Guidelines on Proposed Conversions of One-Way Streets Into Two-Way Streets

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Introduction

The conversion of one-way streets into two-way streets in downtown and urbanized areas began to take place several decades ago and has continued to some extent through the past several decades. There have been some conversions in NC and there have been dozens across the US. There is published and unpublished literature touting the apparent successes, with proponents pointing to lower out-of-direction travel, reduced speeds, reduced noise levels, better business visibility, and even reduced crime rates in some cases. Some authors claim that pedestrians are better off after a conversion, and some authors claim a safety benefit as well. Walker, et al. (1) provide a classic paper making the case for conversions. At the end of this document we have included a list of some other publications on this topic.

However, there is the potential for over-reach in some one-way to two-way conversion proposals. One-way streets have several important positive features which should not be overlooked when considering a conversion. The positive features of one-way streets could include several measures of safety, several measures of pedestrian crossing quality, and several measures of operational efficiency. Within the past ten years at least two proposals to convert one-way state-owned streets to two-way operation have been sent to the Mobility and Safety Division for analysis and the streets were subsequently not converted when the results predicted unfavorable outcomes.

The goal of the Mobility and Safety Division, and indeed all of the NCDOT, is to provide for travel that is as safe and efficient as possible for all users. To that end, when stakeholders propose to convert one-way state-owned streets to two-way operation the Division and the NCDOT have an obligation to investigate the proposal fully. These guidelines outline what that investigation should look like. The remainder of these guidelines describe how a one-way to two-way conversion could affect safety, walkability, and efficiency. Analysis of other aspects (business impacts, noise, crime, etc.) may be important but are generally outside the scope of the Mobility and Safety Division. The guidelines will conclude with recommendations and a list of some alternatives to a one-way to two-way conversion that stakeholders should also consider.

Safety

The safety effects of a conversion from a one-way pair to two-way travel are not obvious. There is no crash reduction factor published by NCDOT (2) and the only crash modification factor for this action in the FHWA Clearinghouse is from China (3). Conversion proponents often claim that two-way streets are safer, based in part on fewer opportunities for sideswipe and lane change crashes. In contrast, supporters of one-way streets point to fewer opportunities for rear-end crashes due to shorter or fewer queues.

A big safety advantage for one-way streets is the reduced number of conflict points at intersections. A conflict point is a place where two traffic streams meet and provide chances for a driver to make an error that could result in a collision with another road user. Figure 1 shows the vehicular conflict points for intersections between a between a one-way street and a two-way street and between two two-way streets. A meeting of a one-way street and a two-way street only has 13 vehicular conflict points, of which five are the more dangerous crossing conflicts. Meanwhile, a four-approach meeting of two-way streets has 32 vehicular conflict points, of which 16 are the more dangerous crossing conflicts and 16 are the less dangerous merging or diverging points. An intersection between a one-way street and a two-way street has 14 vehicle-pedestrian conflict points while an intersection between two two-way streets has 24 vehicle-pedestrian conflict points. At an intersection involving a one-way street there are simply fewer ways for a driver to commit an error.

