Appendix E

Scenario Planning Methodology and Results

Introduction

The Churchman's Crossing Plan Update is a comprehensive update to the 1997 Churchman's Crossing Study that will include new recommendations on transportation improvements based on an updated land use plan and forecast, using measures that can better assess the effectiveness of the full transportation system, including roadways, pedestrian and bicycle facilities, and transit facilities.

As part of this study, the project team used scenario planning to explore a variety of potential land use and transportation system options to understand how various combinations would affect transportation system performance in the study area.

Below is a summary of the scenario planning approach and results.

Scenario Planning Approach

Travel Demand Model

The travel demand model used by DelDOT for most planning and project development activities (known colloquially as the "Peninsula model" due to its coverage of much of the Delmarva peninsula) was used to assess primary travel metrics. The scenario planning focused on comparing metrics for the 2050 horizon year, both to allow for consideration of trends extending beyond the 20-year horizon of the Churchman's Crossing study as well as for consistency with the WILMAPCO Regional Transportation Plan (RTP). The Peninsula model covers the full state of Delaware plus counties in Maryland east of Chesapeake Bay. The model was the primary analysis tool for converting transportation and land use inputs to the two primary transportation output metrics of speed/proximity and relative arterial mobility.

The travel demand model has a level of granularity appropriate for scenario planning. The Churchman's Crossing study area is represented by approximately 16 transportation analysis zones (TAZs), which generally, but not precisely, reflect the study area definition. The map depicted in **Figure 1** shows TAZs in the study area and the boundary of Churchman's Crossing. The transportation network includes freeways, arterials, and key collector roadways that provide connectivity between TAZs (although not the local street network that provide access primarily within individual TAZs). For the purposes of assessing relative arterial mobility, the study area was divided into six subareas, generally divided by natural and manmade barriers such as White Clay Creek, I-95, and railroad lines (**Figure 2**).

The transportation and land use components determine travel demand and travel behaviors, such as the number of person trips generated, length of trips, number of person miles of travel and person hours of travel, as well as mode share and total vehicle miles and hours of travel.

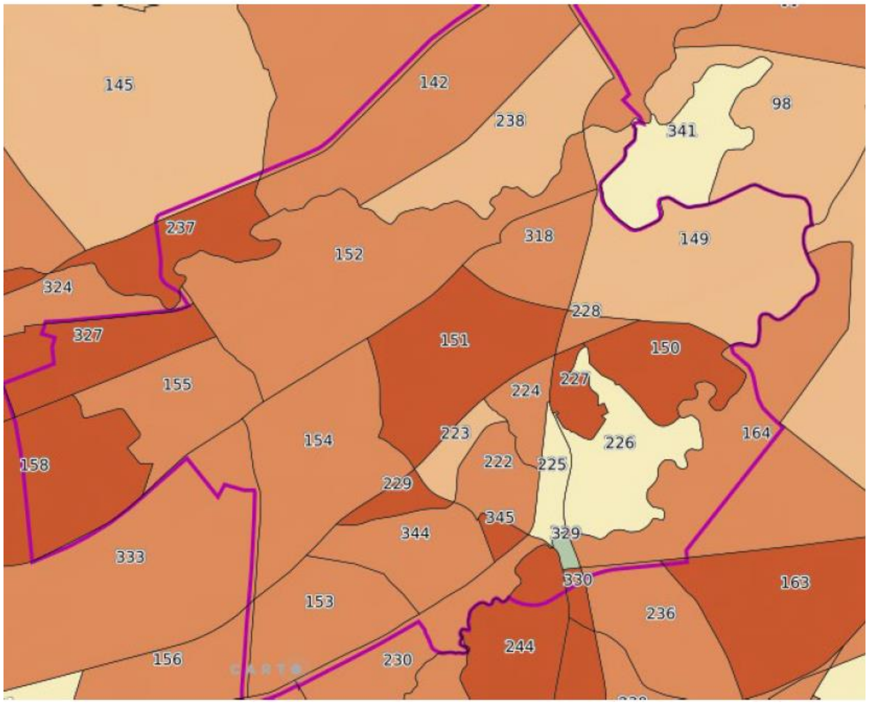


Figure 1. Traffic Analysis Zones in Churchman's Crossing Area

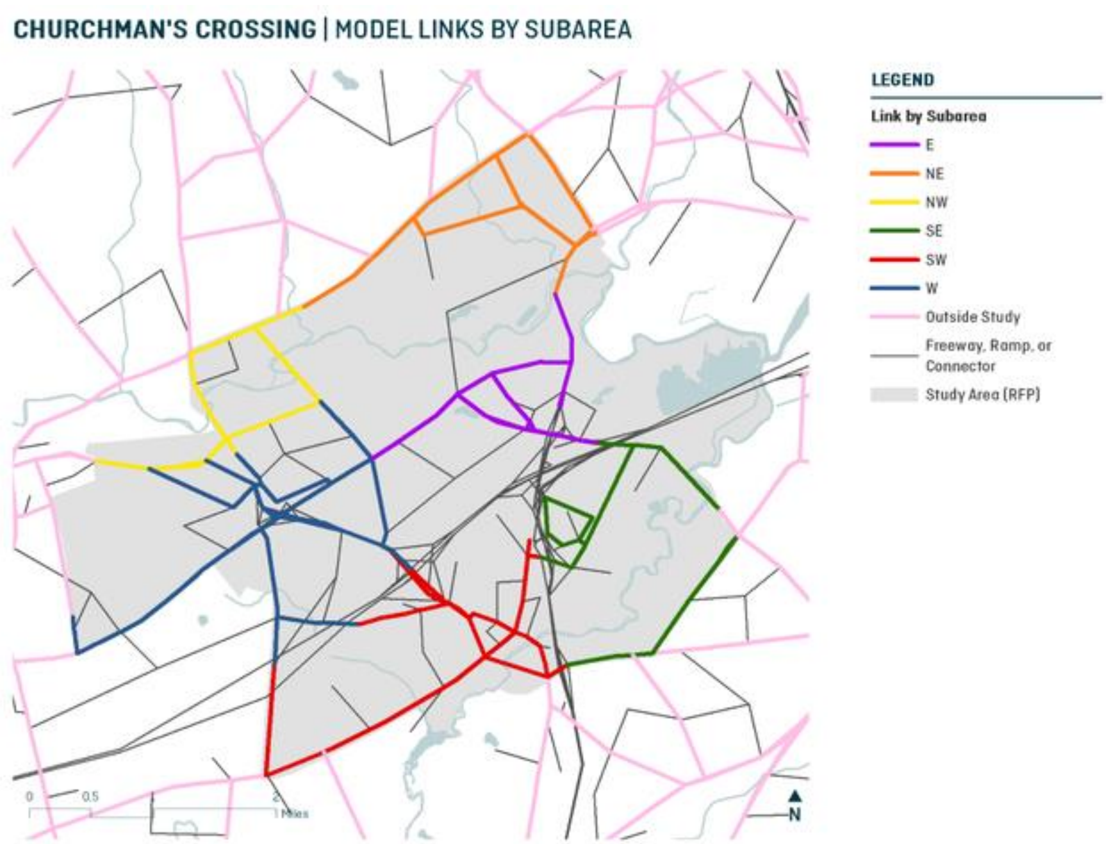


Figure 2. Churchman's Crossing Subarea Peninsula Model Links

"Bookend" Scenarios

The scenarios evaluated were developed and reviewed through a series of project studios conducted on a biweekly basis with staff from the sponsoring agencies (WILMAPCO, DelDOT, and New Castle County Department of Land Use).

The study team identified four bookend scenarios to review transportation system performance. (**Figure 3**). The bookend scenarios are defined by funded and aspirational transportation improvements and expected and balanced land use patterns. The Funded network scenario comprises financially constrained projects in the WILMAPCO 2050 Regional Transportation Plan (RTP) and the Aspirational network scenario consists of unfunded projects in addition to funded RTP projects. The Expected land use scenario constitutes a continuation of existing land use patterns through 2050. The Balanced land use scenario reflects a new pattern of development that incorporates the "3 Ds" of density, diversity, and density to better utilize transportation system investments.

	Transportation	
Land Use	Funded Expected	Aspirational Expected
	Funded Balanced	Aspirational Balanced

Figure 3. Bookend Scenario Nomenclature

These transportation and land use alternatives form four "bookend" scenarios that represent the boundaries of the scenario planning exercise (i.e., Funded network with Expected land use, Aspirational network with Expected land use, Funded network with Balanced land use, and Aspirational network with Balanced land use). The ultimate alternative may lie somewhere in the middle of these options.

The funded transportation network incorporates transportation projects from the fiscally constrained 2050 RTP (**Figure 4**). The funded transportation network includes 18 projects distributed throughout Churchman's Crossing and considers a variety of modes and facility types, bicycle and pedestrian accommodations for improving non-motorized accessibility, and physical road improvements that increase motor vehicle capacity.

