



4.0 The Street



View along Cumberland Avenue

Cumberland Avenue Today

It is clear that traffic conditions on Cumberland Avenue are far from ideal. The existing four-lane cross-section coupled with significant pedestrian activity, drive-through businesses, transit service and commercial deliveries, creates an inherently unsafe and hostile environment for pedestrians. The key traffic characteristics along Cumberland Avenue include:

- Delay as through vehicles are trapped behind a vehicle stopped in the left lane waiting to make a left turn.
- Delay caused by traffic flow friction due to lane changing, as drivers seek to avoid being trapped behind left-turning or stopped vehicles.
- Uneven loading of the two lanes in each direction. In some instances, the outer lane is noticeably under-utilized, most likely due to drivers wishing to avoid the close confines of the curb, sidewalk and pedestrians. At other times, the inner lane is noticeably under-utilized, most likely due to drivers avoiding the possibility of being trapped by left-turning vehicles.
- Commercial delivery vehicles stopping in the outer lane of traffic. This not only blocks traffic in the outer lane, but greatly interferes with the flow of the inner lane, as drivers attempt to change lanes to pass the stopped vehicle.
- Transit vehicles stopped in the outer lane, with the same effect on traffic as noted for commercial delivery vehicles (above).

- Turning movements (both right and left turns) into and out of the numerous driveways, particularly those serving drive throughs at restaurants and banks.
- The frayed and disorderly appearance of the commercial segment of Cumberland Avenue, which reinforces the driver's perception that "something is wrong" with the operation of the street.

Road Diet Concept

What can be done? Even before this study began, discussions of Cumberland Avenue's future have included the three-lane concept, or "road diet." The term "road diet" applies to the practice of reducing the number of lanes on a road, typically converting four-lane roads (two lanes in each direction without room for left-turn lanes) into three-lane roads (one lane in each direction with a center lane dedicated to left turns). This is an emerging practice around the country with a growing list of successful conversions (a number of case studies of three-lane conversions are provided in an appendix to this report and available through the MPC).

Why does this work? The significant drawback to four-lane roads is the lack of an exclusive center left-turn lane. The result is that the middle two lanes serve as de facto left-turn lanes, stopping traffic in that lane when a left turn is being attempted. This situation not only reduces the capacity of the road but is unsafe as the opposing left-turning vehicles limit visibility to oncoming traffic and pedestrians. The three-lane configuration resolves this left by creating a dedicated center left-turn lane which pulls the left-turning vehicles out of the flow of traffic and creates safer sight lines for the turning movement.

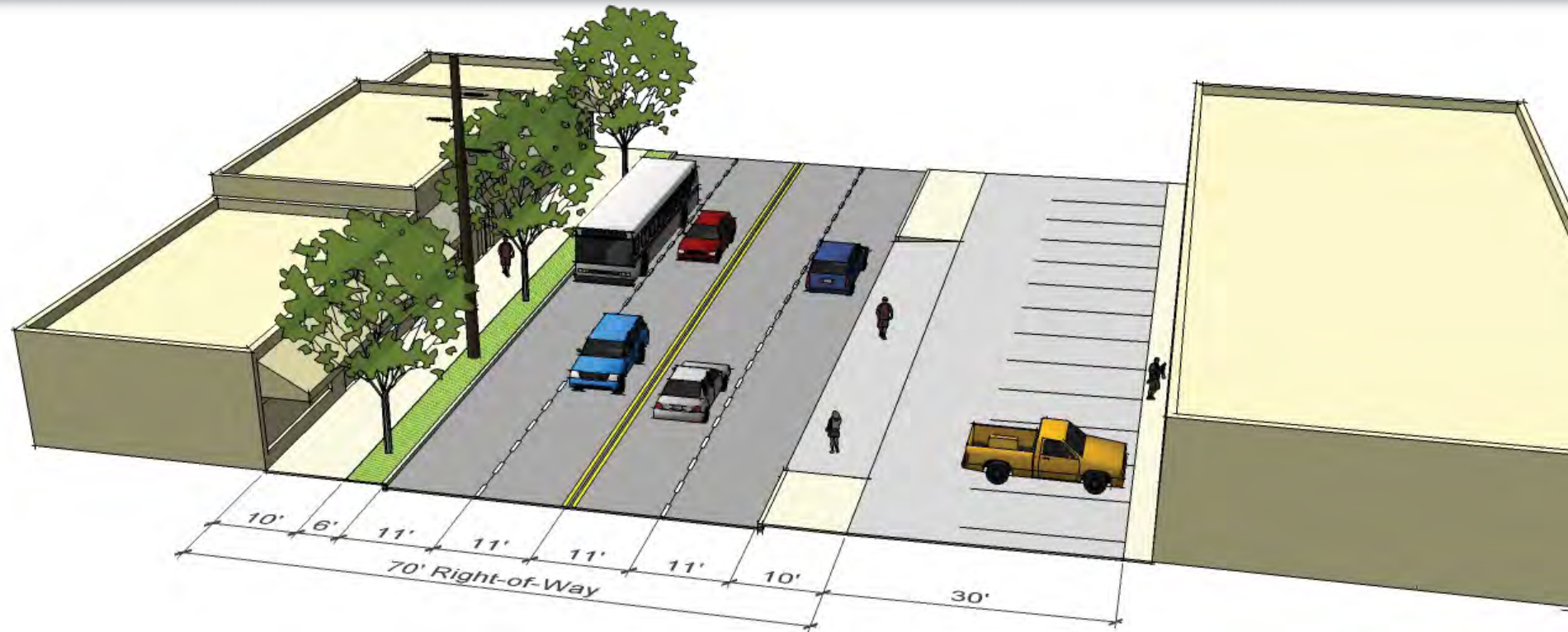
Other results will include slowing traffic down as the one through lane in each direction will not allow for faster cars to pass or change lanes. This reduction in speed will reduce the number and severity of accidents and support a more pedestrian-oriented environment.