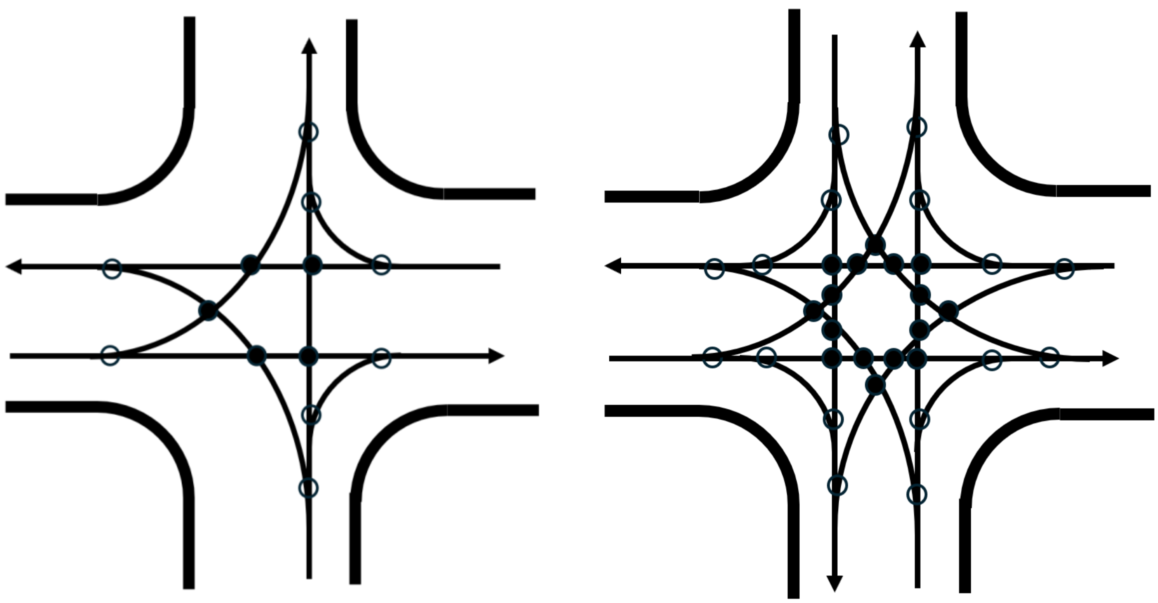

Figure 1. Vehicular conflict points at an intersection between a one-way and a two-way street (left) and at an intersection between two two-way streets (right).
Note that black dots represent crossing conflict points while white circles represent merging or diverging conflict points.

Speed control is often cited as a safety advantage for two-way streets. This is due to the increased stopping and queuing at intersections, and because there is usually only one through lane so vehicles are rarely able to choose their own speeds. It is true that some one-way pairs in the past were relatively uncongested, had few signals, or had high progression speeds, lending themselves to higher average speeds (some may still operate that way). However, on one-way streets agencies can control speeds using signal timing; signals on one-way streets can be set to any progression speed, higher or lower, without affecting the size of the green band. In fact, signals can be added to a one-way corridor to help with progression speed control if too much distance between signals encourages higher speeds and/or to accommodate additional pedestrian crossings. In other words, on one-way streets speed control can be achieved via signal timing 24/7 regardless of congestion, whereas on two-way streets speed control is a result of congestion and is therefore dependent on the time of day. In recent years the City of Raleigh has gained some positive chatter from reducing the progression speed on its main north-south one-way pair through downtown with the expectation that we will see crash reductions and a minimal travel time penalty once data are available.

Fortunately the tools now exist to help professionals estimate the safety effect of a proposed one-way conversion before it is made. In particular, new equations appeared in the draft Highway Safety Manual

(HSM) to be published later in 2025 or in 2026 by AASHTO (4) to estimate crashes on one-way street segments and at intersections involving one-way streets. These equations have not yet been calibrated for North Carolina conditions, but since reporting customs are likely not much different between one-way and two-way streets any calibration should affect both one-way and two-way streets similarly and the equations should provide relative performance fairly accurately. In the draft HSM that was circulated in late-2024 the new equations for crashes on one-way streets and intersections were 16-25, 16-26, 16-47, and 16-77 and these can be compared to the equations for crashes on two-way streets and intersections including 16-17, 16-19, 16-20, 16-27, and 16-37. Table 1 shows the results for segment crashes per mile per year, assuming ten significant driveways per mile and otherwise generic conditions. Meanwhile, Table 2 shows the results for crashes at a signalized intersection, again assuming generic conditions. Note that total crashes for a length of arterial would include the segment crashes from Table 1 and the crashes from Table 2 from each major intersection.

Table 1. Segment crashes estimated from the draft Highway Safety Manual.

AADT, vpd	Estimated crashes per mile per year	
	One-way street	Two-way street
5,000	2.8	1.4
10,000	5.6	3.0
15,000	8.4	4.6

Table 2. Intersection crashes estimated from the draft Highway Safety Manual.