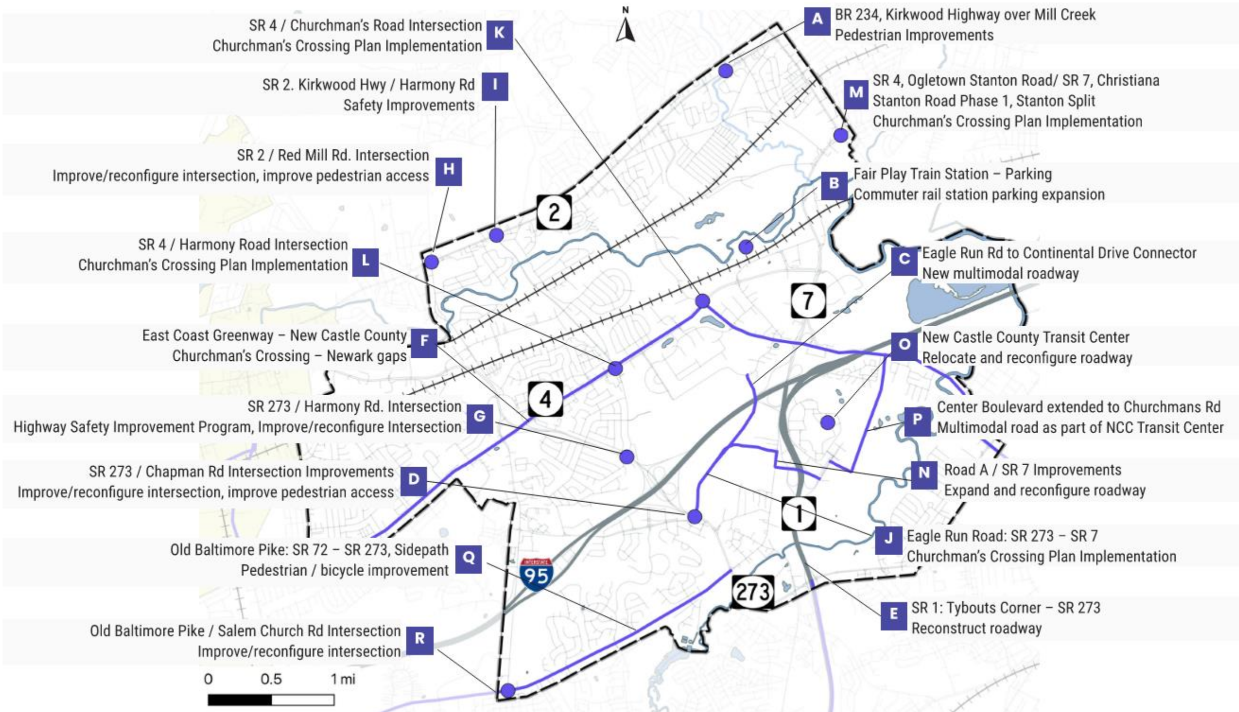


Figure 4. Funded Transportation Projects

The aspirational transportation network was developed by adding selected unfunded transportation projects from the 2050 RTP to the funded transportation network. The selected projects were those that were in the study area and would provide a meaningful change to transportation network capacity (**Figure 5**). The projects for the aspirational transportation network include extending Churchman's Road from SR 4 to SR 2, improving operations along SR 273 from I-95 to SR 1, providing a ramp to Chapman Road from I-95 NB, and widening improvements to I-95. The analysis was performed both with and without I-95 widening, and the differences were found to have effects on I-95 itself, but negligible effects on the arterial system within the Churchman's Study area.

Several additional transportation projects may also be considered during subsequent study phases (**Figure 6**). This additional set of projects also includes a diverse array of improvements, such as interchange, intersection and ramp improvements, existing roadway extensions, transit access roads, and travel demand management projects.

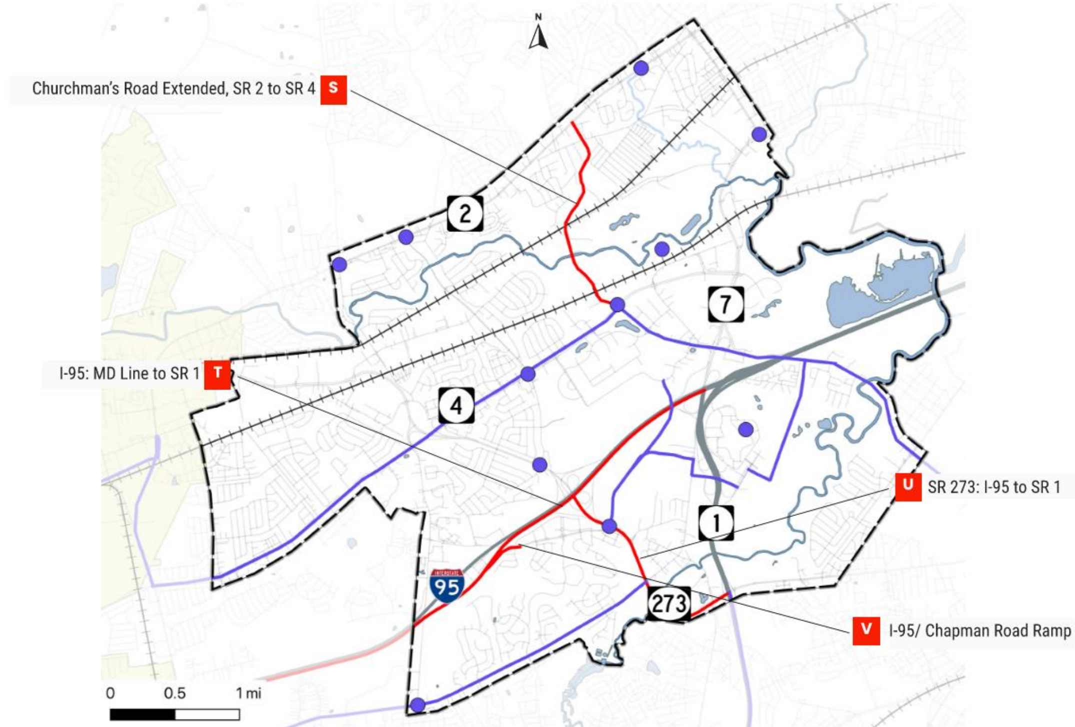


Figure 5. Aspirational Transportation Projects

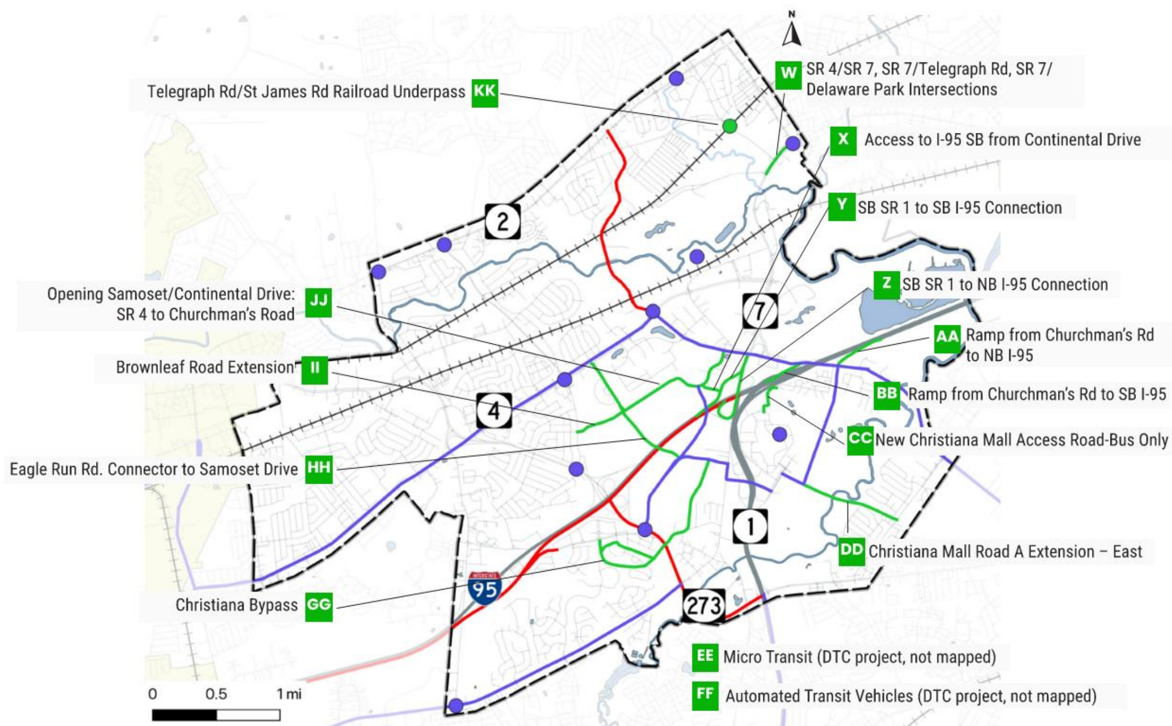


Figure 6. Additional Transportation Projects

Note that many of the projects shown in the transportation system graphics are either too small or too operational in nature to affect overall travel patterns such as trip distribution, mode share, or trip assignment as reflected by the Peninsula Model. The suite of projects included in the Peninsula Model for the Funded network, reflecting major investments throughout the state of Delaware, was selected as a baseline. For the Funded network, the Eagle Run / Continental Drive connector (project C) was added to the network to reflect improved connectivity.