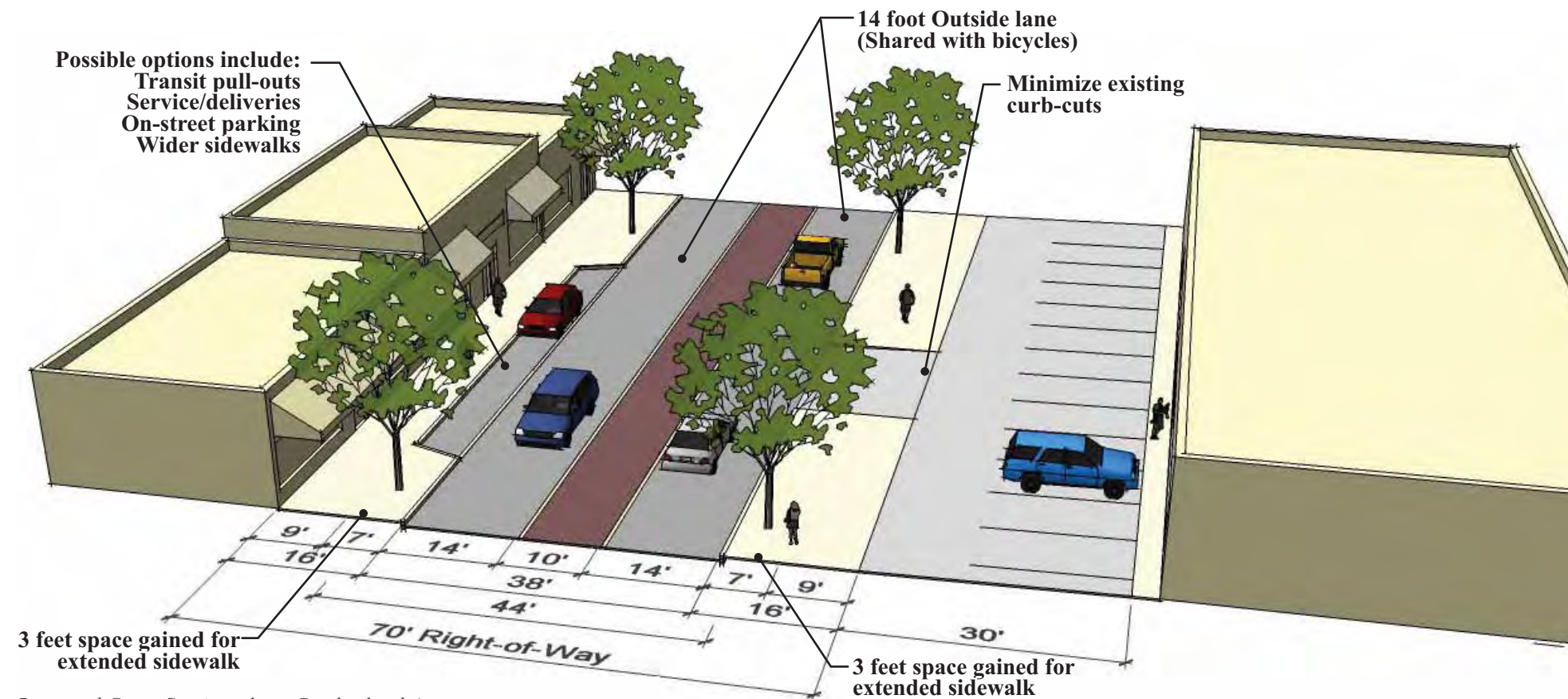
Limited sight lines on a four-lane road



Improved sight lines and visibility on a three-lane road



Existing Cross Section along Cumberland Avenue



Proposed Cross Section along Cumberland Avenue

Cumberland Avenue: Existing & Proposed

Based on public and stakeholder input, there is broad support for the “three-lane” concept on Cumberland Avenue. Yet, the application of a three-lane configuration on Cumberland Avenue will need to balance a number of desires:

- Wider and more attractive sidewalks with consistent design, street trees, pedestrian lighting & street furniture;
- Transit stops in pull-outs that get stopped buses out of the travel lane;
- Bicycle travel in either exclusive lanes or shared travel lanes;
- Potential on-street parking and/or service & delivery areas;
- Accommodation of left turns into existing businesses and driveways;
- Accommodation of emergency vehicles.

