



Underlying Traffic Signal Control: The Key to Effective Transit Signal Priority

A Case Study of MBTA Bus Route 39 along South Huntington Avenue, Boston, MA

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Abstract

On Route 39, the MBTA's* fourth-busiest bus route, buses experience an average delay of 43 s at the Perkins and Bynner Street intersections along South Huntington Ave (Figure 1). While simply implementing Green Extension (Figure 2), a Transit Signal Priority (TSP) tactic, alone provides limited bus delay reduction, combining it with a TSP-friendly signal control logic and a TSP-friendly intersection layout cuts the delay down to just 5 s. This strategy also reduces pedestrian wait times by more than 60%, without sacrificing bike lanes or parking. Microscopic traffic simulations using PTV Vissim reveal that this smart approach does not even increase auto delay.

TSP-Friendly Traffic Signal Control

- The effectiveness of Green Extension mainly depends on (a) how long an extension can be granted (which depends on whether the stop is near-side or far-side) and, (b) the duration of the bus street red phase.
- TSP applied to an existing signal plan can reduce bus delay slightly, but bus delay could be significantly reduced if the bus street red time were shorter and if all stops were far-side. For example, at Perkins Street during the a.m. peak, the red time for S Huntington Ave (the bus street) is 80 seconds. Therefore, even with a far-side stop and a 20-second Green Extension, northbound buses could still experience a 60-second delay!
- Using standard intersection capacity analysis and some clever signal cycle design, we found that the traffic and pedestrian needs of these intersections can be met with cycles ranging from 40 to 70 s, a lot shorter than the cycles that operate today (Figure 3). The key to enabling short cycles is making the pedestrian crossings concurrent with the parallel vehicle phase instead of making pedestrians wait for an exclusive pedestrian phase.
- Figure 4 illustrates both existing and proposed phasing plans (they apply at both intersections). The proposed timing plans were designed to more than satisfy Boston's limits on permitted conflicts. In the a.m., high eastbound left-turn volumes are handled by making Stage 1 long enough to allow most left turns to clear, with fewer than 2.0 left turns per cycle during Stage 2. In the p.m., due to low left-turn volumes, the plan only has two stages, with Stage 2A starting with a 4-second Leading Pedestrian Interval (LPI) to manage high right-turn volumes from South Huntington.