Major street AADT, vpd	Minor street AADT, vpd	Estimated crashes per year	
		One-way street	Two-way street
5,000	5,000	1.9	1.2
10,000	5,000	2.4	2.5
	10,000	3.1	2.9
15,000	5,000	2.8	3.8
	10,000	3.6	4.4
	15,000	4.1	4.9

The results from Tables 1 and 2 provide a mixed picture. On the one hand, on segments two-way streets appear to be generally safer than one-way streets. This could be because two-way streets have fewer wrong-way crashes or fewer sideswipe and lane-change crashes. On the other hand, with larger demands one-way streets are safer than two-way streets at intersections. This could be due to the smaller number of conflict points and fewer stops (better progression) as described above. Thus, the overall safety outcome of a conversion is going to depend upon many details including the numbers of major intersections, the lengths of segments, and the demand patterns. We all should be glad that these equations exist, will be published soon, and hopefully will be calibrated for NC soon afterward so that we can apply them to particular cases.

Walkability

A one-way to two-way conversion could have large impacts on crossing pedestrians. As described below, signals at intersections involving one-way streets have fewer critical phases, meaning that they will almost always have shorter cycles. Both fewer phases and shorter cycles will mean lower delays for crossing pedestrians, and since longer delays tempt more pedestrians to cross on red there is likely some safety impact to this aspect as well. One factor of note is that the higher capacities and longer green times for signals on one-way streets means more scope for pedestrian treatments like leading pedestrian intervals and exclusive pedestrian phases (i.e., Barnes dances).

As mentioned above, intersections involving one-way streets have fewer vehicle-pedestrian conflict points. This means that there are fewer ways for a pedestrian to be hit during typical operations. On the other hand, it is also true that two-way streets generally mean some reduction in vehicle demands due to no backtracking to get to driveways so the absolute exposure of pedestrians to vehicles is reduced.

The tremendous progression potential on one-way streets, as detailed below, allows the possibility of additional midblock pedestrian signals. This is because those extra signals can be placed into the progression pattern so that they introduce very little extra delay or very few extra stops to the vehicle flow on the one-way street. Two-way streets have no such possibility; each extra signal usually introduces a high level of extra delay and stops.

Pedestrian expectations—human factors—regarding a conversion seem to be mixed. At one-way streets there may be some confusion about where the threats from vehicles could be coming from. On the other hand, a conversion on a two-lane street that results in a signal with split phase timing would also add uncertainty for pedestrians.

There are no reliable crash studies available on which to judge the pedestrian safety of one-way versus two-way streets. The best surrogate currently available was published in 2021 in NCHRP 948 (5) and is known as the "20 flags method." The 20 flags method can be applied fairly easily, typically in less than one hour per intersection, to any intersection or interchange. It asks 20 questions and each answer is scored as a "red flag" meaning a safety concern, a "yellow flag" meaning a comfort concern, or "no flag" meaning no safety or comfort concern. Thirteen of the questions apply to pedestrians and the questions apply to each of the four crosswalks at a four-legged intersection, so 52 potential flags are possible for pedestrians.

To try to understand the general case for one-way versus two-way intersections, we applied the 20 flags method to generic examples of both with either two lanes or three lanes as shown in Figures 2 and 3. We made assumptions as needed that should hold for most relevant situations, including moderate to high demands, typical speeds, typical signal timing, and typical traffic control devices. Table 3 shows that for both the two-lane and the three-lane main street, the intersection with a one-way street provided superior pedestrian service quality. Flag 1 provided some of the difference, with one-way streets meaning that pedestrians in some crosswalks did not have to face a threat from right turns. Flag 8 on long red times provided more difference, with pedestrians at one-way intersections having shorter delays (and therefore being less prone to crossing during red). Flag 10 for left turns made up the remainder of the difference, with the pedestrians crossing at the intersection with two-way streets and three lanes having to cross left turn traffic streams in all four crosswalks (if protected left turns are provided, the risk is lessened but not eliminated as pedestrians are still tempted to cross on red). In sum, it appears that on average pedestrians at a well-designed intersection involving a one-way street will have a safer crossing than pedestrians at a well-designed intersection involving two-way streets.