The proposed prototypical section illustrates the combination of these features into a new cross section for Cumberland Avenue. The main features include:

- The reconfiguration of the four travel lanes into three (one travel lane in each direction and a continuous center turn lane). The continuous left-turn lane accommodates left turns at all street intersections and existing driveways. As redevelopment occurs, mid-block driveways should be eliminated, minimized, and/or reduced in width.
- The accommodation of emergency vehicles in the center lane to bypass traffic.
- The accommodation of bicycle travel through the use of 14-foot travel lanes that serve as bicycle-friendly, shared lanes. By not including fully striped bike lanes more space is gained in additional sidewalk width.
- The addition of six feet of gained sidewalk space (three feet on each side) to create wider sidewalks and accommodate street trees.
- The adaptability within the sidewalk space to include a seven-foot bay that can be used for transit pull-outs, on-street parking or special service and delivery zones. These bays would be located strategically and where appropriate for their use.
- The center turn lane can be designed with a variety of potential treatments. These treatments range from striped asphalt to textured materials such as pavers or stamped concrete.



Cumberland Avenue: Proposed

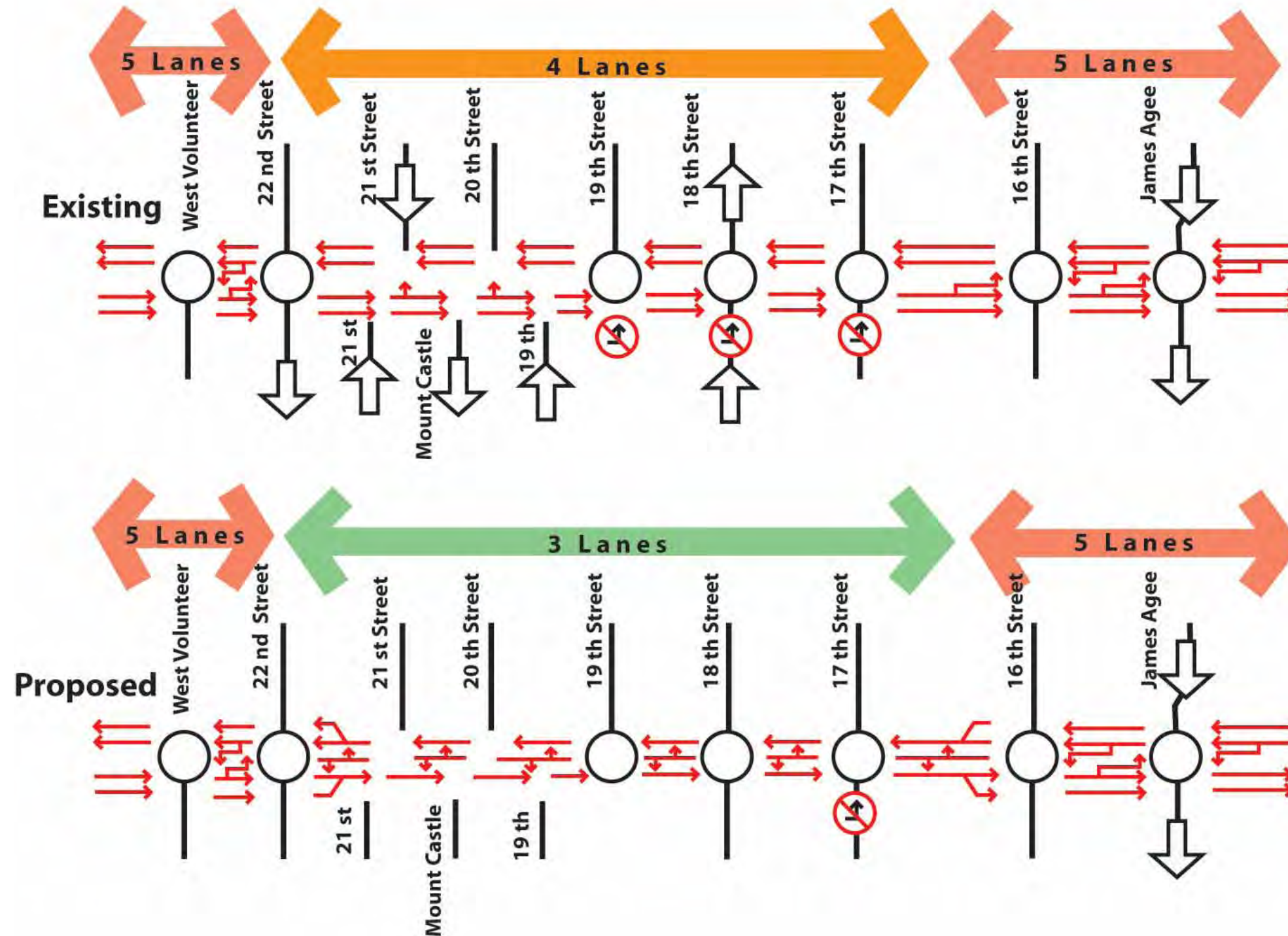
Cumberland Avenue: Existing & Proposed

This illustration conveys the visual impact of the reconfiguration of Cumberland Avenue, including wider sidewalks, street trees, enhanced crosswalks and a center turn lane. The reduced visual width of the road dramatically changes the perception of Cumberland Avenue from a commercial highway to a mixed-use street.

The center turn lane and crosswalks can be designed with a variety of potential treatments. These treatments range from striped asphalt to textured materials such as pavers or stamped concrete. The final details of the streetscape should be determined in the next phase of design and evaluated with further stakeholder comment and review.



Cumberland Avenue: Existing



Traffic Analysis

For the purposes of testing the traffic impact of converting Cumberland Avenue to three-lanes, a traffic simulation model was constructed (using Synchro software). Traffic counts at signalized intersections were collected in the fall of 2006 and used to create a model of the existing four-lane condition that could be compared to potential three-lane alternatives.

Proposed Configuration

Several configurations were initially evaluated, leading to a proposed configuration that was analyzed and compared to the existing four-lane condition. Key features of the proposed configuration include:

- The transition from five lanes to three lanes located between 22nd Street and 21st Street at the western end of the study area, and between 16th Street and 17th Street at the eastern end.
- These transitions leave unchanged the Cumberland Avenue intersections at West Volunteer, 22nd Street and 16th Street, recognizing the importance of these intersections in providing access to the hospital campuses and to the University.
- All turning movement restrictions eliminated, with the exception of the eastbound left turn at 17th Street. The sight distance for this left turn (i.e., the ability to see a westbound vehicle on Cumberland Avenue) is adequate for a permissive left turn (i.e., turn without a protected signal phase). However, this adequacy is not at all apparent to drivers who would be waiting to make a left turn on Cumberland Avenue eastbound, and the experience of making the left turn at a permissive signal would be unnerving for many drivers. The remedy of providing a protected left-turn phase was considered but discarded because of the delay to through vehicles on Cumberland Avenue, the ability to make eastbound left turns at numerous other places, and the desire to diffuse eastbound left turns to a number of locations, rather than concentrating them all at 17th Street.
- Wherever possible, converting the cross street one-way configuration (at 22nd, 21st, Mountcastle, 19th and 18th) to two-way and limiting the street configuration to a single approach lane (accommodating left, through and right-turn movements in that single lane) and thereby maximizing the on-street parking for side streets and minimizing the side-street crosswalk length. This single "LTR" lane is incorporated at 22nd Street northbound, 18th Street northbound and 18th Street southbound.
- Reconfiguration of northbound 17th Street, south of Cumberland Avenue, to include a permissive left turn in addition to a combined through and right.

Table 1: Seconds of Delay and Level of Service (LOS)

	Existing 4 - Lane			Proposed Configuration		
	Cumberland Ave. Sec- onds of Delay		Intersection LOS	Cumberland Ave. Sec- onds of Delay		Intersection LOS
	EB	WB		EB	WB	
W Volunteer Blvd.	13.1	10.4	B	6.2	7.4	B
22nd St.	10.6	22.6	B	2.9	7.0	B
19th St.	13.6	2.0	B	11.8	11.5	B
18th St.	4.7	2.7	A	4.6	10.3	B
17th St.	4.0	9.6	C	22.9	34.8	D
16th St./E Volunteer	18.1	17.9	C	18.1	23.6	C
15th St. /James Agee	2.3	2.9	A	2.6	5.0	A
Total	66.4	68.1		69.1	99.6	

Table 2: Arterial Analysis

	Existing 4-Lane		Proposed Configuration	
	EB	WB	EB	WB
Free Flow Speed	35 mph	35 mph	30 mph	30 mph
Travel Time (seconds):				
Running	110.0	116.5	124.0	132.9
Signal Delay	65.8	72.1	75.2	109.1
Total	175.8	188.0	199.2	242.0
Overall Speed (mph)	15.3	15.0	13.5	11.7

Traffic Performance

The existing four-lane configuration and proposed three-lane configuration are compared for the p.m. peak hour (4:30-5:30) in Table 1, using three evaluation measures:

1. The seconds of delay to traffic on Cumberland Avenue, both east-bound and westbound. This measure of delay most directly defines the performance for through traffic; that is, traffic with neither origin nor destination in our study area. Through traffic performance is important, since a number of stakeholders, including City staff, are concerned that the changes to Cumberland Avenue, no matter how beneficial to the area locally, should not have an adverse impact on traffic through the area.
2. Intersection Level of Service – This measure is correlated to the average seconds of delay for all entering vehicles, not just those on Cumberland Avenue. This is a measure of overall service to all users, local traffic entering/exiting Cumberland Avenue, as well as through traffic with neither origin or destination in the area.
3. Arterial Analysis – This analysis computes the total driving time and speed for travel through the entire seven-intersection study area. The delay component of this analysis correlates very closely with the Cumberland Avenue delay times (measure 1 above), but arterial analysis also adds the useful measure of overall travel time and overall travel speed.

Important Conclusions

- In the peak hour, peak direction (p.m. peak hour westbound), the proposed configuration results in an increment of delay of 31.5 seconds. In the p.m. peak in the minor direction, the delay is 2.7 seconds.
- The increment of delay in the peak hour is greatly outweighed by the ability to make left turns, the relaxation of one-way restrictions, the ability to reclaim part of the street width for uses other than vehicular traffic, and the change in character in the area.
- Traffic level of service at intersections is fully adequate at all of the proposed intersections in the three-lane configuration. At five of the intersections, the overall intersection level of service is unchanged between the existing and the proposed configuration. At these five intersections, the level of service (ranging from LOS “A” to LOS “C”) is acceptable for peak hour service in an urban area. At two of the intersections, the level of service changes by one gradation. At the 18th Street intersection, the proposed configuration results in a change of level of service from LOS “A” to LOS “B.” At the 17th Street intersection, the proposed configuration results in a change of level of service from LOS “C” to LOS “D,” a level of service fully acceptable for an urban arterial street during the peak hour.
- At all intersections under the proposed configuration, the traffic level of service is LOS “D” or better, and therefore more than adequate for an urban arterial such as Cumberland Avenue.
- Overall travel time between James Agee and W. Volunteer in the peak hour will increase by 54.0 seconds westbound and 23.4 seconds east-bound.

Why 30,000 Vehicles can be Carried on a 3-Lane Street

Typical “rule of thumb” guidelines call for widening a street to five lanes as its traffic volume approaches or exceeds 20,000 average daily traffic (ADT). On Cumberland Avenue, by contrast, the existing ADT in the section proposed to be converted is approximately 30,000 (as counted just to the east of 17th Street). How do we reconcile, therefore, the typical guideline of 20,000 ADT with the detailed traffic analysis that shows that the 3-lane section performs well at 30,000 ADT? There are three compelling factors that reconcile these two numbers:

1. Low Peak Hour to Daily Traffic Ratio – For the typical arterial street in the greater Knoxville area, the ratio of peak hour traffic to average daily traffic (the “K” factor) is around 8.5 percent (0.085). Within the peak hour, the ratio of peak direction traffic to total peak hour traffic (the “D” factor) is around 55 percent (0.55). For a typical street in Knoxville, with an ADT of 30,000, we would therefore expect a peak hour peak direction flow of 30,000 (0.085 “K” factor) (0.55 “D” factor) = 1,400 hourly vehicles, in the peak direction. However, Cumberland Avenue has only 1,060 vehicles during the peak hour in the peak direction. The actual peak hour of 1,060 vph is 74% of the 1,400 peak hour volume that would be expected, on a 30,000 ADT street under typical Knoxville traffic flow patterns. This unusually low ratio of peak hour to total flow reflects the extended duration of heavy mid-day traffic flows, due to the unique characteristics of the University, hospitals and restaurants. The peak hour peak direction flow of 1,060 vph, under the assumption of typical Knoxville “K” and “D” factors, would amount to an ADT of 22,700, only slightly above the 20,000 ADT guideline.
2. Low Cross Street Directional Volume – The typical guideline, for widening to a multi-lane street, of around 20,000 ADT, is based on an assumption that the street in question will intersect with major streets, where traffic signal green time will have to be divided equally between the two streets. Such an equal division of traffic signal green time would diminish the green time available for the street in question. The proposed 3-lane segment of Cumberland Avenue, however, does not intersect with any streets that approach the volume of Cumberland Avenue, thereby requiring a traffic signal green time comparable to Cumberland Avenue. Rather, all of the cross streets in the proposed 3-lane section – 19th Street, 18th Street and 17th Street – are carrying, at most, one-half the traffic of Cumberland Avenue, thereby preserving the great majority of the traffic signal green time for Cumberland Avenue. This factor alone (aside from the peaking factors (above) would raise the “rule of thumb” threshold well above the 20,000 ADT level.
3. Impact of Continuous Left-Turn Lane – Typically, the 20,000 ADT guidelines for widening to a multi-lane street is predicated on the base condition being a two-lane street, without turning lanes, or with turning lanes only at major intersections. Without a continuous left-turn lane, the capacity of the street is diminished by left-turning vehicles obstructing the travel lanes at minor intersections and driveways. The typical guidelines for widening, at around 20,000 ADT reflect the constraints on flow due to the absence of the continuous left-turn lane. Provision of a left-turn lane, as called for in the proposed 3-lane configuration of the Cumberland Avenue plan, would in itself call for a reasonable threshold considerably higher than the 20,000 ADT typically cited.