* MBTA = Massachusetts Bay Transportation Authority

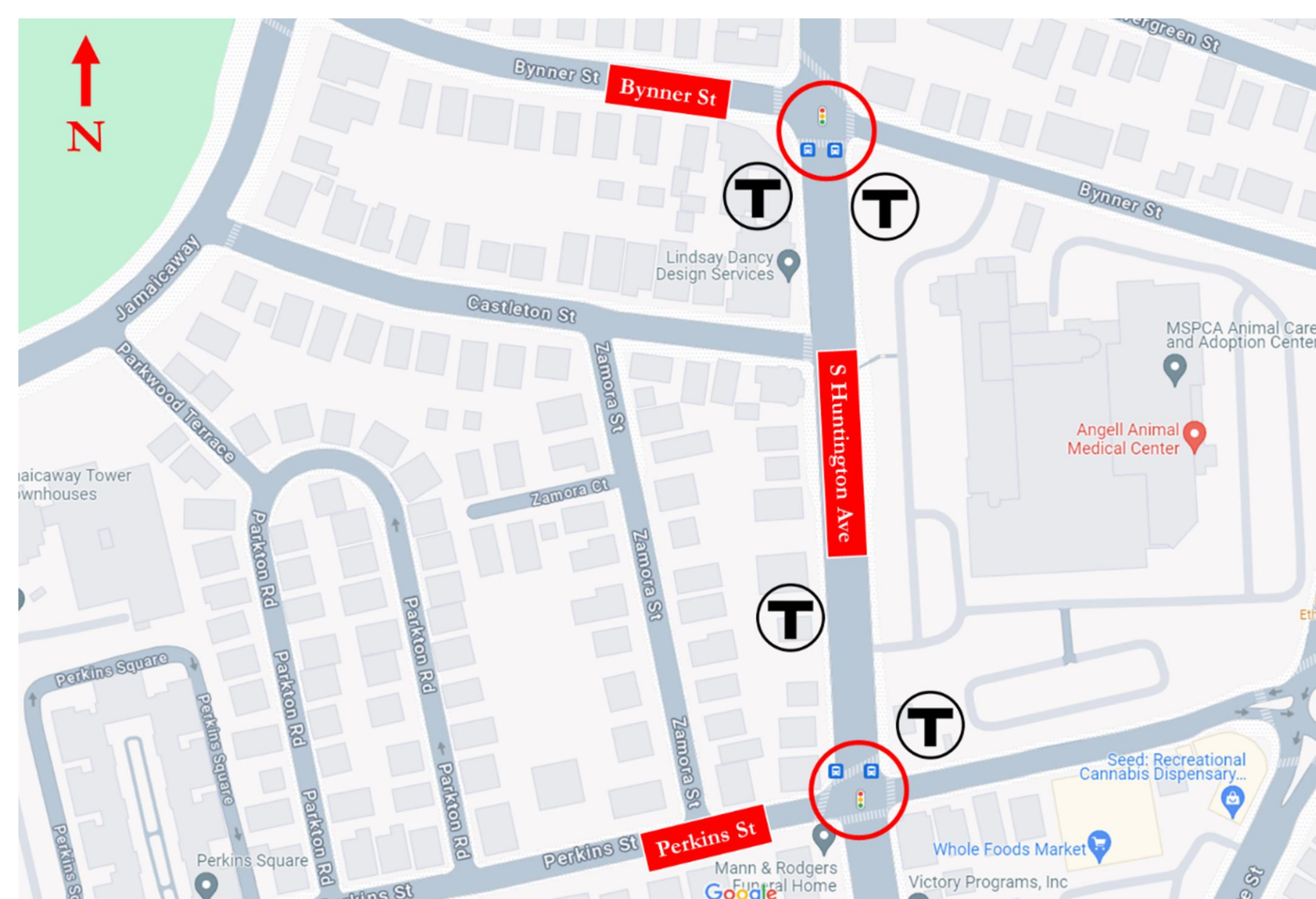


Figure 1. S. Huntington Ave, with intersections of interest and bus stops indicated. Google Maps, 2024.

A bus that would have arrived at the intersection on red will request for Green Extension so it makes it through the intersection with no delay