For the Aspirational and Additional Transportation Projects network, explicit modeling of the following elements included:

- Churchman's Road Extended (project S)
- Widening I-95 from the Maryland state line to SR 1 (project T); examined as a sensitivity test and coded as one additional lane in each direction to reflect the general addition of capacity given interchange spacing and the possibility of capacity addition in the form of collector-distributor lanes. The possible interchange at SR 72 was not included in the I-95 widening scenario.
- Widening of SR 273 between I-95 and SR 1 (project U), examined as a sensitivity test to reflect different interpretations of the plan guidance to provide "intersection/road improvements" to improve operations and capacity.
- Relocation of the ramp from NB I-95 at SR 273 to connect to Chapman Road instead (project V), to test the sensitivity of traffic heading from NB I-95 to EB SR 273
- Ramp from Churchman's Road to NB I-95 (project AA)

The Expected land use scenario, defined as the continuation of current trends, is the first of two land use bookends. This scenario, which is also referred to as "business as usual" (BAU), is based on existing growth patterns, and projects that are already in development or expected to occur based on regional econometric studies. The Balanced scenario, which includes the implementation of polies and actions to increase an area's mixture of uses and improve density, diversity, and design, is the second land use bookend.

Figure 7 provides the current, expected, and balanced land use assumptions in Churchman's Crossing, including estimates of population, households, jobs, and activity units per acre by TAZ in the study area with a forecast year of 2050.

TAZ	Acreage	Subarea	Description	2019 Pop	2019 HH	2019 Jos	2019 AU/acre	2050 Expected Pop	2050 Expected HH	2050 Expected Jobs	2050 AU / acre	2050 Balanced Pop	2050 Balanced HH	2050 Balanced Jobs	2050 AU / acre	2050 Delta Pop	2050 Delta HH	2050 Delta Jobs
142	859	NE	Fairplay North	6120	2712	1413	8.8	5917	2421	1324	8.4	5917	2421	1324	8.4	0	0	0
238	567	NE	Fairplay South	226	75	1478	3.0	268	82	1443	3.0	268	82	1443	3.0	0	0	0
318	296	E	Center Pointe	386	66	1811	7.4	334	61	2000	7.9	1963	755	2190	14.1	1629	694	190
149	960	E	DelTech Vicinity	25	11	3357	3.5	24	10	3731	3.9	24	10	3731	3.9	0	0	0
228	53	E	95_7_58 Gore	0	0	362	6.9	0	0	393	7.5	0	0	393	7.5	0	0	0
150	335	SE	Cavaliers Vicinity	2521	1057	232	8.2	4542	1693	271	14.4	4542	1693	271	14.4	0	0	0
227	105	SE	Christiana Mall	0	0	2569	24.6	620	248	2794	32.7	1599	615	2975	43.8	979	367	181
226	432	SE	Fashion Center	0	0	1046	2.4	207	83	1176	3.2	410	158	1252	3.9	203	75	76
225	109	SE	SR 7 - SR 1 Gap N	110	42	2	1.0	153	53	3	1.4	153	53	3	1.4	0	0	0
329	20	SE	SR 7 - SR 1 Gap N	2	0	4	0.3	2	0	10	0.6	2	0	10	0.6	0	0	0
222	200	SE	Christiana Town Center	332	105	1569	9.5	309	92	1711	10.1	309	92	1711	10.1	0	0	0
224	133	SE	Eagle Run East	149	53	122	2.0	569	164	132	5.3	569	164	132	5.3	0	0	0
223	106	SE	Eagle Run West	0	0	464	4.4	0	0	542	5.1	0	0	542	5.1	0	0	0
151	684	E	Christiana Hospital	91	32	12006	17.7	449	143	13626	20.6	5170	1880	14966	29.4	4721	1737	1340
154	749	W	Birchwood Park	4729	1982	1757	8.7	4668	1739	1907	8.8	4668	1739	1907	8.8	0	0	0
229	82	SW	95_273_Chapman Gore	0	0	1163	14.2	0	0	1263	15.4	0	0	1263	15.4	0	0	0
344	363	SW	Norwegian Woods	1533	580	708	6.2	1582	584	768	6.5	1582	584	768	6.5	0	0	0
345	39	SW	Old Christiana	333	123	129	11.9	328	108	139	12.0	328	108	139	12.0	0	0	0
158	868	NW	Ogletown Far West	9284	3610	481	11.3	9115	3247	455	11.0	9115	3247	455	11.0	0	0	0
155	438	NW	Ogletown West	1957	708	507	5.6	1908	632	480	5.4	1908	632	480	5.4	0	0	0
152	1252	NW	Ogletown East	5662	2372	1802	6.0	5602	2212	2457	6.4	13582	5224	2372	12.7	7980	3012	-85
237	359	NW	Sycamore Gardens	3141	1397	506	10.2	3066	1250	479	9.9	3066	1250	479	9.9	0	0	0
	9007		TOTALS	36601	14924	33487	7.8	39663	14822	37104	8.5	55175	20707	38806	10.4	15512	5885	1702
Churchmans Subtotals																		
	2917	NW	Ogletown North	20044	8086	3295	8.0	19691	7341	3871	8.1	27671	10353	3786	10.8	7980	3012	-85
	1427	NE	Fairplay	6345	2787	2891	6.5	6185	2503	2767	6.3	6185	2503	2767	6.3	0	0	0
	749	W	Ogletown South	4729	1982	1757	8.7	4668	1739	1907	8.8	4668	1739	1907	8.8	0	0	0
	1992	E	Center Point	502	110	17536	9.1	807	214	19750	10.3	7157	2645	21280	14.3	6350	2431	1530
	484	SW	Old Christiana Vicinity	1867	703	2000	8.0	1910	692	2170	8.4	1910	692	2170	8.4	0	0	0
	1439	SE	Christiana Mall Vicinity	3114	1256	6009	6.3	6402	2333	6639	9.1	7584	2775	6896	10.1	1182	442	257
	9007		Churchman's Study Area	36601	14924	33487	7.8	39663	14822	37104	8.5	55175	20707	38806	10.4	15512	5885	1702
	277625		Total County	562429	204151	291342	3.1	580554	200768	281217	3.1	596066	206653	282919	3.2	15512	5885	1702
	268618		Remainder of County	525828	189227	257856	2.9	540891	185946	244113	2.9	540891	185946	244113	2.9	0	0	0

Figure 7. Land Use Data by TAZ in Churchman's Crossing

Scenario Planning Metrics

Three primary screening metrics were used to assess the relative performance of the scenarios from the perspective of land use and transportation system effectiveness. These metrics were developed through the bi-weekly project studios with the sponsoring agencies (**Figure 8**).

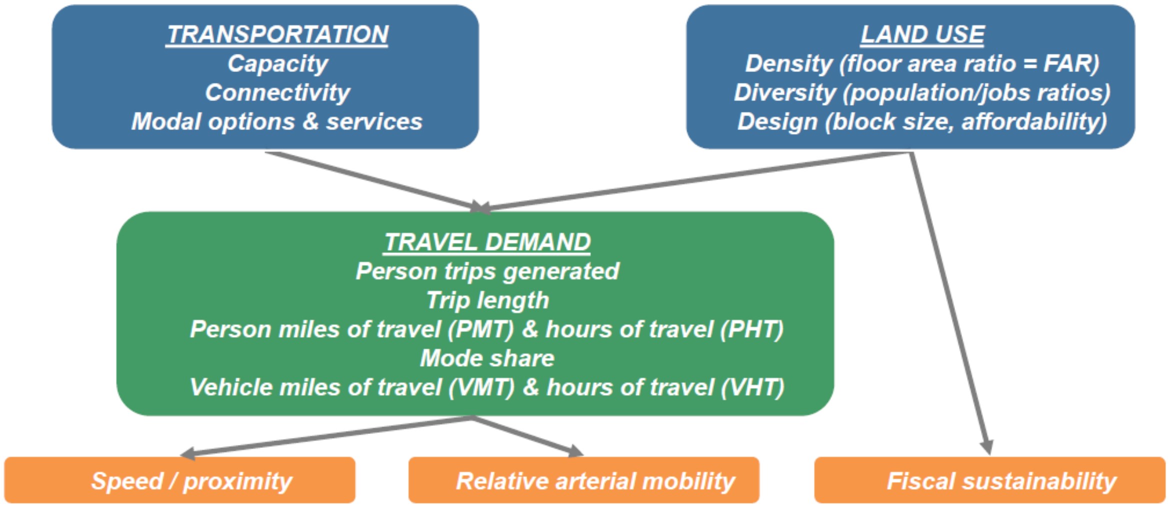


Figure 8. Scenario Screening Metric Flowchart

The three metrics for scenario planning included:

- **Speed/proximity** analysis: an assessment of the level of urbanity based on the degree to which destinations are reached based on proximity. The relationship of speed and proximity shows that places with a variety of nearby destinations associated with greater levels of urbanity are well served by lower travel speeds, while more rural environments (where possible destinations are, by definition, more distant) require higher speeds (**Figure 9**). This is a result of the fact that all travelers have fixed travel time budgets (a certain number of hours for each day's activities) and that completing trips within that travel time budget is a more important metric than simply the number of miles traveled.