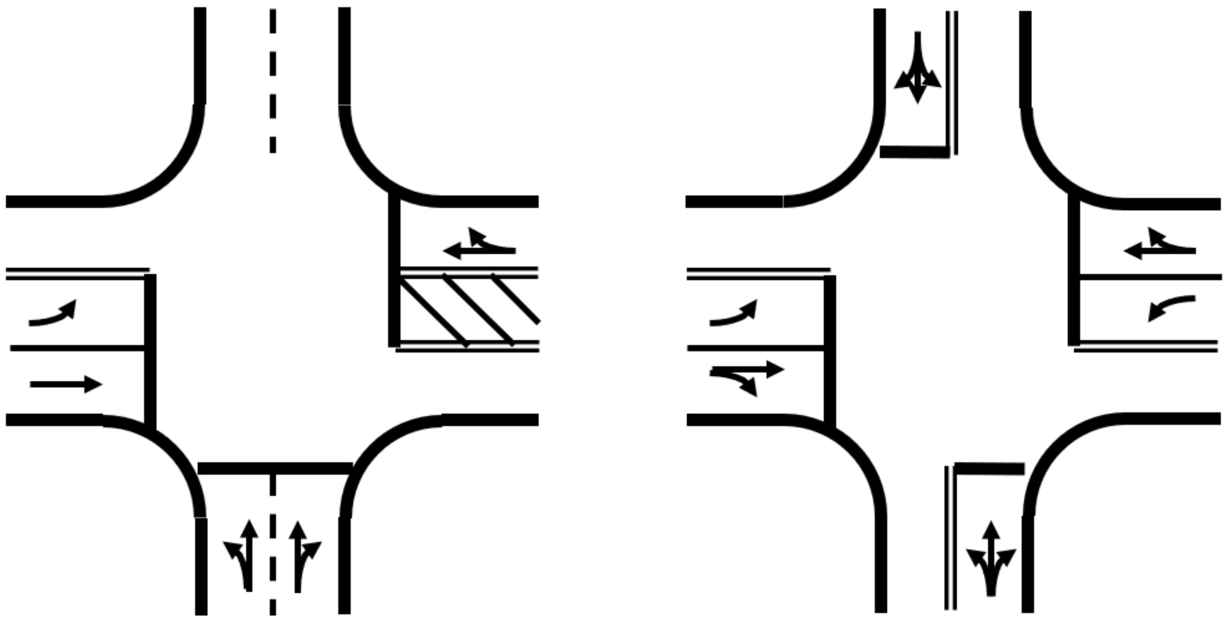

Figure 2. Two-lane one-way north-south conversion.

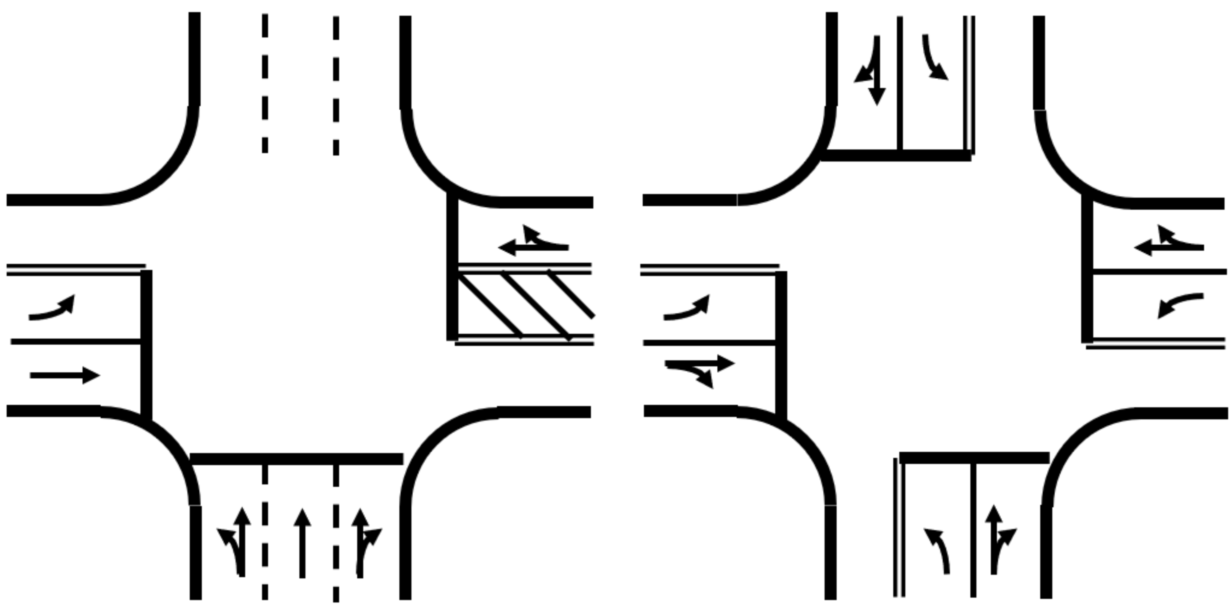

Figure 3. Three-lane one-way north-south conversion.

