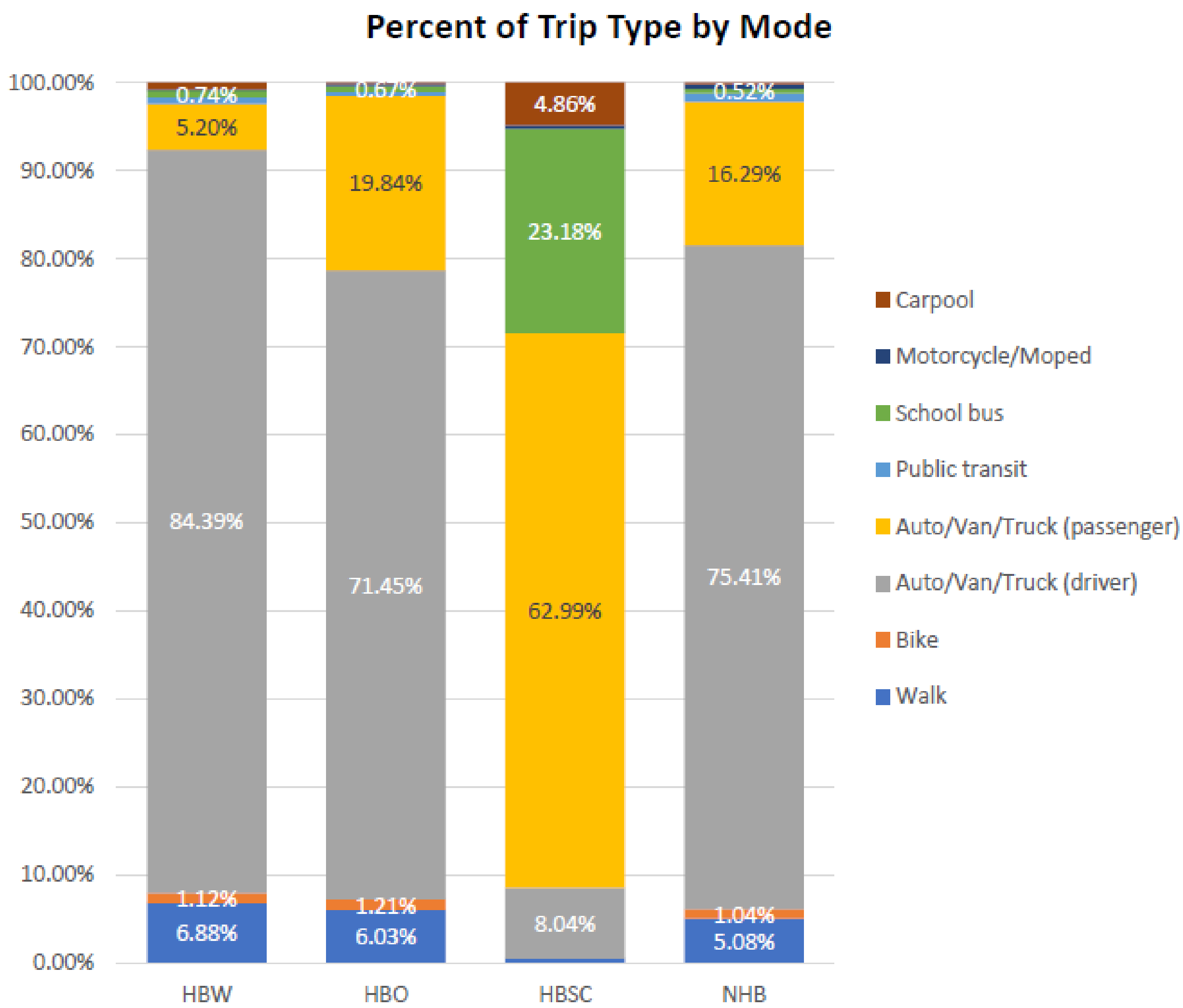

Figure 5. Trip Type by Mode

Goals and Objectives for the Asheville Metropolitan Area

Asheville is a growing city and metropolitan area home to nearly a half million residents. ...some common challenges and some more unique to the city. In moving forward with their long-range transportation plan (LRTP), the French Broad River Metropolitan Planning Organization is focusing on themes of safety, multimodality, and connectivity based on some of the challenges of growth and accessibility Asheville and surroundings are facing. The Asheville of the future is envisioned as a city with a safe and efficient multimodal transportation network that meets the needs of residents and tourists alike.

Goals

There are three primary goals for the Asheville Metropolitan Area:

1. Safety
2. Multimodality
3. Connectivity

Goal #1: Safety

The primary goal for the Asheville Metropolitan Area is to improve safety for all roadway users.

Objective #1: Decrease traffic fatalities and injuries

- Measure of Effectiveness #1: Rate of fatal crashes
- Measure of Effectiveness #2: Rate of crashes with severe injury

Objective #2: Improve crosswalk and sidewalk infrastructure and ensure ADA compliance.

- Measure of Effectiveness #1: Percent of improved crosswalks and sidewalks
- Measure of Effectiveness #2: Percent of survey respondents that rate the safety of the crosswalk and/or sidewalk as at least a 7 out of10

For a metropolitan area to increase safety for all roadway users, it needs to improve upon existing infrastructure and have ADA compliant crosswalks and sidewalks. This should decrease pedestrian and bicyclist injuries and fatalities, leading to an increase in pedestrian and bicyclist utilization of the corridor.

Goal #2: Multimodality

The second goal for the Asheville Metropolitan Area is to create an efficient, multimodal network of streets.

Objective #1: Create new (or improve existing) pedestrian and bicycle infrastructure

- Measure of Effectiveness #1: Number of pedestrians and bicyclists per hour
- Measure of Effectiveness #2: Percent of survey respondents that identify as at least "enthused and confident" before and after bicycle infrastructure improvements

Objective #2: Create new (or improve existing) transit infrastructure

- Measure of Effectiveness #1: Number of transit users per hour

Measure of Effectiveness #2: Transit travel time between TAZs

A modern metropolitan area needs to be planned with more than just cars in mind. That means considering the needs of pedestrians, cyclists, and transit riders, without creating an impedance on each other. This is a crucial step towards transportation equity.

Goal #3: Connectivity

The third and final goal for the Asheville Metropolitan Area is to improve connectivity throughout the region.