Traffic Diversion & Future Volumes

Another important consideration is the ability of the three-lane configuration to accommodate projected future traffic volumes and the potential diversion of traffic away from Cumberland Avenue. The Metropolitan Planning Commission staff used the Regional Travel Demand Model to test the impact of the three-lane concept relative to potential traffic diversion and project future (2020) traffic volumes. This analysis reflects anticipated impacts including a decrease in volume on Cumberland Avenue with an associated increase in volume on Neyland Drive (which should be noted is consistent with the University’s long-term transportation plan). Key results include:

- A 5-10% decrease in current volume on Cumberland Avenue in the study area with the three-lane configuration
- A 7-10% increase in current volume on Neyland Drive
- Slight increases in current volume on Highland Avenue, 17th Street, and 16th Street
- Projected volume increase by 2020 of 8-11% on Cumberland Avenue
- An overall volume change/diversion pattern in 2020 that decreases on Cumberland Avenue and increases on Neyland Drive, Forest Avenue, and Clinch (between 16th & 17th Street)

Streetscape Concept Plan

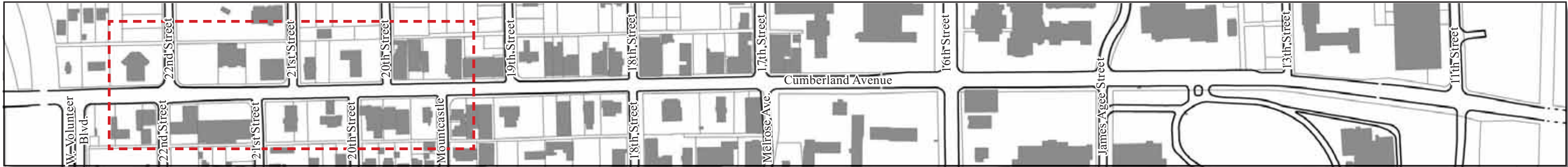
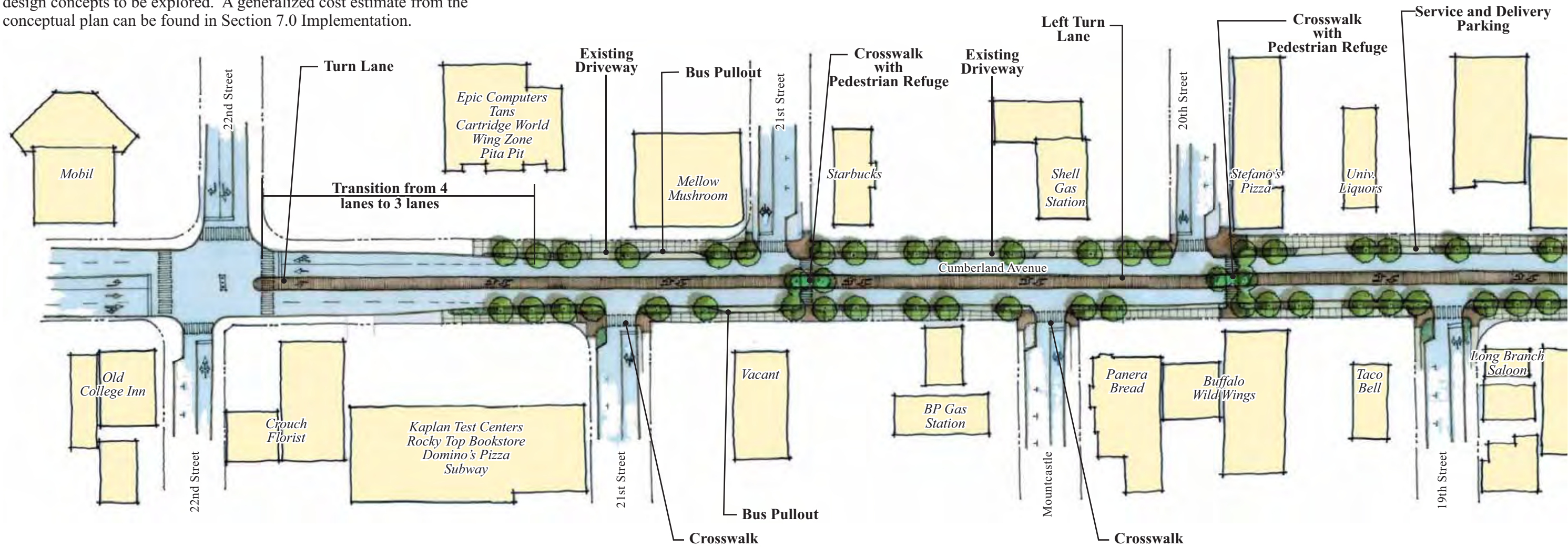
This concept plan applies the three-lane configuration on Cumberland Avenue to illustrate how it could be designed relative to the lane transitions, driveways, bus pull-outs, street trees and 2-way conversion of side streets. This plan represents only a preliminary concept design but it does allow for order-of-magnitude cost estimates to be prepared and initial design concepts to be explored. A generalized cost estimate from the conceptual plan can be found in Section 7.0 Implementation.