Table 3. 20-flag results.

Flag no.	Flag name	Flag type (Y = yellow, R = red)															
		One-way two-lane				Two-way two-lane				One-way three-lane				Two-way three-lane			
	Approach:	W	E	N	S	W	E	N	S	W	E	N	S	W	E	N	S
1	Right turns		R	R		R	R	R	R		R	R		R	R	R	R
2	Tight walking																
3	Non-intuitive	R								R							
4	Uncontrolled path																
5	Indirect path																
6	Unusual movements																
7	Multilane crossing	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
8	Long red time			Y	Y	R	R	R	R			Y	Y			R	R
9	Undefined crossing																
10	Left turns	R		R				R	R	R		R		R	R	R	R
11	Driveways																
12	Sight distance																
13	Grade change																
Total yellow		6				4				6				4			
Total red		5				10				5				10			

Efficiency

The discussion of the efficiency of a one-way to two-way conversion turns somewhat on the number of travel lanes on the street to be converted. Figure 2 (above) showed an intersection at a typical conversion with two lanes on the converting street, while Figure 3 showed an intersection at a typical conversion with three lanes on the converting street. It is easy to see from the diagrams that one-way streets are much more efficient for travelers than two-way streets. When a two-lane street is converted, the resulting two-way street does not have left turn lanes at intersections. When a three-lane street is converted it loses a through lane.

A look at the signal phasing provides more detail on why one-way streets are more efficient than two-way streets. At the one-way intersections in Figure 2 or 3 the signal would have three critical phases, including one phase for minor street left turns (the minor street is east-west in Figures 2 and 3), one phase for the minor street opposing throughs and right turns, and one phase for the major street (northbound as shown in Figures 2 and 3). However, the two-way streets on the right sides of Figures 2 and 3 would need four critical phases; the minor street would still have two critical phases but the major street would also need two critical phases. The three-lane conversion in Figure 3 would result in a third critical phase for left turns from the major street and a fourth critical phase for the major street opposing throughs and right turns. Meanwhile, the two-lane conversion in Figure 2 would result in a highly inefficient split phase, with a third phase for northbound movements and a fourth phase for southbound movements. With a conversion, major street through movements would go from receiving, typically, 50 percent of the cycle time as green to, typically, 25-30 percent of the cycle as green. Regardless of the green split, going from three critical phases to four introduces a “lost time” penalty of about four percent of the cycle; in other words, an additional four percent of all time at the signal would be wasted due to additional starting and stopping.

The effects described in the previous paragraph are well known but it could be helpful to see some numbers to illustrate the size of the effects so we developed Table 4. Table 4 shows demand to capacity (v/c) ratios for typical major and minor street demands based on critical lane calculation techniques. The critical lane technique makes many assumptions that should be detailed in an analysis of a particular case but should hold up on average for NC urban and suburban conditions. A v/c of 0.9 typically means level of service E conditions—full but not gridlocked—while anything under 0.7 means little delay and anything over 1.0 means spillback and long delays. Cases with a v/c of 0.9 or above are highlighted in the table. The results in Table 4 show that with a two-lane major street a conversion means a loss of 29 to 67 percent of v/c, with many cases changing from good operations to spillback. These large deteriorations are mainly because the two-way street needed the split phase signal timing described above. Table 4 shows that a three-lane conversion means a loss of 15 to 30 percent of v/c, with only a couple of cases analyzed going from good operations to congestion or spillback.

Table 4. Typical v/c ratios for potential two-lane and three-lane conversions.