Objective #1: Optimize travel to and from tourist destinations

Measure of Effectiveness #1: Travel time between TAZs frequented by tourists

Measure of Effectiveness #2: Distribution of trips to/from TAZs frequented by tourists

Objective #2: Improve traffic flow through high traffic intersections

Measure of Effectiveness #1: Vehicles per hour vs. roadway capacity

Measure of Effectiveness #2: Hours of vehicle delay

The Asheville area faces challenges of significant tourist traffic and unforgiving geography complicating improvements for traffic flow. As such, improving connectivity may largely be a matter of encouraging more efficient distribution of tourist traffic (via signage and other improvements) and improving traffic flow in high-traffic areas with changes to intersection designs and signal timing.

In summary, the long range transportation plan of the French Broad River Metropolitan Planning Organization consists of three goals. These goals encompass safety, multimodality, and connectivity. Each goal contains a list of objectives and measures of effectiveness to guide the process of infrastructure improvements throughout this metro area. The singular combined goal is that the Asheville Metropolitan Area will have a safe, efficient street network to pedestrians, bicyclists, transit users, and automobiles alike, helping to connect this growing city.

Table 11. Goals, Objectives, and Measures of Effectiveness for Asheville Metropolitan Area

Goals	Objectives	Measures of Effectiveness
Improve Safety	Decrease traffic fatalities and injuries	Rate of fatal crashes
		Rate of crashes with severe injury
	Improve crosswalk and sidewalk infrastructure and ensure ADA compliance	Percent of improved crosswalks
		Percent of survey respondents that rate the safety of the crosswalk as at least a 7 out of 10
Create Multimodality	Create new (or improve existing) pedestrian and bicycle infrastructure	Number of pedestrians and bicycles per hour
		Percent of survey respondents that identify as at least enthused & confident
	Create new (or improve existing) transit infrastructure	Number of transit users per hour
		Transit travel time between TAZs
Improve Connectivity	Optimize travel to and from tourist destinations	Travel time between TAZs frequented by tourists
		Distribution of trips to/from TAZs frequented by tourists
	Improve traffic flow through high traffic intersections	Vehicles per hour vs. roadway capacity
		Hours of vehicle delay

Needs Assessment for the Asheville Metropolitan Area

The Asheville area is expected to grow significantly in the next 30 years. Because of that fact, it is important to determine the future needs of Asheville's transportation network. Using the model and socio-economic data provided, we projected highway assignment for a no-build scenario to pinpoint some of the changes expected leading up to 2050 and to assess where significant issues (such as congestion and delay) may occur without intervention. This information can then be used to inform alternative strategies to encourage changes and address some of the problems brought to light.

Figure 6 is a flow map showing whether a street is over capacity or not. Red and orange represent a street being used above its capacity, while yellow is 50 to 100% capacity, and green is 0 to 50% capacity. Figure 6 is using data from the base year dataset, which is from 2015. The map shows that the area needing the most capacity improvements is the central area of the district, encircling Asheville proper and extending east/west and north/south. Interstates 26 N/S, 40 E/W, and 240 as well as highway US-25 are frequently near, at, or above capacity. Parallel roadways also saw significant amounts of congestion. Due to the geography of the region, a significant amount of traffic is funneled through the city center and along those corridors. These routes serve both as the main local connections within those areas of Asheville and as the main through connection to other towns and cities in and beyond the region.

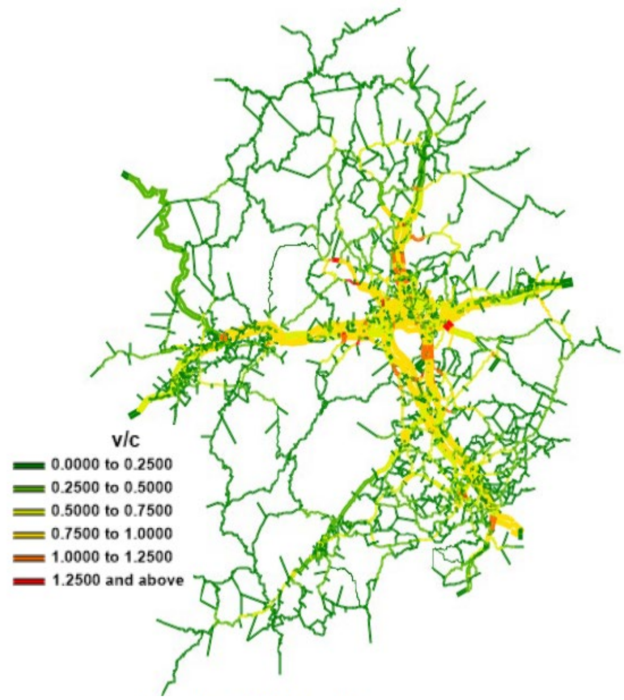

Figure 6. Base Year (2015) Flow Map

Looking ahead to 2050, the problems pinpointed in the 2015 data are exasperated further. A significant amount of the congestion forecast for 2050 was still concentrated on the set of major highways and corridors extending west, east, and southeast from central Asheville. However, as pictured in Figure 7, said corridors saw a near universal increase in congestion, with almost all of them being forecasted to be over capacity in 2050.

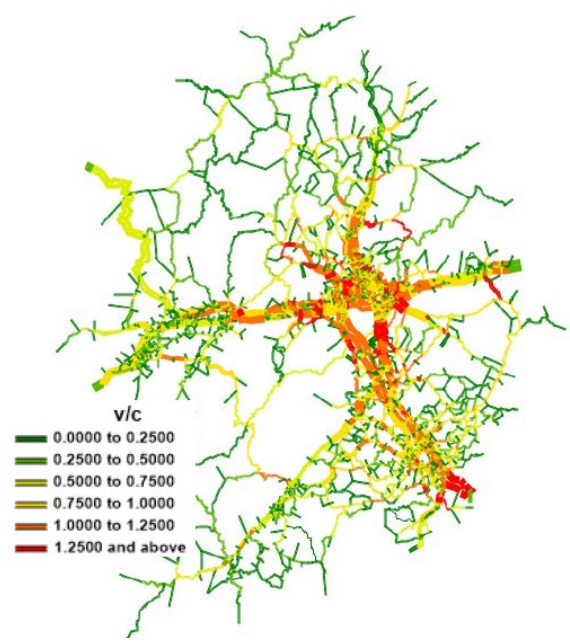

Figure 7. Future Year (2050) Flow Map

In addition, several smaller and local streets are now being used at the higher end of their intended capacity, as seen in Figure 7. As it stands, due to the current roadway network and geographical constraints, most traffic is forced through the city center even if it is going around. It appears the smaller roads with the largest increase in congestion act as some of the only alternative links connecting some of the major corridors extending out from the center besides the central freeway loop, which may be part of the reason for the increase.