Curb Cuts

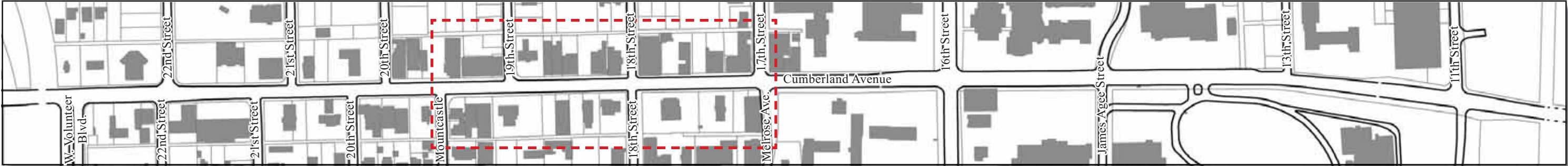
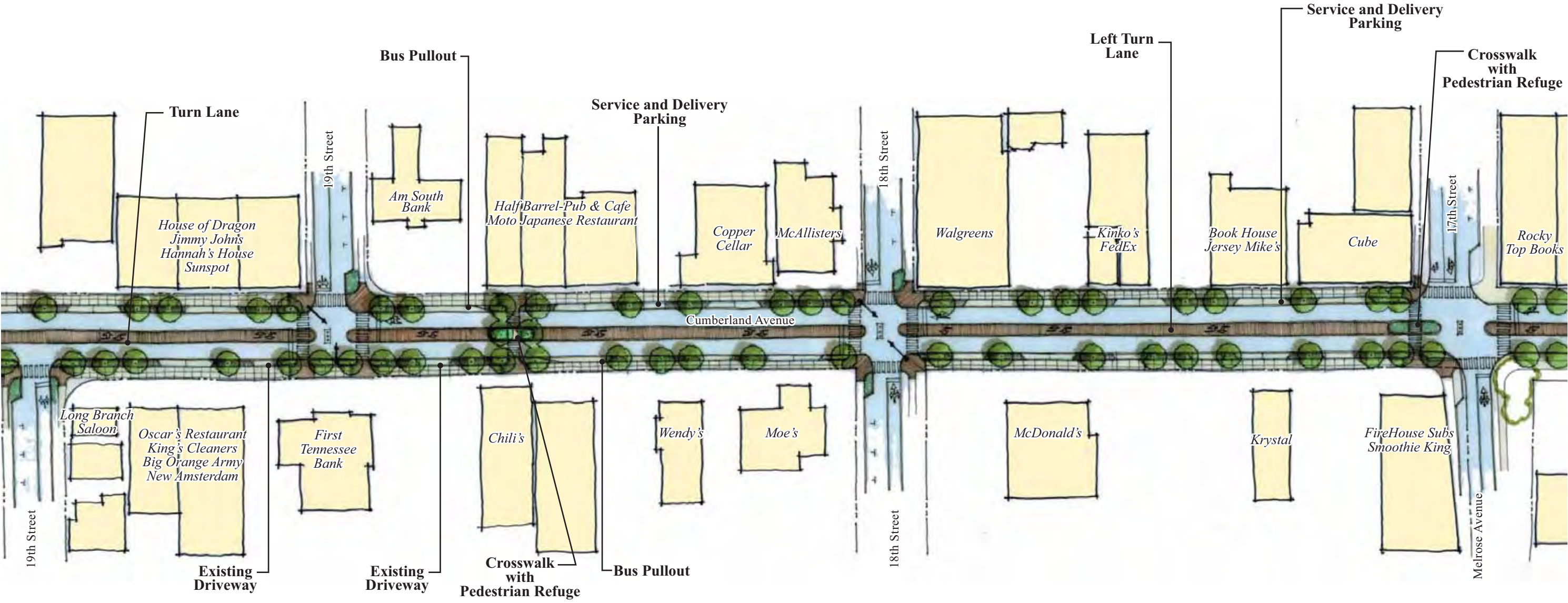
This long-term success of this streetscape plan will require an aggressive approach to reducing and eliminating curb cuts between blocks to reduce the number of pedestrian and vehicle conflicts and reduce the use of the center turn lane for mid-block turning movements.