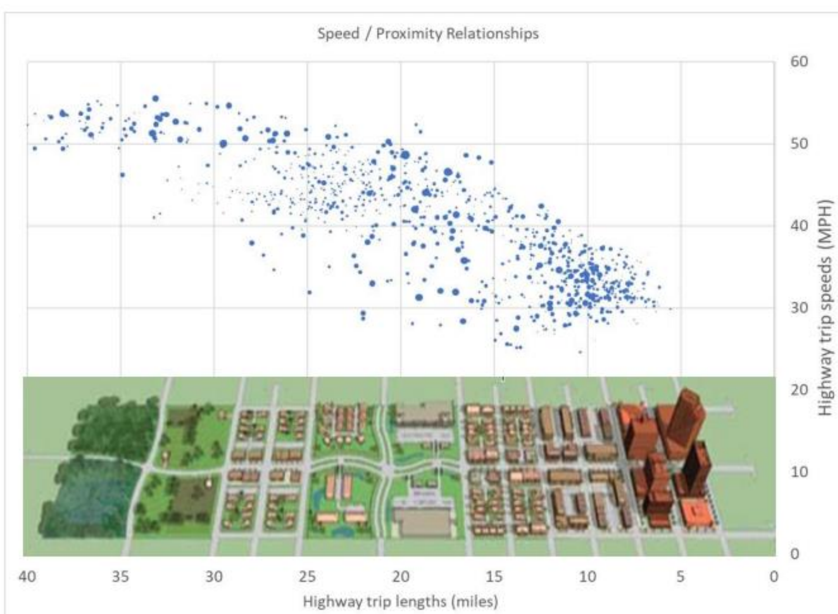


Figure 9. Speed and Proximity Relationship

- **Relative arterial mobility**: an assessment of travel times across the study area arterial network at peak commuter periods as compared to free-flow conditions. This screening metric is the ratio of peak travel speeds to free-flow speeds, which are based on relationships for urban arterial roadway Level of Service (LOS) defined by the Highway Capacity Manual (HCM) (**Figure 10**). For example, given an urban street that has a free-flow speed of 45 mi/h, segments with an average speed that exceeds 18 mi/h are LOS D or better.

LOS	Travel Speed Threshold by Base Free-Flow Speed (mi/h) 55	50	45	40	35	30	25	Volume-to-Capacity Ratio[a]
A	>44	>40	>36	>32	>28	>24	>20	≤ 1.0
B	>37	>34	>30	>27	>23	>20	>17	
C	>28	>25	>23	>20	>18	>15	>13	
D	>22	>20	>18	>16	>14	>12	>10	
E	>17	>15	>14	>12	>11	>9	>8	
F	≤17	≤15	≤14	≤12	≤11	≤9	≤8	
F	Any							> 1.0

Note: [a] Volume-to-capacity ratio of through movement at downstream boundary intersection.

Figure 10. HCM Level of Service (LOS) Travel Speed Threshold

An analysis of existing mobility in Churchman's Crossing shows that speeds are slightly higher in the morning peak period (AM) than afternoon peak period (PM), that congestion is evenly distributed throughout the study area, and that the arterial network performs at LOS C or D during the AM period and LOS D during the PM period (**Figure 11**).

2019 Relative Arterial Mobility Analysis

Area	VMT AM	VMT PM	Estimated MPH AM	Estimated MPH PM	MPH @ Freeflow	AM / Freeflow	PM / Freeflow	AM Arterial LOS	PM Arterial LOS
W	38,900	42,400	24.8	21.7	43.7	0.57	0.50	C	D
SW	27,600	28,000	21.3	19.1	44.5	0.48	0.43	D	D
SE	13,600	15,200	25.8	20.0	48.0	0.54	0.42	D	D
NW	22,100	24,100	24.0	19.8	44.3	0.54	0.45	D	D
NE	43,100	47,100	25.8	21.3	45.8	0.56	0.47	C	D
E	28,200	32,400	26.8	22.1	45.3	0.59	0.49	C	D

Figure 11. Existing Relative Arterial Mobility

- **Fiscal sustainability**: an assessment of the degree to which tax revenue is associated with future development. Fiscal sustainability, which is strongly associated with land use and development, considers the costs and benefits of the outcomes of future scenarios as well as the potential return on investment brought by "higher and better" land uses that generate additional tax revenue while also increasing the costs of public services. Fiscal sustainability also must consider the capital, operations, and maintenance costs of transportation elements.

Scenario Planning Results

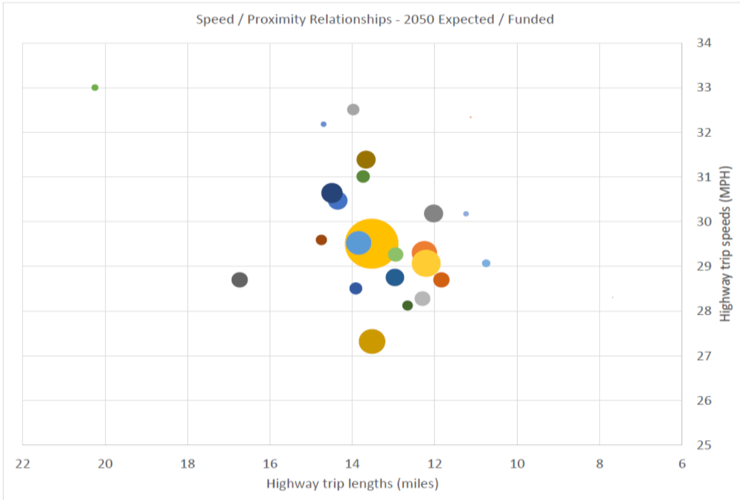
Speed / Proximity

Results of the speed / proximity analysis are presented graphically in **Figure 12** and summarized in **Table 1**. In **Figure 12**, each bubble represents a single TAZ in Churchman's Crossing and the size of the bubbles are relative to the activity units (AU, population plus jobs) in each TAZ. **Figure 12 (a)** shows the baseline Expected / Funded scenario. In **Figure 12 (b)**, under the Expected / Aspirational scenario, the average speeds generally increase, or the TAZ bubbles generally move up, as capacity increases due to additional aspirational transportation projects. Comparing **Figure 12 (c)** to **Figure 12 (a)**, the Balanced land use forecast generally results in shorter trips, which is shown by the TAZ bubbles shifting slightly to the right.

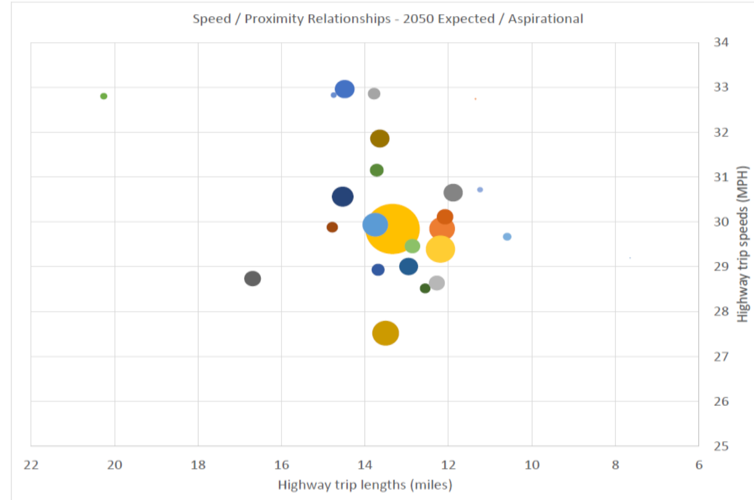
Figure 12 (d) shows the average speed / proximity relationship for all TAZs in Churchman's Crossing, which is also summarized in **Table 1.** The results indicate that the changes to both transportation (additional Aspirational projects) and land use (increased density, diversity, and design in the Balanced land use forecast) improve the speed / proximity metrics by increasing speeds and reducing trip lengths. New transportation system capacity increases speed, as expected. However, new roadway connections also improve connectivity for local TAZs so that trips in the Expected land use scenario have shorter paths in the Aspirational network, thereby offsetting the tendency for transportation capacity changes to induce longer trip lengths.

Table 1. Speed / Proximity of Transportation and Land Use Bookend Scenarios

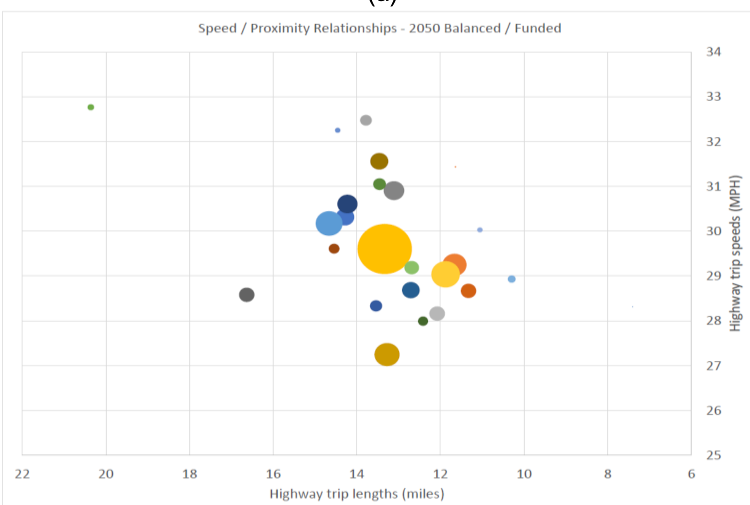
Scenario	Average Length (miles)	Average Speed (mph)
Expected / Aspirational	13.31	29.85
Expected / Funded	13.39	29.43
Balanced / Funded	13.26	29.53



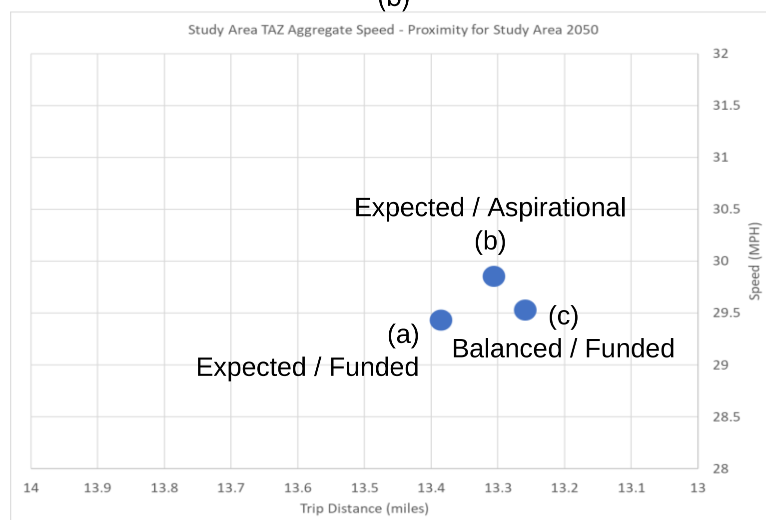
(a)



(b)



(c)



(d)

Figures (a) – (c) show the average speed and average trip length for each TAZ in Churchman's Crossing under Existing / Funded (a),Existing / Aspirational (b), and Balanced / Funded (c) scenarios. Bubble size for each TAZ is relative to the number of activity units (population plus jobs) in each TAZ.
Figure (d) shows the aggregate average speed and average trip length for all TAZs under each scenario.