Once the data was compared for the base year and future year, there were some key differences. Average speed decreased by almost 50%, delay per mile travel increased over 330%, total delay increased 450%, total flow increased 45%, total VMT increased 40%, and total VHT increased by 170%. This shows that the Asheville metro area will be in high need of quality infrastructure improvements to handle the demand of the next 30 years.

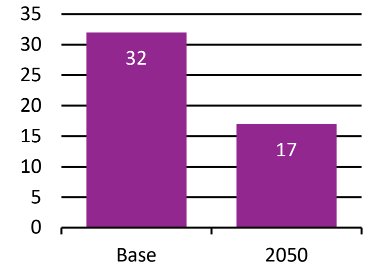

Figure 8. Average Speed

If these projections prove to be accurate, put simply, if Asheville does not make some major infrastructure changes in the next 30 years or find other ways to mitigate traffic, they will be overwhelmed by travel demand. The roadway network as it stands cannot accommodate the level of growth the region is expected to see by 2050 in its current form.

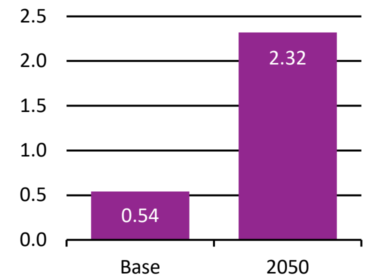

Figure 9. Delay per Mile Traveled

The analysis of the 2050 forecast shows a clear need for additional intervention to mitigate the projected congestion of the no-build scenario. However, the region also faces a couple of additional constraints that make the type of interventions that are common in other similar-sized cities (such as additional beltways) difficult.

Asheville, as well as many of the surrounding towns in the region, essentially lie within a mountain pass. Many of the most congested corridors follow the development-filled valleys between these mountainous areas. As such, a significant amount of the population is concentrated along these corridors, and due to the topography, it is difficult to build alternate routes or beltways. In addition, many of the slightly flatter areas immediately south of Asheville along the French Broad River are natural areas that the town and region would want to preserve. While only the area immediately surrounding the Blue Ridge Parkway is officially protected, a significant amount of regional tourism and identity comes from the area's natural spaces and forests, and construction of roadways through those mostly untouched areas would likely be met with sharp opposition.

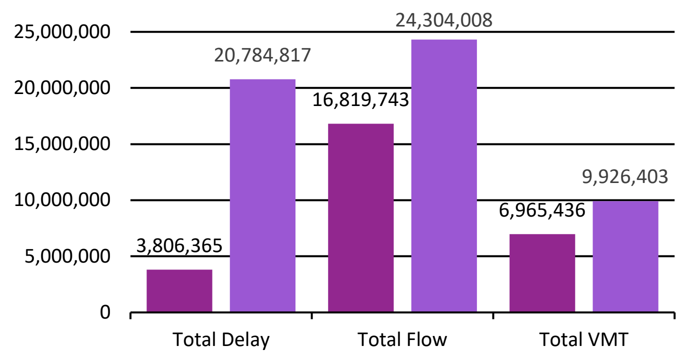

Figure 10. Total Delay, Flow, and VMT

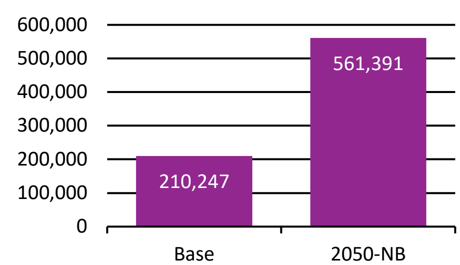

Figure 11. Total VHT

A successful approach to addressing these needs would have to keep these considerations in mind. FBRMPO may find it helpful to reference other mountainous cities and how they have dealt with or are dealing with similar issues of congestion in geographically constrained environments.

Alternate Scenarios for Asheville Metropolitan Area

In our previous memo, we analyzed the 2050 no-build scenario traffic projection for the Asheville MPO and found that the network as it stands would not be equipped to handle the increase in trips that Asheville is expected to see in the coming two decades. Most of the network was forecasted to be substantially over capacity without additional mitigation strategies. Herein, we propose a series of alternative scenarios for relieving some of the forecasted congestion, and analyze their impact on average speed, delay, and vehicle-to-capacity ratios across the network.

For the highway and land use scenarios, we focused on southern Asheville and points south along US-25 towards Fletcher and the airport, since the spot seemed to see some of the most congestion with the least alternative routes. Our changes to the transit scenario were more systemwide due to being fare and frequency changes rather than routing alternatives.

Highway Scenario

Examining the future year 2050 highway flow map, we observed that the corridor to Asheville's south, with US-25 (Hendersonville Road) and US-25A (Sweeten Creek Road) was consistently a problem area, at or above capacity in the no-build. This may be due to the lack of alternative north-south through routes along the corridor, despite significant development around the area.

As a potential lower-cost highway solution, we tested connecting smaller roads along the western side of US-25 (including Stuyvesant Road and Old Shoals Road) into one longer minor arterial to provide an additional north-south route parallel to US-25 between Airport Road and Biltmore Village. This included improvements to the existing roads. Since it did go largely through residential neighborhoods, the new roadway was assumed to remain undivided and one lane each direction to minimize impact, but with a small classification and capacity upgrade to minor arterial and an increased speed limit of 40.