Bus Pull-Outs & Pedestrian Refuge Islands

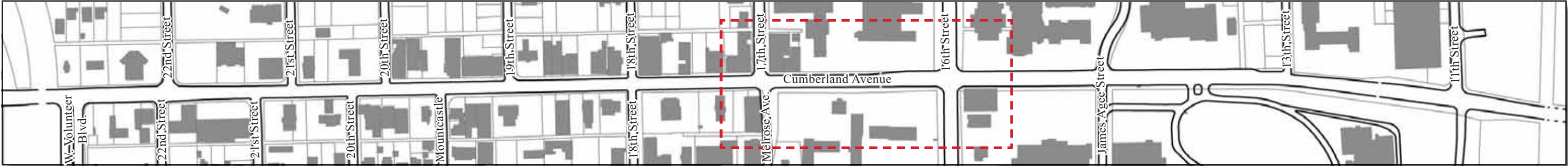
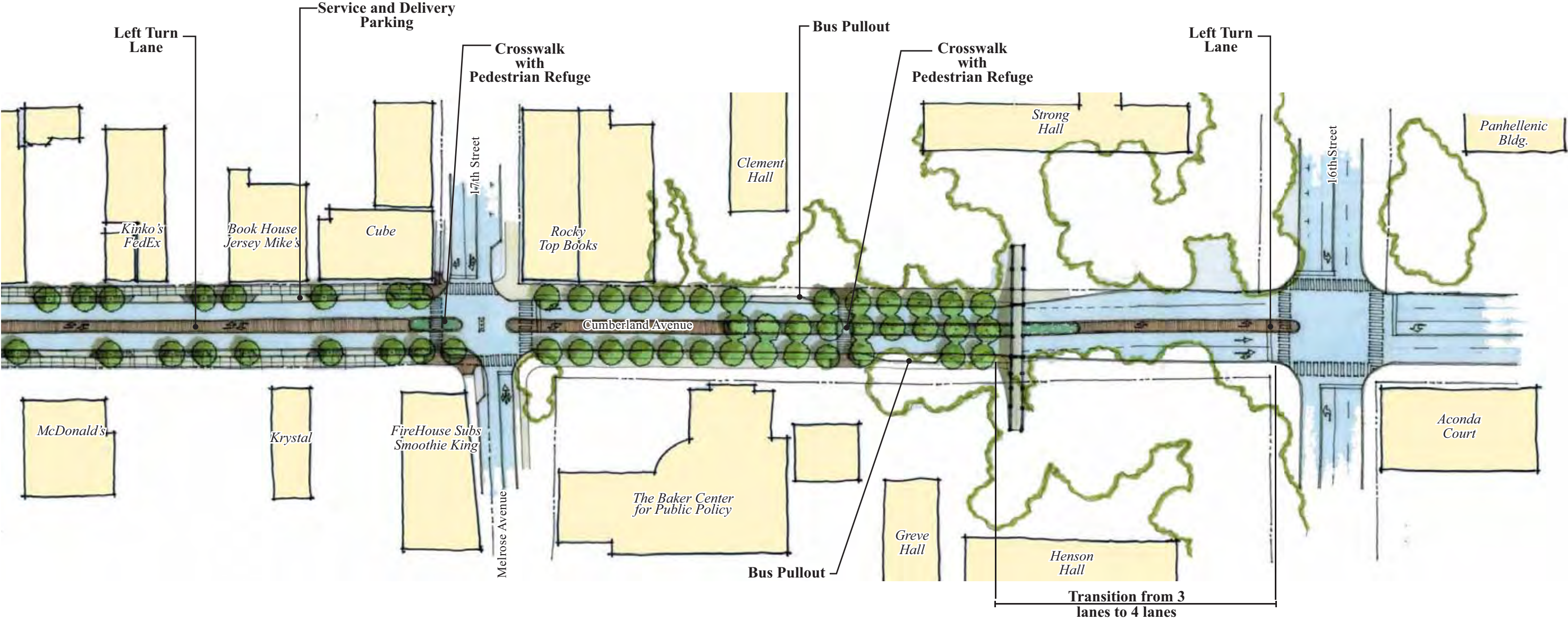
Preliminary locations of bus pull-outs have been suggested in this plan. These locations will need further review and determination by KAT. Pedestrian islands have been illustrated in some locations but may conflict with emergency vehicle access, further review and determination of their possible use will be necessary.



Key Map



Key Map



Key Map

The Street

Streetscape Design Intent