Major AADT, vpd	% major demand in peak direction	Demand for each turn, vph	Minor through demand, vph ea. direction	Two-lane major street				Three-lane major street			
				One-way v/c	Two-way v/c	Diff. in v/c	% diff. in v/c	One-way v/c	Two-way v/c	Diff. in v/c	% diff. in v/c
15000	50	100	150	0.48	0.75	0.26	54	0.41	0.50	0.09	23
			300	0.59	0.85	0.27	46	0.51	0.61	0.10	19
		200	150	0.64	0.91	0.27	42	0.56	0.66	0.10	17
			300	0.74	1.02	0.27	37	0.66	0.76	0.10	15
	60	100	150	0.53	0.75	0.22	41	0.44	0.55	0.11	25
			300	0.63	0.85	0.22	35	0.54	0.65	0.12	22
		200	150	0.69	0.91	0.22	33	0.59	0.70	0.11	19
			300	0.79	1.02	0.23	29	0.69	0.81	0.12	17
25000	50	100	150	0.64	1.06	0.43	67	0.51	0.66	0.15	30
			300	0.74	1.17	0.43	59	0.61	0.76	0.16	26
		200	150	0.79	1.23	0.44	55	0.66	0.82	0.15	23
			300	0.89	1.33	0.44	49	0.76	0.92	0.16	21
	60	100	150	0.71	1.06	0.35	50	0.56	0.74	0.18	32
			300	0.81	1.17	0.36	44	0.66	0.84	0.19	28
		200	150	0.87	1.23	0.36	41	0.71	0.89	0.18	26
			300	0.97	1.33	0.36	38	0.81	1.00	0.19	23

Table 4 and the discussion above account for motorist delay at an isolated intersection but on most one-way pairs intersections are not isolated and progression between signals is important. Progression is the ability to drive through two or more signals on green at a steady speed. Progression is one of the primary advantages of a one-way street. Signals along a one-way street are much easier to progress than on a two-way street. In fact, good two-way progression is possible at any signal spacing and any speed with a one-way pair design. However, Table 5 shows that the signal spacings that allow good two-way progression (bandwidth at least 40 percent of cycle) on a two-way street with conventional signals are very limited. Note that on a two-way street with split phase signals two-way signal progression is virtually impossible.

Table 5. Limits of good two-way progression on a two-way street with conventional signals.

Cycle length, sec	Speed, mph	Signal spacings that allow good two-way progression, ft
120 (three phases)	25	0 to 440 and 1760 to 2640
	30	0 to 530 and 2110 to 3170
	35	0 to 620 and 2460 to 3700
160 (four phases)	25	0 to 590 and 2350 to 3520
	30	0 to 700 and 2820 to 4220
	35	0 to 820 and 3280 to 4930

The practical result from the spacings shown in Table 5 is that good two-way progression is not possible on most two-way streets. Engineers trying to provide progression on a former one-way pair are faced with a choice of providing good progression in one direction on both streets (the other direction of both streets will suffer), providing progression in one direction on one main street and the other direction on the other main street (likely resulting in highly unbalanced demands), or giving up on progression.

In an attempt to quantify the general effects of progression in proposed conversion cases we developed Table 6 from basic Highway Capacity Manual (6) calculations. Like the v/c calculations above, we made many assumptions to arrive at Table 6 and are confident that they cover most NC situations, but for particular conversion proposals analysts should use inputs specific to their site. For Table 6 we assumed 0.6 to 0.7 for the v/c for one-way streets and 0.9 for two-way streets. The percent arrivals on green numbers shown in Table 6 are default values from the Manual. Table 6 shows the estimated delay with no consideration of progression (i.e., random timing) and with signals timed for progression. The top row of data show that in the peak direction (60% of demand) in a one-way pair progression can reduce delay by 74 percent to a very small value; in the peak direction after conversion progression is still helpful, with a delay reduction of 27 percent, but not nearly to the level of a one-way system. Meanwhile, in the off-peak (40% of demand) direction of a one-way pair progression still helps a good bit with a 39 percent reduction, while in the off-peak direction of a pair of two-way streets motorists pay the price with 13 percent more delay than they would have had otherwise (highlighted cell in Table 6). Overall the table shows that signal progression is a wonderful tool in a one-way pair but of marginal usefulness once a two-way conversion has been made.

Table 6. Typical effect of progression on delay.