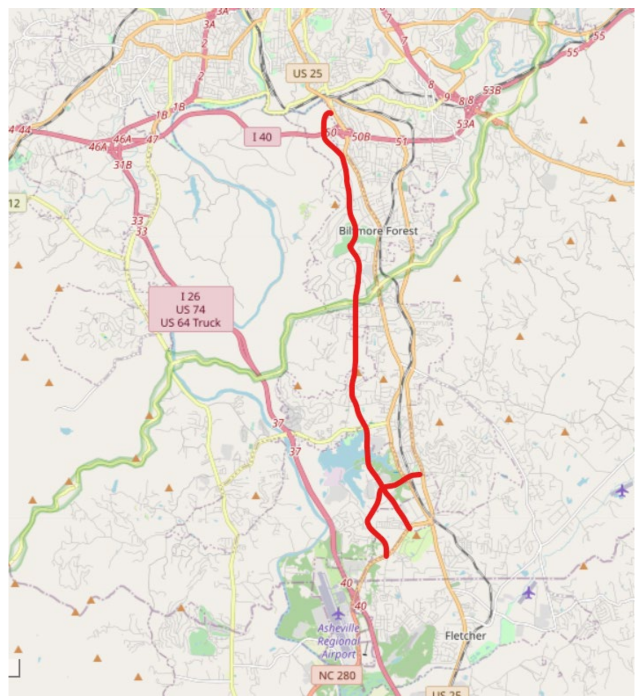

Figure 12. Roadways Edited as Part of Highway Scenario

A small additional set of connections and improvements were made just south of Lake Julian on Haygood Street, to improve connections from the new arterial to Asheville Regional Airport and back to US-25 and US-25A for continuation south to Fletcher (The location of Lutheridge Camp and Conference Center prevented the continuation of the new roadway into Fletcher).

Upon doing highway assignment, the new roadway did help relieve congestion on US-25 and US-25A consistently, though by fairly small amounts. It siphoned off a small amount of traffic from those travelling north-south through the residential neighborhoods west of US 25. A few adjacent side roads also saw improvements. However, significant stretches both of US-25 and the newly created road remained at 100%-150% capacity, with the worst problem points between Biltmore Forest and just

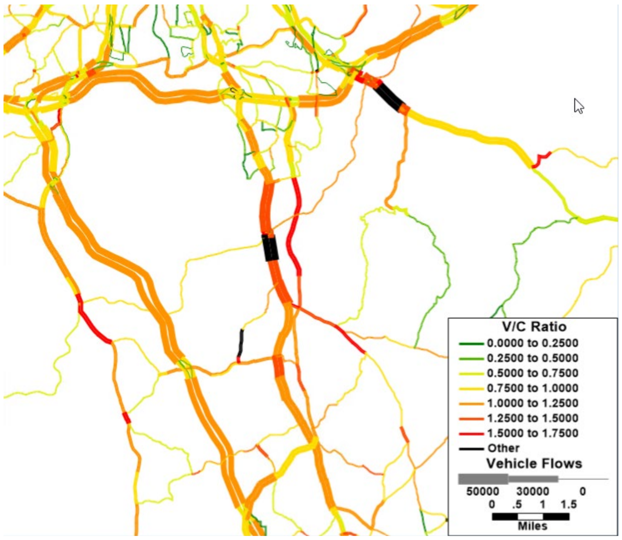

Figure 13. No-Build 2050 Highway Capacity Flow Map, zoomed in on US-25 and US-25A

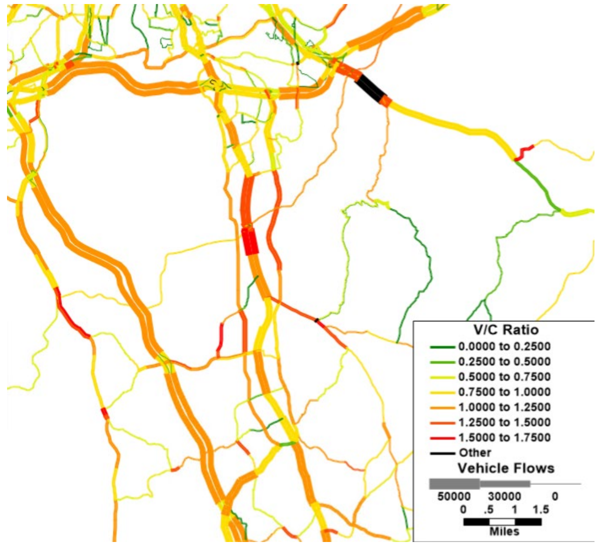

Figure 14. Highway Scenario 2050 Highway Capacity Flow Map with added Roadway Connection

south of the Blue Ridge Parkway on US-25/25A and between Overlook Road and Long Shoals Road on the new roadway.

The new roadway also had a small impact across the network. Average speeds increased on interstates, principal arterials, and minor arterials, while delay per miles traveled decreased on all roadway types except local roads. All types saw either improvement or no change, though the change was arguably negligible (1mph improvement in speed, less than half a minute reduction in delay), as shown in Table 12 below.

While the overall reduction in congestion was small, the roadway's success in keeping much of US-25 and 25A at or below capacity compared to the no-build points to the fact that the creation of alternate routes, even if not necessarily major or wide roads in themselves, can help even out traffic flows and assist in managing congestion. Considering Asheville's location and geography, constructing larger arterials may not always be possible for relieving traffic, and ways to better utilize and connect smaller roads may be one of the more realistic ways to provide congestion relief in some areas. Alone, this scenario wouldn't be enough to make a large difference, but paired with other improvements, roadway connections like this one may prove a significant part of Asheville's strategy.

Table 12. Average Speed and Delay per Miles Traveled, No-Build vs Highway Scenario

Average Speed		
	No-Build 2050	**Highway Scenario**
Interstate	20	21
Principal Arterial	15	16
Minor Arterial	15	16
Major Collector	19	19
Minor Collector	20	20
Local	12	12
Delay per Miles Traveled		
	No-Build 2050	**Highway Scenario**
Interstate	1.96	1.85
Principal Arterial	2.78	2.47
Minor Arterial	2.44	2.17
Major Collector	1.68	1.59
Minor Collector	1.53	1.48
Local	3.53	3.53

Transit Scenario

Another scenario was based on changes to transit. While transit routes were not modified, the transit fare was dropped to $0 and the transit wait time was decreased from 15 to 10 minutes. As shown in Figure 16, this change had a large impact on capacity. Compared to the no build scenario (Figure 15), there is much less red and yellow on the map – the majority of it is green, signifying roadways being below capacity. The majority of problems are still seen on the interstates, particularly in the southeast, where US-25 and I-26 split. There was practically no change in that particular area from the no build future year, versus the future year with transit changes.