Figure 12. Speed / Proximity Comparisons for Transportation and Land Use Bookend Scenarios

Relative Arterial Mobility

Results of the relative arterial mobility analysis are presented in **Figure 13** and **Figure 14**. **Figure 13** summarizes the Peninsula model outputs for vehicle miles traveled (VMT) and speeds in miles per hour (mph) by subarea (shown in **Figure 2**). The speeds provided in **Figure 13** were calibrated based on the 2019 Peninsula model run and the observed speeds in the Churchman's Crossing area from the National Performance Management Research Data Set (NPMRDS) travel-time information. **Figure 14** summarizes the ratio of peak travel speeds from the Peninsula model analysis shown in **Figure 13** to uncongested free-flow speeds and the corresponding arterial LOS for each subarea as defined by the HCM (see **Figure 10**).

AM Peak

	VMT			
	Funded		Aspirational	
Area	Expected	Balanced	Expected	Balanced
W	48,900	50,000	46,500	47,500
SW	28,900	29,500	34,000	35,600
SE	15,400	15,400	15,000	15,600
NW	24,300	24,600	21,800	22,300
NE	47,900	48,800	55,700	57,300
E	35,300	38,500	38,600	41,700
Subtotal	200,700	206,800	211,600	220,000

	Speed (MPH)			
	Funded		Aspirational	
Area	Expected	Balanced	Expected	Balanced
W	22.1	21.5	23.3	22.6
SW	20.3	19.9	20.6	20.6
SE	24.1	23.9	24.8	25.0
NW	21.7	21.1	24.3	24.0
NE	20.9	20.0	23.4	22.6
E	23.2	22.6	28.6	27.8
Subtotal	21.8	21.2	24.1	23.6

PM Peak

VMT			
Funded		Aspirational	
Expected	Balanced	Expected	Balanced
55,200	56,100	51,500	53,900
31,200	31,900	37,800	40,300
17,800	18,300	17,100	18,200
26,500	27,100	23,400	23,400
55,100	55,600	65,200	67,600
42,400	45,200	44,500	47,600
228,200	234,200	239,500	251,000

Speed (MPH)			
Funded		Aspirational	
Expected	Balanced	Expected	Balanced
18.8	18.4	20.0	19.2
18.3	18.2	19.7	19.4
18.9	18.4	19.6	20.0
16.6	16.4	20.0	20.0
16.2	15.7	19.0	18.6
18.6	17.9	23.5	23.1
17.8	17.4	20.3	20.0

Figure 13. Relative Arterial Mobility of Transportation and Land Use Bookend Scenarios

Results of the Peninsula Model indicate that balanced growth increases VMT by about 3% and reduces speeds by about 0.5 MPH. Likewise, the Aspirational network scenario adds roadway capacity that results in an increase of area VMT by about 1% and increases by speeds by about 1 to 2 MPH (**Figure 13**).

All scenarios have Relative Arterial Mobility LOS of D during the AM peak period and a mix of LOS D and LOS E during the PM peak period. The Aspirational network scenario performs slightly better from the perspective of Relative Arterial Mobility LOS (**Figure 14**). However, the results of running the Aspirational network scenario in the Peninsula model indicate that widening I-95 will have negligible impact on overall arterial mobility.

AM Peak

Area	Congested/Freeflow Speed Ratio			
	Funded		Aspirational	
	Expected	Balanced	Expected	Balanced
W	0.51	0.49	0.53	0.52
SW	0.42	0.42	0.39	0.39
SE	0.51	0.50	0.52	0.53
NW	0.49	0.48	0.55	0.54
NE	0.46	0.44	0.48	0.46
E	0.49	0.48	0.55	0.53
Subtotal	0.48	0.46	0.50	0.49

Area	Arterial Mobility LOS			
	Funded		Aspirational	
	Expected	Balanced	Expected	Balanced
W	D	D	D	D
SW	D	D	E	E
SE	D	D	D	D
NW	D	D	D	D
NE	D	D	D	D
E	D	D	C	D

PM Peak

Area	Congested/Freeflow Speed Ratio			
	Funded		Aspirational	
	Expected	Balanced	Expected	Balanced
W	0.43	0.42	0.46	0.44
SW	0.38	0.38	0.37	0.37
SE	0.40	0.39	0.41	0.42
NW	0.38	0.37	0.45	0.45
NE	0.35	0.34	0.39	0.38
E	0.40	0.38	0.45	0.44
Subtotal	0.39	0.38	0.42	0.41

Area	Arterial Mobility LOS			
	Funded		Aspirational	
	Expected	Balanced	Expected	Balanced
W	D	D	D	D
SW	E	E	E	E
SE	E	E	D	D
NW	E	E	D	D
NE	E	E	E	E
E	E	E	D	D

Figure 14. Congested / Free-flow Speed Ratio and Arterial Mobility LOS

To achieve a goal of LOS D in all subareas, there would need to be a reduction of approximately 10,000 VMT per peak period with the combined Aspirational network and Balanced land use scenario. This reduction of VMT relates to about 2% of overall area VMT. This goal can be achieved by increasing capacity, reducing trips, and reducing trip lengths.

Fiscal Sustainability

It is important to be aware of the fiscal considerations of both land use and transportation and making sure Churchman's Crossing remains fiscally sustainable. One of the ways this can be accomplished is by encouraging higher and better land uses that consider the fiscal return on investment which have benefits for private property owners in terms of higher returns on investment and the public sector in terms of property taxes that can be used for funding transportation and other services for people living and working there. Therefore, while considering implementation mechanisms for these scenarios, it is important to consider both capital costs of transportation projects as well as how land use can help fund operating costs (**Figure 15**).

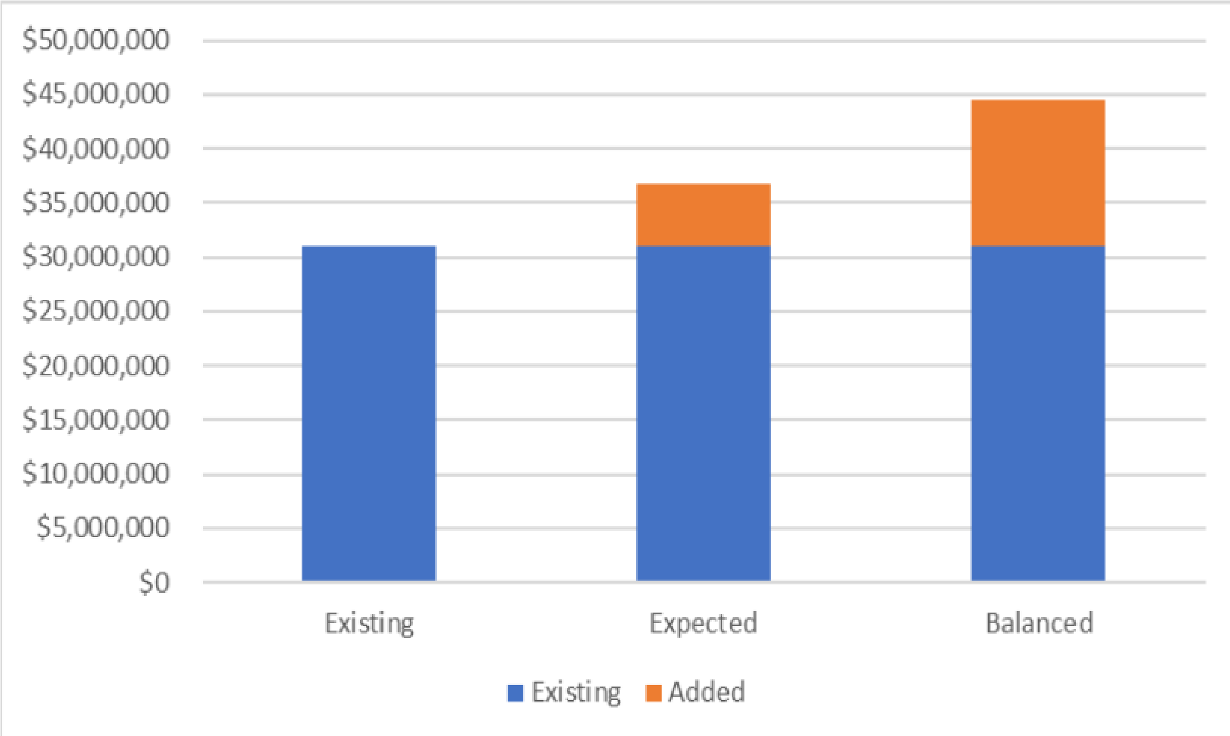


Figure 15. Estimated Property Tax Yields from Land Use Development

Sensitivity Analysis

An additional sensitivity analysis was conducted for the vicinity of Christiana Hospital. This location was selected for its developable opportunities between the hospital and I-95. The results of these analyses highlight the importance of the three performance measures discussed above: the relationship of speed and proximity with regards to accessibility, area-wide relative arterial mobility, and fiscal sustainability as it pertains to the costs and benefits associated with future developments.