Concept	Direction	Arrivals on green, %	Delay not considering progression, sec/veh	Delay considering progression, sec/veh	Difference in delay, %
One-way	60% of demand	90	26	7	-74
	50% of demand	75	31	14	-55
	40% of demand	60	37	23	-39
Two-way	60% of demand	52	61	44	-27
	50% of demand	25	68	68	0
	40% of demand	6	76	86	+13

The paragraphs above on v/c and progression do not account for any changes in the demand pattern after a conversion. Demands could change in many different ways. At the very least, with a one-way pair there are always some extra miles driven due to property access; in a north-south one-way pair, for example, a northbound driver trying to access a driveway on the southbound street will have to drive past the driveway, make a turn onto an east-west street, and then another turn onto the southbound one-way street. In an extreme case, a conversion could result in such poor operations on the two-way streets that many motorists divert to other routes altogether. We are fortunate that good tools to estimate demands at the corridor level are available—at NCDOT, the dynamic traffic assignment tool in Transmodeler has proven useful in many cases—and if there is any possibility of sizable demand changes due to a conversion a detailed demand prediction should be made.

Summary

One-way to two-way conversions have been proposed and, on occasion, executed in NC and elsewhere for several decades, and requests continue to come in. As this document showed, there are no general and easy answers that fit all such cases. There are pluses and minuses for one-way streets relative to two-way streets for safety, walkability, and efficiency. If the previous paragraphs showed a pattern, it was that one-way streets are generally:

- Better for safety if a corridor has a dense network of major intersections, as one-way streets are usually safer at major intersections and less safe between signals;
- Better for crossing pedestrians; and
- Better for efficiency, with higher capacity and superior progression, although changes in demand patterns could offset some of that.

In turn, this could lead us to some very general guidelines, in that we should not convert from one-way to two-way when:

- There are shorter segments between signals;
- The crash frequencies in the past few years are low, showing little potential for safety improvement;
- There are higher pedestrian demands;
- Vehicular demands are higher and are already near capacity in peak periods; or
- A large proportion of the demand is through, longer-distance, or freight traffic, such as on a US or NC numbered route or a connection to a freeway.

When the opposite conditions prevail, converting from one-way to two-way makes much more sense in general. We should also note that conversions on two-lane streets that result in split phasing of the signal on the new two-way street are particularly inefficient and have other difficulties.

The guidelines shown above are general however. One-way conversions are so important and have such profound impacts that a thorough analysis will almost always be justified. Fortunately, excellent tools are available to analysts these days to allow those analyses to be conducted thoroughly and quickly. The tools include:

- Demands can be predicted using dynamic traffic assignment, conducted with Transmodeler;
- Travel efficiency can be estimated using Transmodeler (note that it makes little sense to do a macroscopic traffic analysis after a microscopic demand estimation);
- Crashes can be predicted using the HSM second edition (hopefully NC calibration of the one-way street models will occur soon, but using uncalibrated models in the meantime would still be helpful); and
- Walkability can be checked using the 20 flags method from NCHRP 948.

Figure 3 provides a flowchart that shows the general work flow when considering a one-way to two-way conversion.