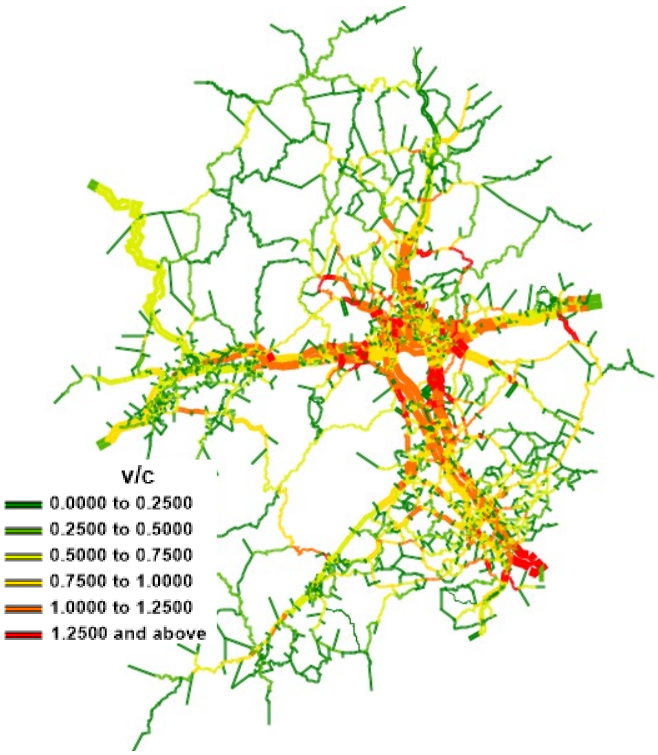

Figure 15. Future Year (2050) No-Build Flow Map

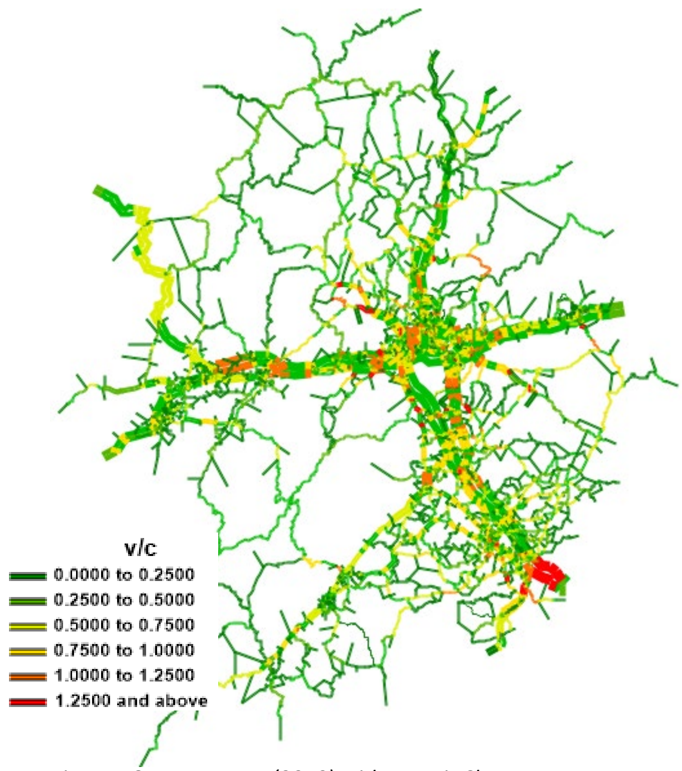

Figure 16. Future Year (2050) with Transit Changes

The transit changes also had a significant positive impact across the network. As shown in Table 13, average speeds increased significantly on every road type, and while impact on delay was smaller, all road types except major collectors saw improvements in delay.

Increased mode choice and environmental goals were both major objectives FBRMPO hopes to accomplish moving forward, which make transit improvements potentially a good option. However, increasing transit mode share can be difficult at times with fares and wait times all being additional "costs" to the user compared to auto mode. The change in transit mode share overall, though positive, was miniscule, as shown in Table 14. However, this scenario shows that eliminating fares and increasing frequency makes a substantial impact on improving average speeds on roadways and relieving congestion for relatively low cost (no additional transit routes or highway construction).

Table 13. Average Speed and Delay per Miles Traveled, No-Build vs Transit Scenario

Average Speed		
	No-Build 2050	**Transit Scenario**
Interstate	20	39
Principal Arterial	15	22
Minor Arterial	15	24
Major Collector	19	27
Minor Collector	20	30
Local	12	25
Delay per Miles Traveled		
	No-Build 2050	**Transit Scenario**
Interstate	1.96	0.64
Principal Arterial	2.78	2.55
Minor Arterial	2.44	2.20
Major Collector	1.68	1.68
Minor Collector	1.53	1.06
Local	3.53	2.19

Table 14. Mode Share, No-Build vs Transit Scenario

Mode Share			
	No-Build 2050	**Transit Scenario**	***Change***
Auto	97.11%	96.97%	-0.14%
Transit	0.73%	0.91%	+0.17%
Walk	2.15%	2.12%	-0.03%

Land Use Scenario

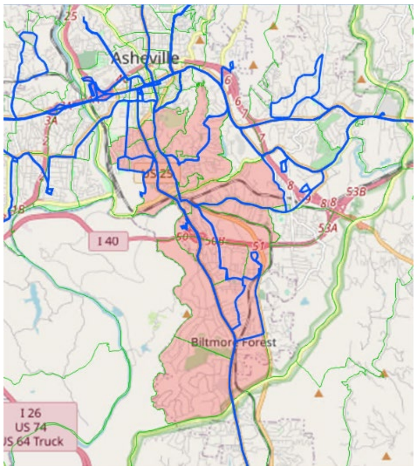

Figure 17. TAZs where Population was Increased (red)

The third and least successful scenario was based on adjusting land uses along the US-25 corridor. Significant parts of the population currently exist in TAZs further away from any transit access in somewhat suburban spawl styed developments. We attempted to adjust this, increasing the population in southeast Asheville between downtown and Biltmore Forest by 10% (primarily with one and two person households and zero and one car households, considering demographic trends and mode choice goals) and taking that population from large suburban multi-car households in TAZs surrounding the US-25 corridor but without access to transit. The hope was that in doing so, more population would live along transit and in the case of zero car households, be more likely to utilize it.