The Christiana Hospital Vicinity (TAZ 151) in Churchman's Crossing shows strong potential to balance land use in the study area by increasing the number of households and improving its existing density, diversity, and design. An aerial view of Christiana Hospital and the surrounding area is shown in **Figure 16**.

Figure 16. Aerial View of Christiana Hospital Vicinity (TAZ 151)

Design, diversity, and design, also known as the "3Ds", are critical components for balanced growth, allowing for a greater range of development opportunities beyond categorical bookend scenarios. Because the Balanced scenario includes an increase in both jobs and housing in the Hospital Vicinity it increases the total number of peak hour vehicle trips. However, changes to "3D" elements can substantially reduce vehicle trip generation, including each of the elements described in the bullet list below:

- Changing the urban form to be a grid of walkable streets rather than a central large building surrounded by parking areas
- Refining the balance of jobs and housing so that all growth in the TAZ is residential rather than a mix of commercial and residential
- Reducing the average number of vehicles per household from the countywide average of 1.5 to a localized average of 1.0, which can be achieved by policies such as unbundling parking from housing costs

To provide some context for the degree to which the Balanced land use scenario and the sensitivity tests might result in a different sense of place, the study team evaluated density, diversity, and design for several similar sites in the Philadelphia region that had similar accessibility to the regional core via a relatively exurban location on the SEPTA commuter rail system and a set of relatively similar demographics (focused on the western side of the region). The following aerial images depict different places with a range of land use types, development intensity and street connectivity. Each place is located, like Churchman's Crossing, on the southwestern side of metropolitan Philadelphia more than 20 miles from the downtown core, with access to a train station situated on a SEPTA line. Given that the Churchman's Crossing offers a similar regional accessibility with the Fairplay train station, these locations are appropriate for comparison with the study area.

The first location is Downingtown, a residential village center that primarily serves as a bedroom community for Philadelphia. Activity density in Downingtown is 10 activity units per acre (AU/acre) and the jobs to housing ratio is 1.1 jobs per household (J/HH) (**Figure 17**). Compared to Downingtown, Churchman's Crossing has higher activity density and is a more significant jobs center.

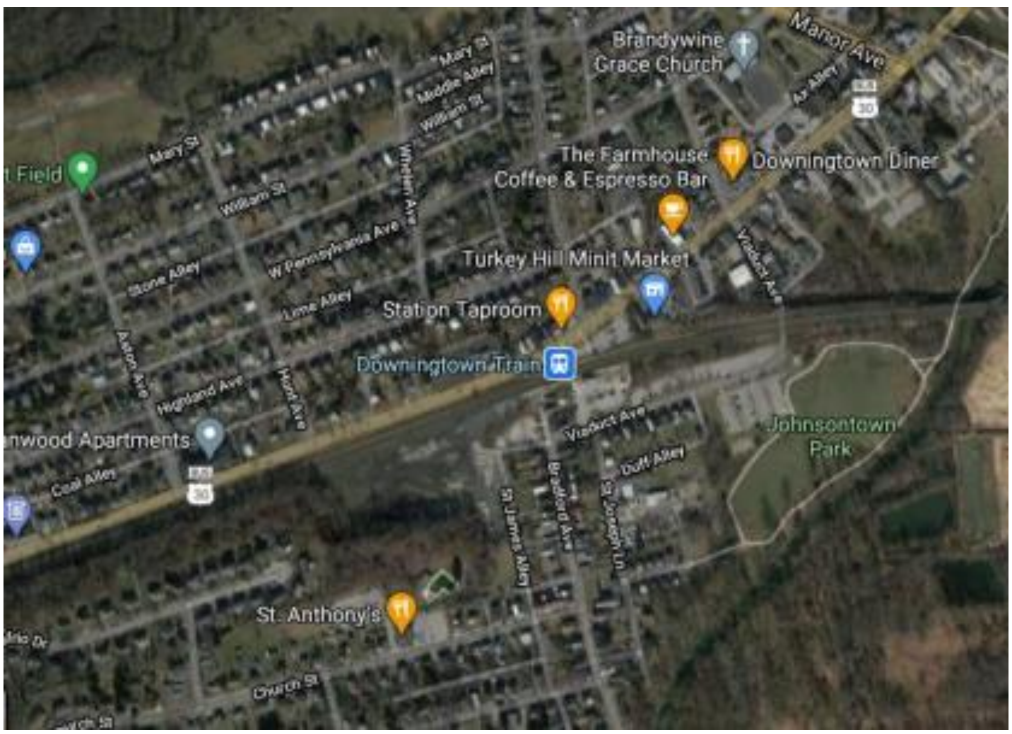


Figure 17. Downingtown, Pennsylvania – Village Center

The second location is Media, Pennsylvania, an urban town center that has high activity density, a robust street grid network, and a diverse mix of land uses. Activity density in the area around the downtown trolley in Media is 80 AU/acre with a jobs to housing ratio of 20 J/HH. Activity density and jobs to housing ratio in the area around the SEPTA station in Media is approximately 10 AU/acre and 0.6 J/HH (**Figure 18**). Compared to Media, Churchman's Crossing has much lower activity density and a higher jobs to housing balance due to the current lack of residential development. While this scenario is not under consideration for Churchman's Crossing, it represents one end of the scale of commuter-rail oriented development.

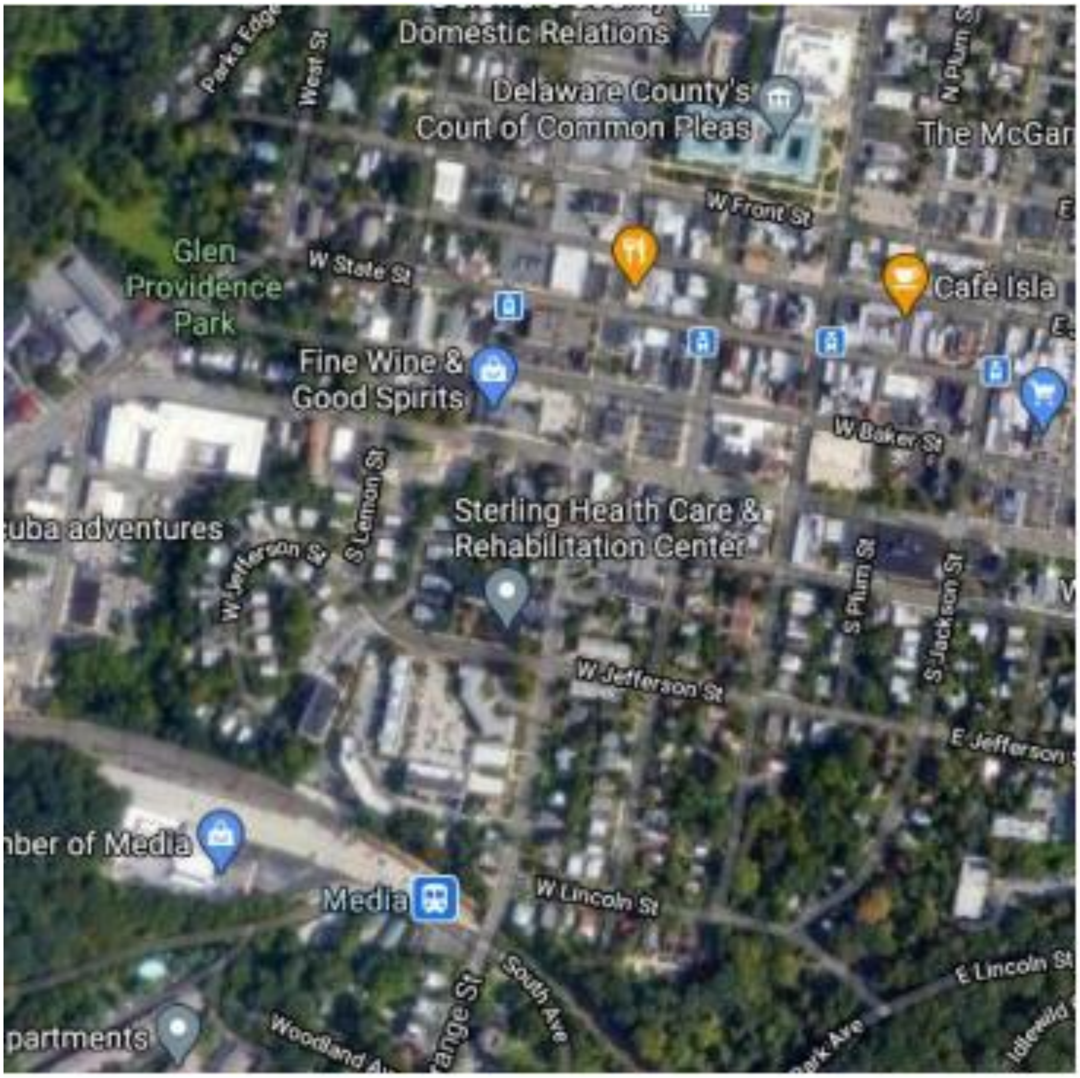


Figure 18. Media, Pennsylvania – Urban Town Center

The third location is in the King of Prussia area, specifically the Hughes Park neighborhood adjacent to the SEPTA station. The location is like Churchman's Crossing since both are suburban areas with a strong potential for suburban commercial retrofit. Moreover, both are primarily jobs areas that have grown up around pockets of residential neighborhoods. The activity density in Hughes Park is 10 AU/acre and its jobs to house ratio is 10 J/HH (**Figure 19**).