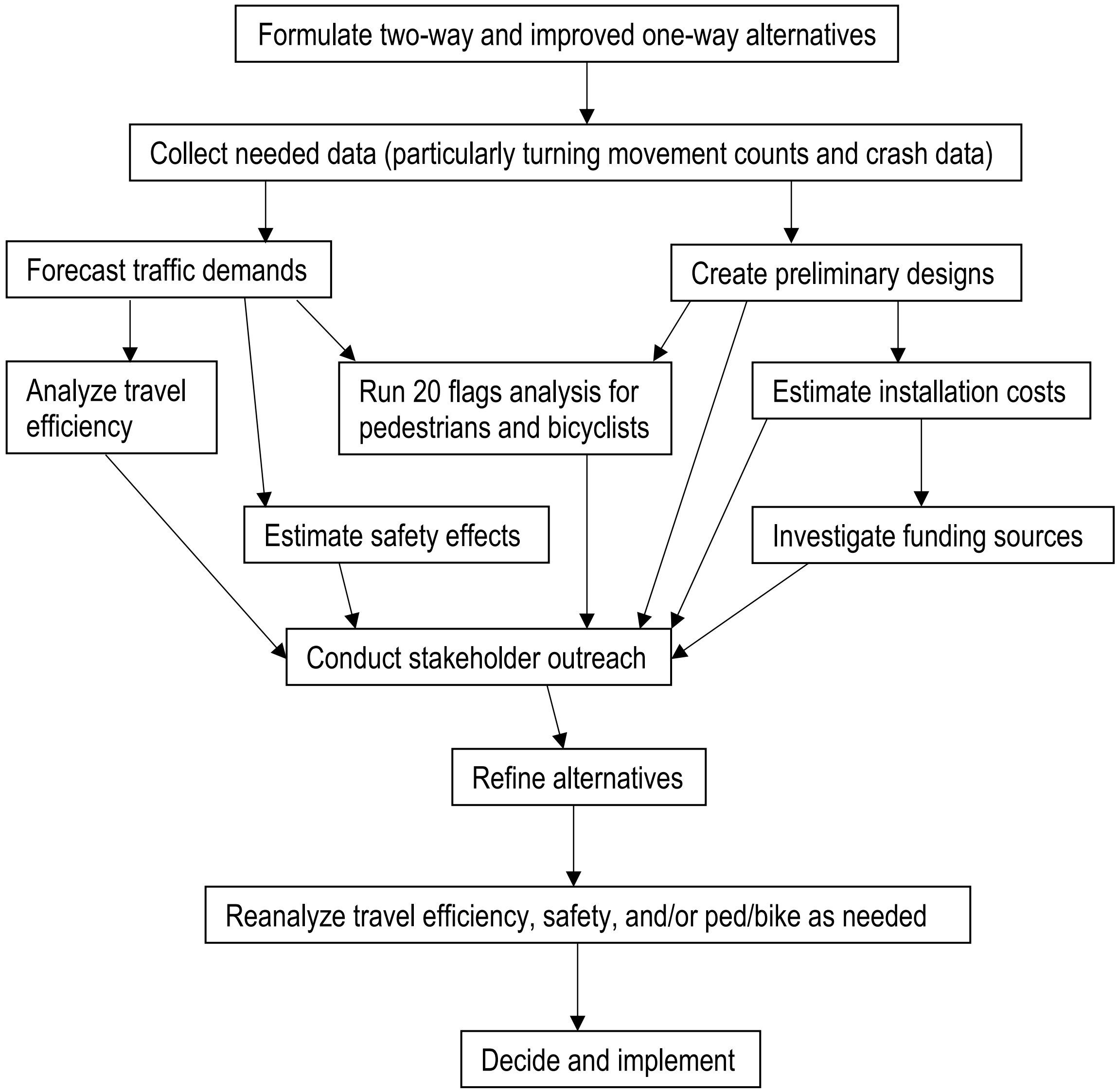

Figure 3. General work flow while considering a one-way to two-way conversion.

Of course there are other factors to consider in a final decision besides safety, walkability, and travel efficiency. Conversion costs can be substantial, and funding sources can be fickle. A range of potential impacts on a wide variety of stakeholders should be considered. Impacts during any construction can be high as well.

We also urge anyone considering a one-way to two-way conversion to think about other alternatives as well, as there is a growing list of such possibilities. First, agencies thinking about a conversion should also consider a "quasi couplet" (7). A quasi couplet usually works on a pair of three-lane or four-lane major streets by restriping so both streets have two-way traffic but there are more lanes in one direction on one street and in the other direction on the other street, with signal progression favoring the direction with more lanes. Second, another alternative to a typical conversion, particularly in dense grid street networks, is to prohibit left turns at many intersections, which encourages drivers wishing to go left to make three right turns instead (8). Proponents of two-way travel get their outcome without adding signal phases or split phasing. Finally, there are a number of options available to improve a one-way pair instead of removing it, including:

- Narrow each street to two lanes, taking advantage of the great efficiency of the one-way system;
- Apply curb bump outs at intersections to slow turns and shorten pedestrian exposure;
- Use leading pedestrian intervals and exclusive pedestrian phases;
- Allow on-street parking to build business and help slow speeds;
- Use slower progression speeds; and
- Install midblock signals to slow speeds and enhance pedestrian crossing.

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