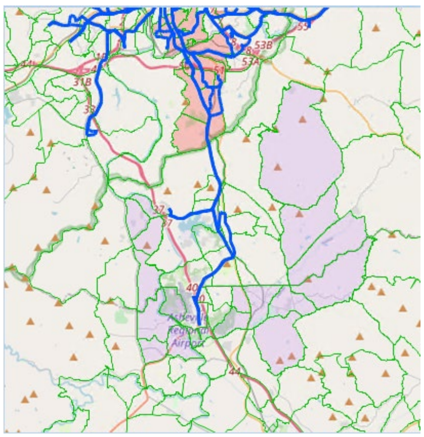

Figure 18. TAZs where Population was Decreased (purple)

In some ways, this was successful. The land use changes scenario saw the largest shift in mode choice to transit (see table 15), even over the transit improvement scenario. Most roadway types also saw a very small decrease in delay per miles travelled.

Unfortunately, this was not without its problems. Overall, there was a small *increase* in vehicle-to-capacity ratio along nearly the entire US-25/US-25A corridor in the land use change scenario compared to the no-build 2050 forecast outside of a few of the most rural roads and some stretches near the airport and Fletcher, as shown in figures 6 and 7. In addition, average speeds were lower than even the no-build scenario on all roads except local roads (see table 16).

Two main possible reasons for the comparative flaws of this scenario arise. The most likely reason is that while housing was changed

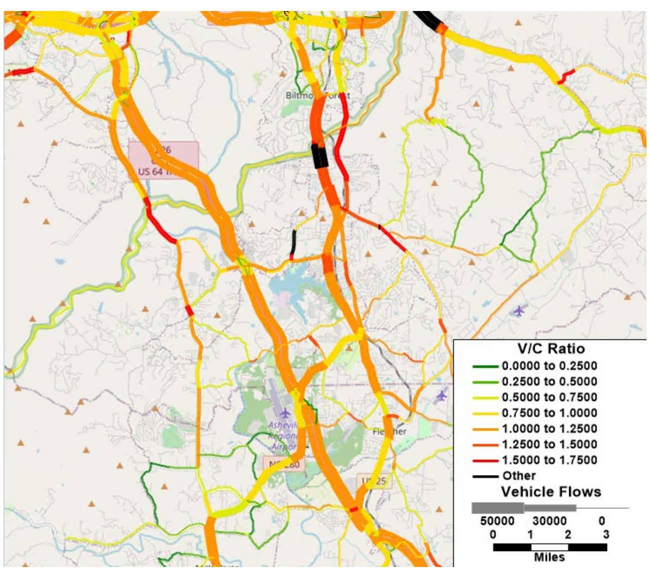

Figure 19. No-Build 2050 Highway Capacity Flow Map, Zoomed in on US-25 and US-25A

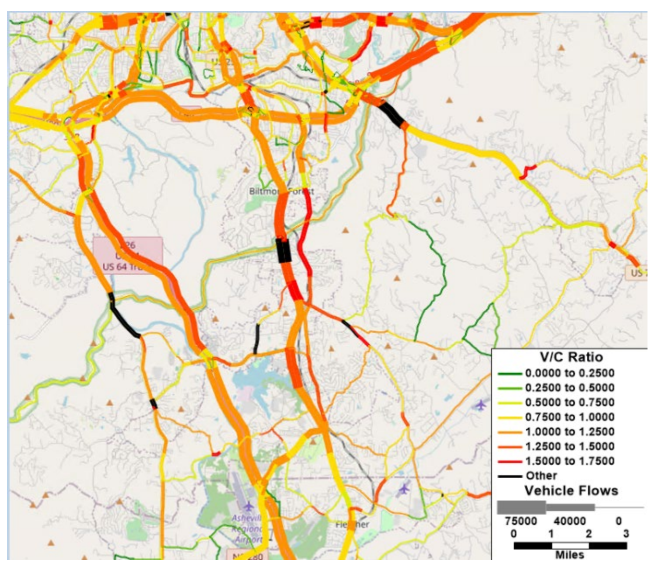

Figure 20. Land Use Scenario 2050 Highway Capacity Flow Map

to be closer into the city center, employment was not adjusted likewise. This may have caused an issue where people still had to travel long distances from their residences to places of employment (potentially suburban job centers), putting more people on the road for longer distances and pushing the roadways further over capacity.

The other potential reason is that while our adjustment to smaller households was meant to represent a more urban-friendly crowd in contrast to typical larger suburban households, our adjustments to the auto ownership data may have not been enough to not lead to more auto ownership per person, due to smaller households that still owned at least one car.

Arguably, the land use change scenario offers a trade-off of increased transit use and reduced delay for significantly lower average speeds and more roadways over capacity. While the MPO and other stakeholders could decide which side of this is more important, the fact that other alternatives like the transit scenario provided similar positive results with fewer consequent issues makes the land use scenario a suboptimal solution.

Table 15. Mode Share, No-Build vs Land Use Scenario

Mode Share			
	No-Build 2050	**Land Use Scenario**	***Change***
Auto	97.11%	96.87%	-0.24%
Transit	0.73%	1.01%	+0.27%
Walk	2.15%	1.84%	-0.31%

Table 16. Average Speed and Delay per Miles Traveled, No-Build vs Land Use Scenario

Average Speed		
	No-Build 2050	**Land Use Scenario**
Interstate	20	17
Principal Arterial	15	13
Minor Arterial	15	13
Major Collector	19	17
Minor Collector	20	18
Local	12	14
Delay per Miles Traveled		
	No-Build 2050	**Land Use Scenario**
Interstate	1.96	1.87
Principal Arterial	2.78	2.62
Minor Arterial	2.44	2.27
Major Collector	1.68	1.57
Minor Collector	1.53	1.43
Local	3.53	3.73

Conclusion

After analyzing these three scenarios, the transit improvement scenario stands as seemingly the best option to move forward with of the set. It made a larger positive impact on delay, vehicle-to-capacity ratio, average speeds and mode choice than the highway scenario, and had significantly less negative side effects than the land use change scenario. It also likely could be enacted at a reasonable cost (outside of lost fare recovery revenue), considering the scenario did not require any new construction and only required a 10-minute wait (20-minute frequency) to make an impact networkwide.