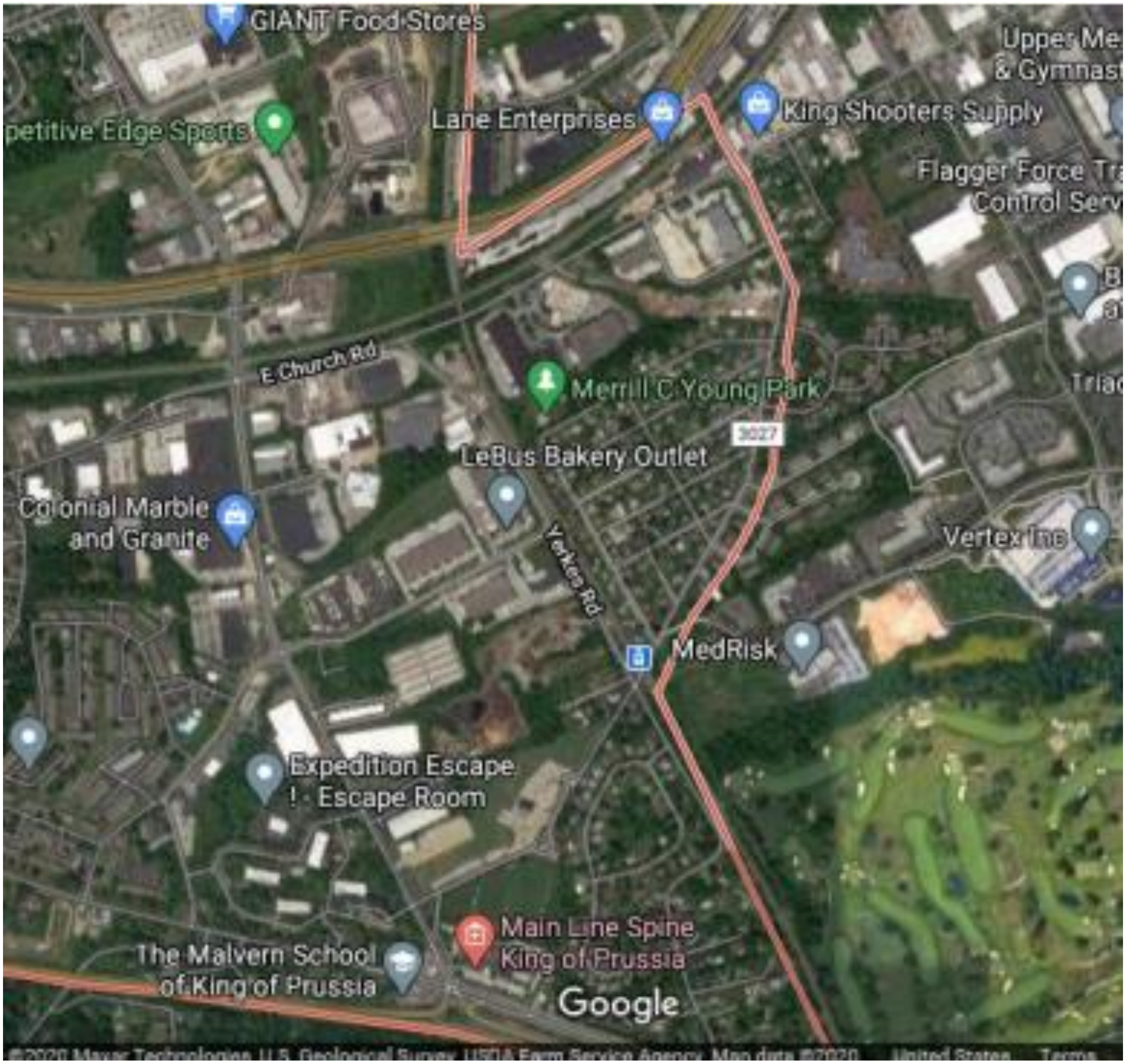


Figure 19. King of Prussia (Hughes Park), PA – Suburban Commercial Retrofit

EPA MXD Analysis

As noted above, the Peninsula model has a level of detail appropriate for scenario planning and was used to evaluate the bookend scenarios. However, transportation improvements internal to a single TAZ and changes in the "3Ds" of density, diversity, and design cannot be easily quantified using the Peninsula model alone. The EPA developed a spreadsheet-based tool called the mixed-use trip generation model, or MXD, that can be used to estimate internal trip capture, walking and transit use, and corresponding trip-generation impacts for mixed-use development, such as what is being evaluated for the Christiana Hospital vicinity. The EPA MXD tool was used to perform the sensitivity analysis for the Christiana Hospital vicinity in TAZ 151.

Christiana Hospital Vicinity Results

TAZ 151 is a suburban commercial center that has an existing activity density of 17 AU/acre and a job to housing ratio of 375 J/HH. A sensitivity test conducted for the Christiana Hospital vicinity based on the Balanced scenario increases the development footprint by 43% and increases the traffic footprint by 19% (**Figure 20**). This scenario modifies density, without any changes to diversity or design. Additional results show the Expected scenario forecast activity density and job to housing ratio to be 21 AU/acre and 95 J/HH, while the Balanced scenario forecasts 29 AU/acre and 8 J/HH, respectively.

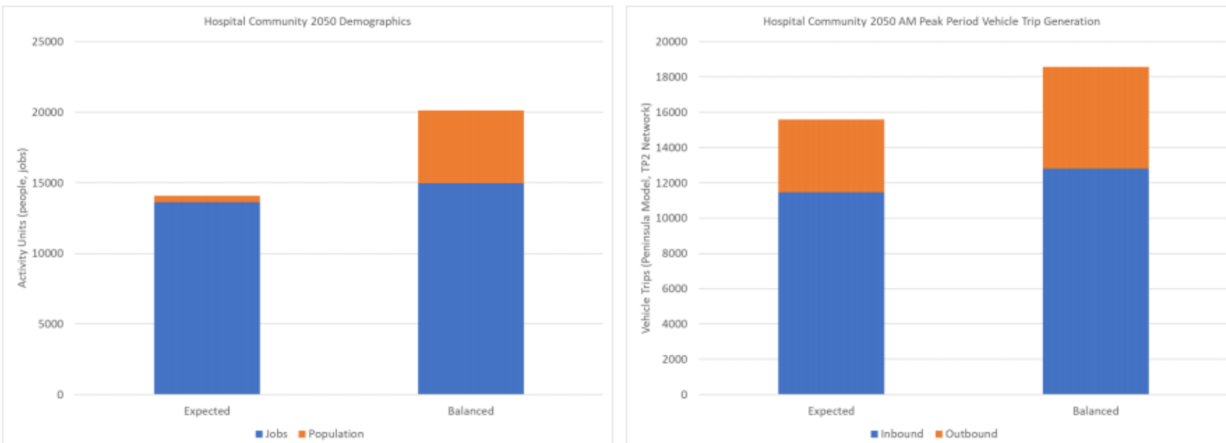


Figure 20. Balanced Scenario Impact on Hospital Area Activity Density and Vehicle Trip Generation

Figure 21 shows the impact that changing the design has on PM peak hour trips originating from TAZ 151. Changing the urban form of the campus from a few large buildings surrounded by parking lots (the current 8 intersections per square mile) to a grid of walkable streets spaced approximately 500 feet apart (or about 106 intersections per square mile) is projected to decrease the number of trips generated in TAZ 151 under the Balanced land use scenario.

Figure 22 shows the impact that changing the diversity has on PM peak hour trips originating from TAZ 151. The Expected land use scenario does not include substantial increases in residential units, as shown by the flat line. For the Balanced land use scenario, as the percent of the increase in development in TAZ 151 shifts from a mix of both commercial and residential to more residential, the number of projected trips generated from the area decreases. As more housing is provided, employees can live closer to work and generate fewer trips to and from the TAZ.