There are some promising aspects of the highway and land-use scenarios that may be able to be considered in addition to or in tandem with the transit scenario, namely the use of small roadway connections to improve traffic flow and keep more roadways under capacity and shifts in density helping encourage mode shift to transit. However, as a whole, said scenarios are likely not the best solutions for Asheville to pursue.

Appendix

Table 17. Scenario Reporting Worksheet

	Base	2050-NB	Scenario 1 (Highway)	Scenario 2 (Transit)	Scenario 3 (Land Use)
Description	2020 SE data on 2020 highway and transit network	2050 SE data on no-build highway and transit	Additional road connection alongside US-25 & US-25A	Fare free, and headway decreased 33% to 20 minutes (wait decreased to 10)	Population shift inward along US-25 corridor closer to transit
Trip Productions					
HBW	345,576	492,091	492,091	492,091	490,814
HBO	916,055	1,295,423	1,295,423	1,295,423	1,292,298
HBSC	92,378	129,510	129,510	129,510	128,332
NHB	433,928	613,808	613,808	613,808	612,356
TOTAL	1,787,936	2,530,831	2,530,831	2,530,831	2,523,800
Person Trips					
HBW	345,576	492,091	492,091	492,091	490,814
HBO	916,055	1,295,423	1,295,423	1,295,423	1,292,298
HBSC	92,378	129,510	129,510	129,510	128,332
NHB	433,928	613,808	613,808	613,808	612,356
TOTAL	1,787,936	2,530,831	2,530,831	2,530,831	2,523,800
Trips by Mode					
Auto					
HBW	338,515	482,539	482,539	482,098	480,944
HBO	889,479	1,258,990	1,258,990	1,257,374	1,256,526
HBSC	89,051	124,954	124,954	124,767	124,197
NHB	417,277	591,228	591,228	589,833	589,827
Transit					
HBW	2,121	2,717	2,717	3,283	3,699
HBO	6,485	8,384	8,384	10,395	11,415
HBSC	571	778	778	1,002	1,085
NHB	5,115	6,721	6,721	8,421	9,483
Walk					
HBW	4,939	6,834	6,834	6,710	6,171
HBO	20,091	28,049	28,049	27,653	24,357
HBSC	2,757	3,779	3,779	3,741	3,049
NHB	11,535	15,858	15,858	15,554	13,046
TOTAL	1,787,936	2,530,831	2,530,831	2,530,831	2,523,800

	Base	2050-NB	Scenario 1 (Highway)	Scenario 2 (Transit)	Scenario 3 (Land Use)
Total Delay					
Interstate	1,423,206	7,363,001	6,924,778	7,889,090	7,363,001
Principal Arterial	1,026,477	5,757,890	5,036,089	3,310,128	5,757,890
Minor Arterial	502,045	2,989,490	2,891,516	1,640,928	2,989,490
Major Collector	423,821	2,536,500	2,380,167	1,632,686	2,536,500
Minor Collector	423,821	2,023,940	1,903,803	544,039	2,023,940
Local	6,995	113,996	114,260	121,578	113,996
Total Flow					
Interstate	4,582,750	5,796,502	5,745,489	2,236,630	6,179,906
Principal Arterial	4,810,484	7,170,073	7,139,333	2,717,349	7,774,815
Minor Arterial	3,018,851	4,410,028	4,602,349	1,792,554	4,838,470
Major Collector	2,191,342	3,678,915	3,651,475	1,541,431	4,059,411
Minor Collector	2,191,342	3,202,014	3,138,542	805,506	3,588,687
Local	24,973	46,478	46,504	177,308	43,965
Total VMT					
Interstate	3,036,715	3,764,649	3,737,885	3,596,575	3,930,100
Principal Arterial	1,374,107	2,074,071	2,035,036	1,298,202	2,196,383
Minor Arterial	806,084	1,227,236	1,332,406	746,663	1,314,467
Major Collector	865,583	1,507,840	1,497,450	972,585	1,614,962
Minor Collector	865,583	1,320,295	1,283,952	512,960	1,412,633
Local	17,362	32,312	32,330	190,555	30,565
Total VHT					
Interstate	77,025	188,870	181,081	141,883	238,090
Principal Arterial	47,559	142,252	129,936	60,174	169,753
Minor Arterial	28,455	80,806	82,385	30,882	102,343
Major Collector	28,353	79,823	76,977	36,357	94,523
Minor Collector	28,353	67,021	64,020	16,927	77,748
Local	502	2,618	2,623	4,848	2,162
Average Speed					
Interstate	39	20	21	39	17
Principal Arterial	29	15	16	22	13
Minor Arterial	28	15	16	24	13
Major Collector	31	19	19	27	17
Minor Collector	31	20	20	30	18
Local	35	12	12	25	14

	Base	2050-NB	Scenario 1 (Highway)	Scenario 2 (Transit)	Scenario 3 (Land Use)
Delay per Miles Traveled					
Interstate	0.47	1.96	1.85	0.64	1.87
Principal Arterial	0.75	2.78	2.47	2.55	2.62
Minor Arterial	0.62	2.44	2.17	2.20	2.27
Major Collector	0.49	1.68	1.59	1.68	1.57
Minor Collector	0.49	1.53	1.48	1.06	1.43
Local	0.40	3.53	3.53	2.19	3.73

Final Recommendations for Asheville Metropolitan Area

Building on our previous memo detailing three different approaches to ensure that Asheville's transportation network will be able to handle projected future growth needs, this memo represents our finalized recommendation to the French Broad River Metropolitan Planning Organization. This memo combines three broad categories – transit, land use, and highways - into a singular recommendation.

Transit

The transit scenario was simple, but effective. The fare was reduced to $0, and wait time was decreased from 15 to 10 minutes. The scenario led to a dramatic improvement in roadway capacity compared to the same network with no changes, as shown in Figure 21. The scenario led to a positive increase in transit mode ride share, but not to a statistically significant amount, despite the strong network flow improvements.

In addition, making the transit network fare free is a necessary step to ensure more equitable access to transportation. Wait time reduction also improves equity by giving passengers 33% more opportunities to catch a bus throughout the day.

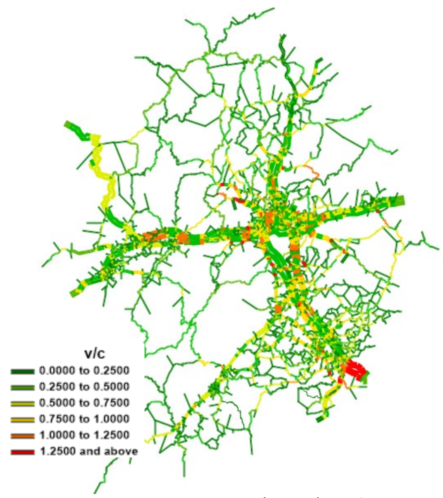

Figure 21. Future Year (2050) with Transit Changes

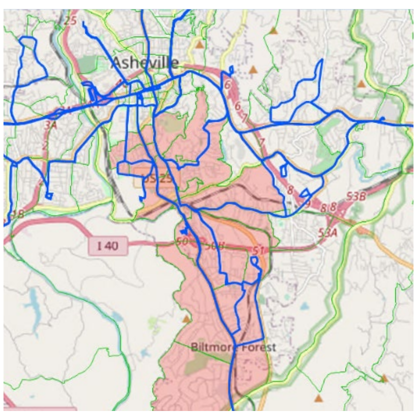

Figure 22. TAZs where Population was Increased (red)

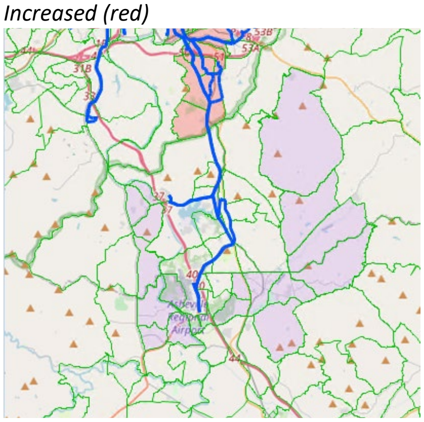

Figure 23. TAZs where Population was Decreased (purple).

Land Use

The land use scenario attempted to densify along major transit lines in southern Asheville, shifting that population from larger suburban households. It also switched out four-car households for zero-car or one-car households in an effort to encourage transit usage. Despite significant issues with worsening overall roadway speed and volume-to-capacity ratios, the land use strategy was successful in encouraging significant mode shift.

FBRMPO would want to analyze the land use strategies and transit improvements in tandem and to weigh them against each other. If the transit strategy can sufficiently improve volume to capacity ratios across the system, it may mitigate or avoid the increase in over-capacity roads and decrease in average speeds that our land use scenario test showed. Considering both strategies individually made small but significant differences in the mode choice, it is possible that when paired together, a larger shift to transit can be achieved, helping further improve delay and speeds on roadways while meeting sustainability goals.

Encouraging additional shifts in employment to match shifts in population would also help address the parts of the strategy that saw the most issues, since shifting population without shifting places of employment seemed to lead to longer trips (as shown by increase in VHT and VMT).

Highway Connections

The highway/street connection scenario attempted to create a third alternative roadway alongside US-25 and US-25A to reduce congestion. The strategy made the smallest impact on things like average speed, delay, and mode choice, while slightly reducing the volume-over-capacity ratio of adjacent roadways. While the effect it did have was positive, the small impact combined with the cost of building new stretches of roadway means it would probably be a minimal part of the strategies FBRMPO would want to enact moving forward.

However, one main reason this strategy is still worth considering in strategic spots is Asheville's unique geography and topography. As a city wedged within a mountain valley, significant amounts of development are clustered in certain areas often with only a few through roadways. The topography makes construction of new boulevards or beltways infeasible, in contrast to other nearby similar sized cities with a lot of land to work with. Connecting smaller collectors into alternate routes makes the most of existing roadways where building new, large arterials or highways would be impractical.

The improvements from the transit strategy may reduce traffic volume enough to make a highway strategy less necessary. However, in areas where roads are still over-capacity or few roadway alternatives exist, connecting smaller roadways to make better use of roads that already partially exist can be a viable strategy for helping siphon off small amounts of traffic from congested arterials or to spread out traffic.

Conclusion

Our final recommendation is a stacked approach prioritizing the three strategies and enacting them in tandem. As outlined in Figure 4, the priority would be the transit strategy, as the option that is projected to make the most difference with a more doable change (frequency improvement and fare elimination). A land use shift strategy that shifts population into urban transit-served households should be a long-term strategy pursued alongside if projections and observations continue to show good projections for roadway capacity, while creating alternate roadways by connecting smaller roads would be used surgically to solve remaining bottlenecks where fully building new arterials is not a reasonable option. Tackling these strategies in this priority order but simultaneously allows for their benefits to build upon each other and their cons to be minimized.

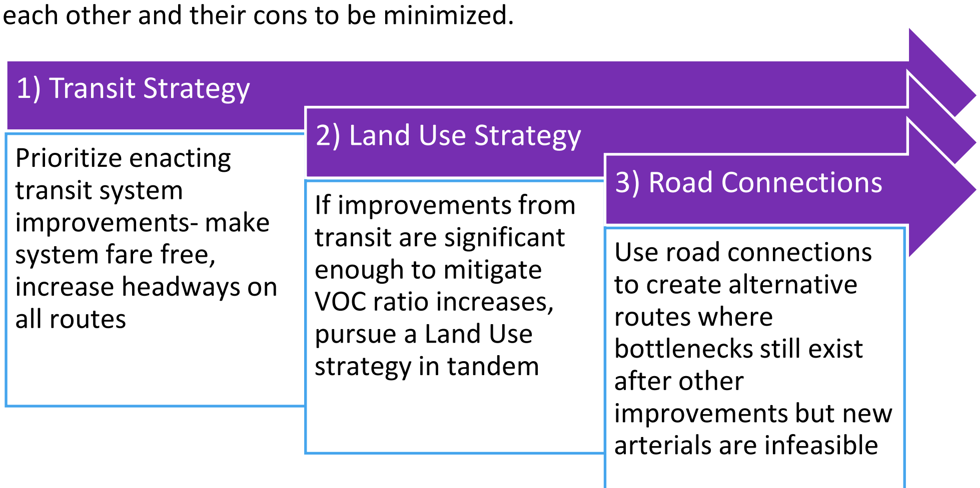

Figure 24. Recommended Strategies in Order of Priority