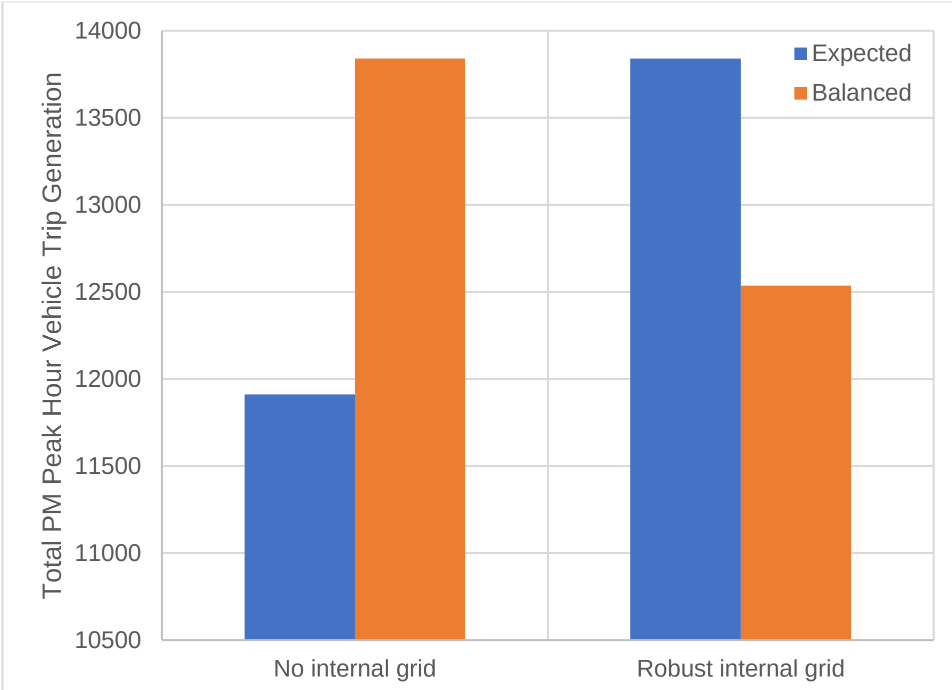


Figure 21. Trip Generation Sensitivity to Neighborhood Design, TAZ 151

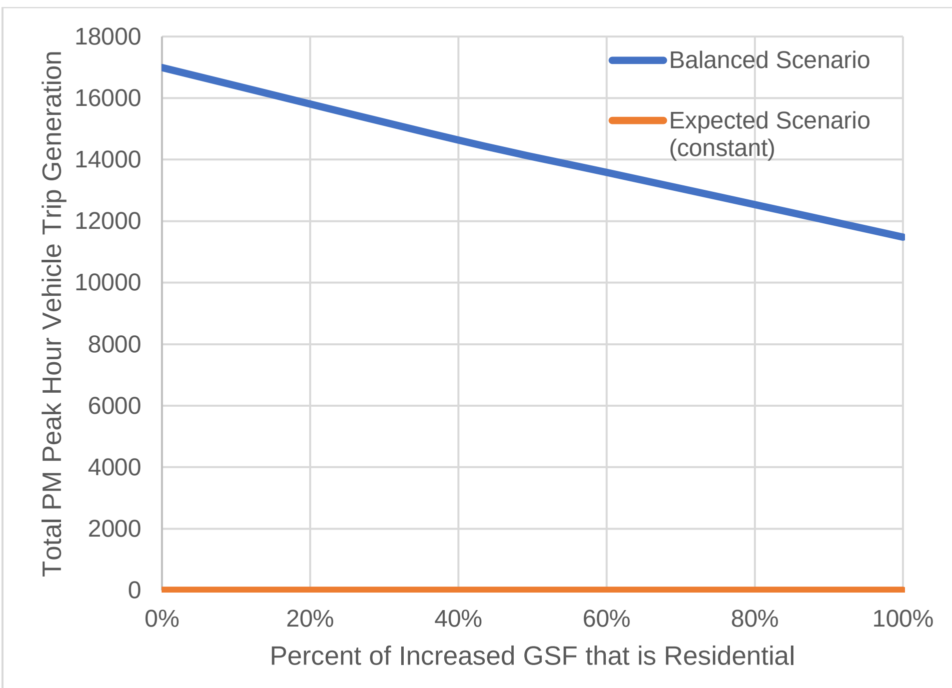


Figure 22. Trip Generation Sensitivity to Diversity, TAZ 151

Finally, **Figure 23** shows the impact of policies to reduce the average number of vehicles per household. Trips can be further reduced when the combination of density, diversity, design, and other policies encourage short, internal trips within the TAZ.

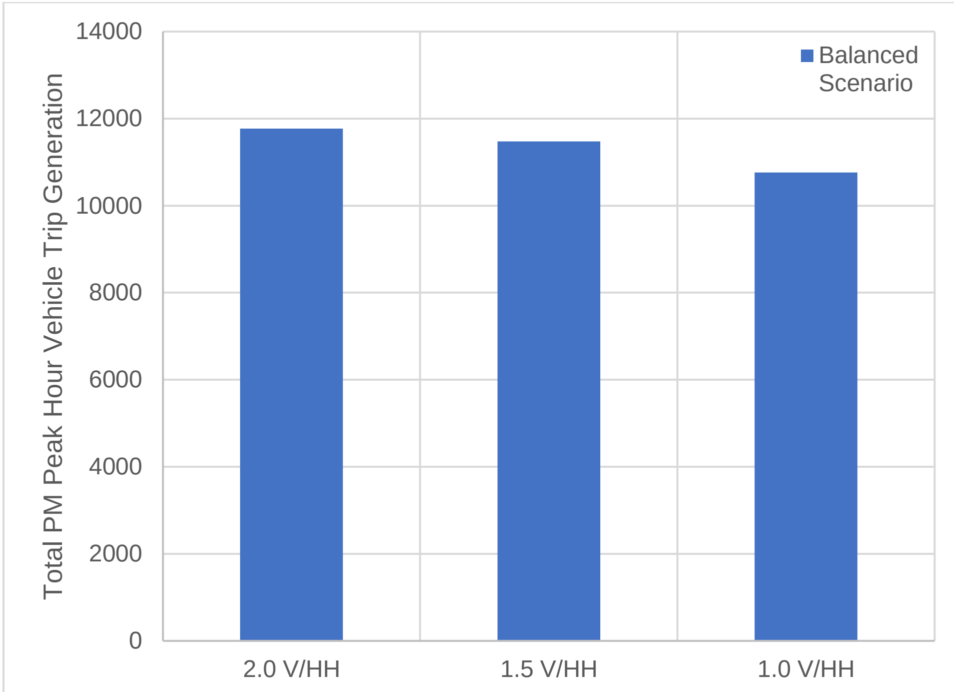


Figure 23. Trip Generation Sensitivity to Residential Demographics

Figure 24 demonstrates the combined impacts of the "3Ds" of density, diversity, and design on PM peak vehicle trip generation in TAZ 151 in the vicinity of the hospital. The Balanced Land Use Scenario and its incorporation of "3D" elements results in fewer PM peak vehicle trips than the Expected Land Use Scenario, even though the Balanced Lane Use Scenario anticipates more total development than the Expected Land Use Scenario.

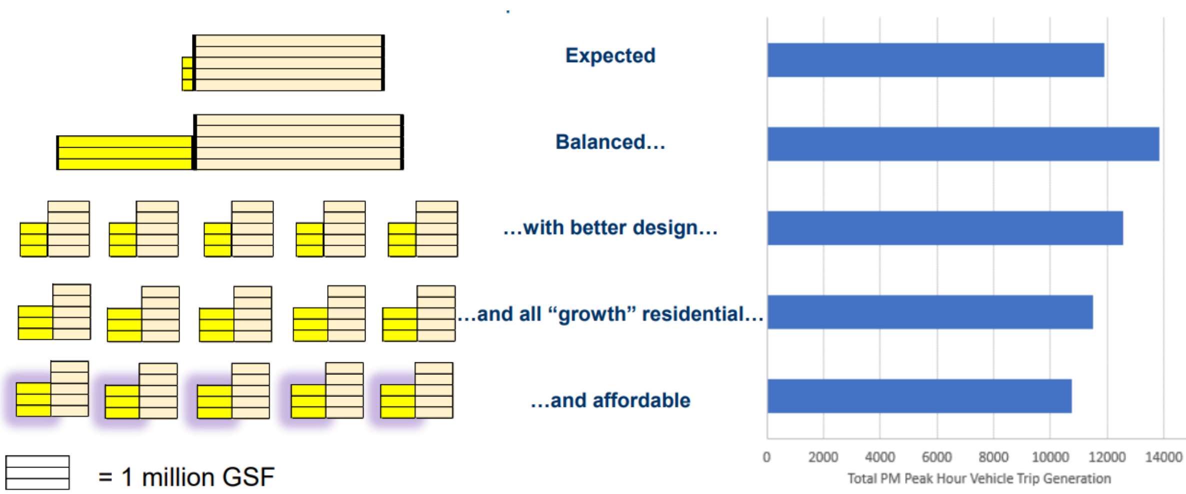


Figure 24. Impact of Density, Diversity, and Design on PM Peak Vehicle Trip Generation

Findings

Key findings of the scenario planning approach are:

- Under any of the scenarios examined, the arterial roadway system in the study area will operate at close to Arterial Mobility Level of Service (LOS) D from an areawide perspective.
- A land use scenario that better balances jobs and housing in the study area provides a more efficient use of transportation system investments, and that efficiency can be further improved with supportive land use and Transportation Demand Management (TDM) policies.
- Important transportation projects to improve multimodal connectivity within the study area are those that span multiple properties, including Churchman's Crossing Extended, a new arterial connection across I-95, and enhanced transit connecting the Fairplay station to the Christiana Mall transit center. Implementation tools that leverage private sector interest in these projects should be examined further.