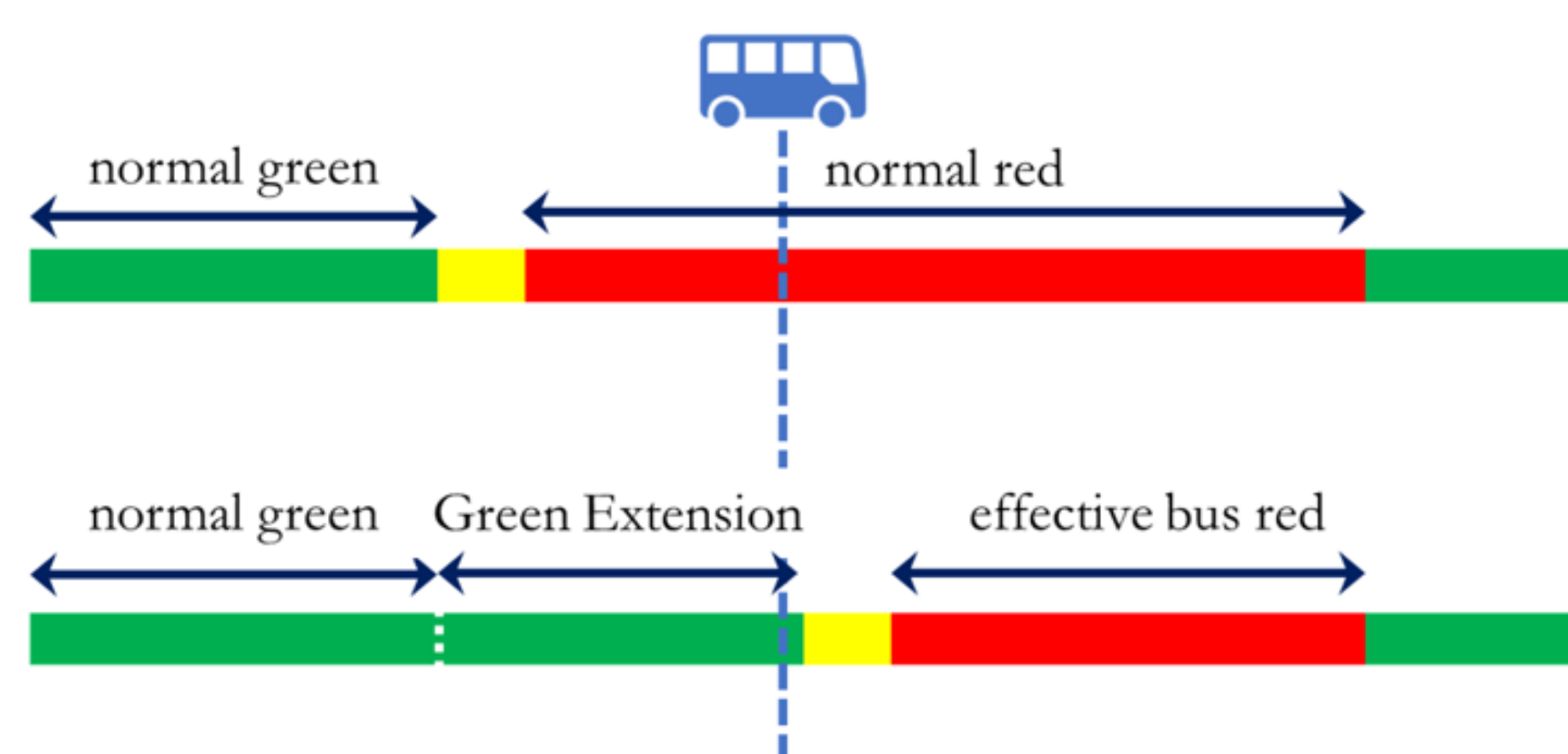


Figure 2. Illustration of Green Extension

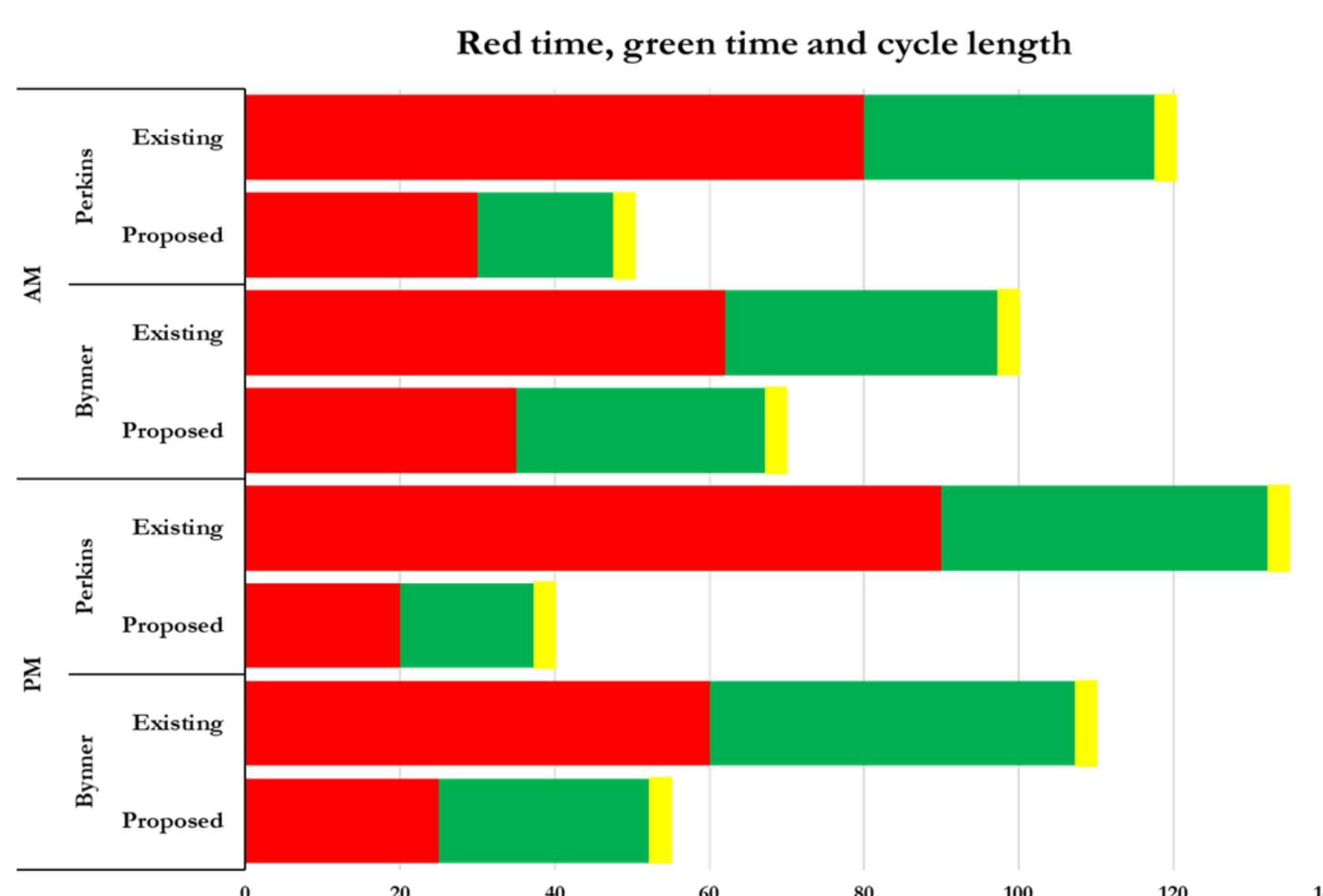


Figure 3. Existing and Proposed Red Times, Green Times, and Cycle Lengths

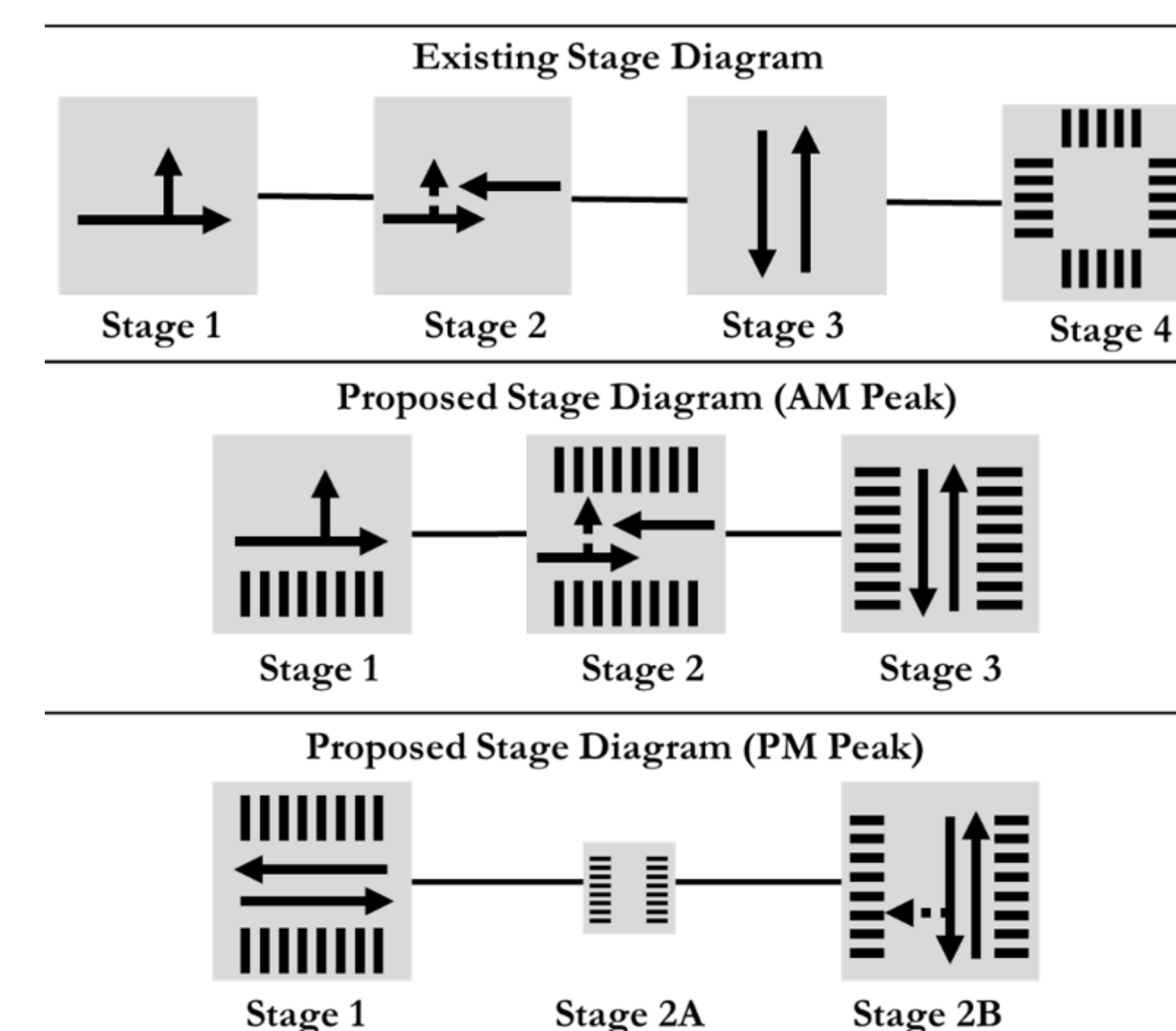


Figure 4. Stage Diagram for Both Intersections

	Stage 1	Stage 2	Stage 3	
AM Peak				
Perkins St	7 3 1	16 3 1	15 3 1	50
Bynner St	7 3 1	20 3 1	31 3 1	70

	Stage 1	Stage 2A	Stage 2B	
PM Peak				
Perkins St	16 3 1	4	12 3 1	40
Bynner St	20 3 1	4	23 3 1	55

* RCI = red clearance, LPI = leading pedestrian interval

Figure 5. Proposed Timing Plans

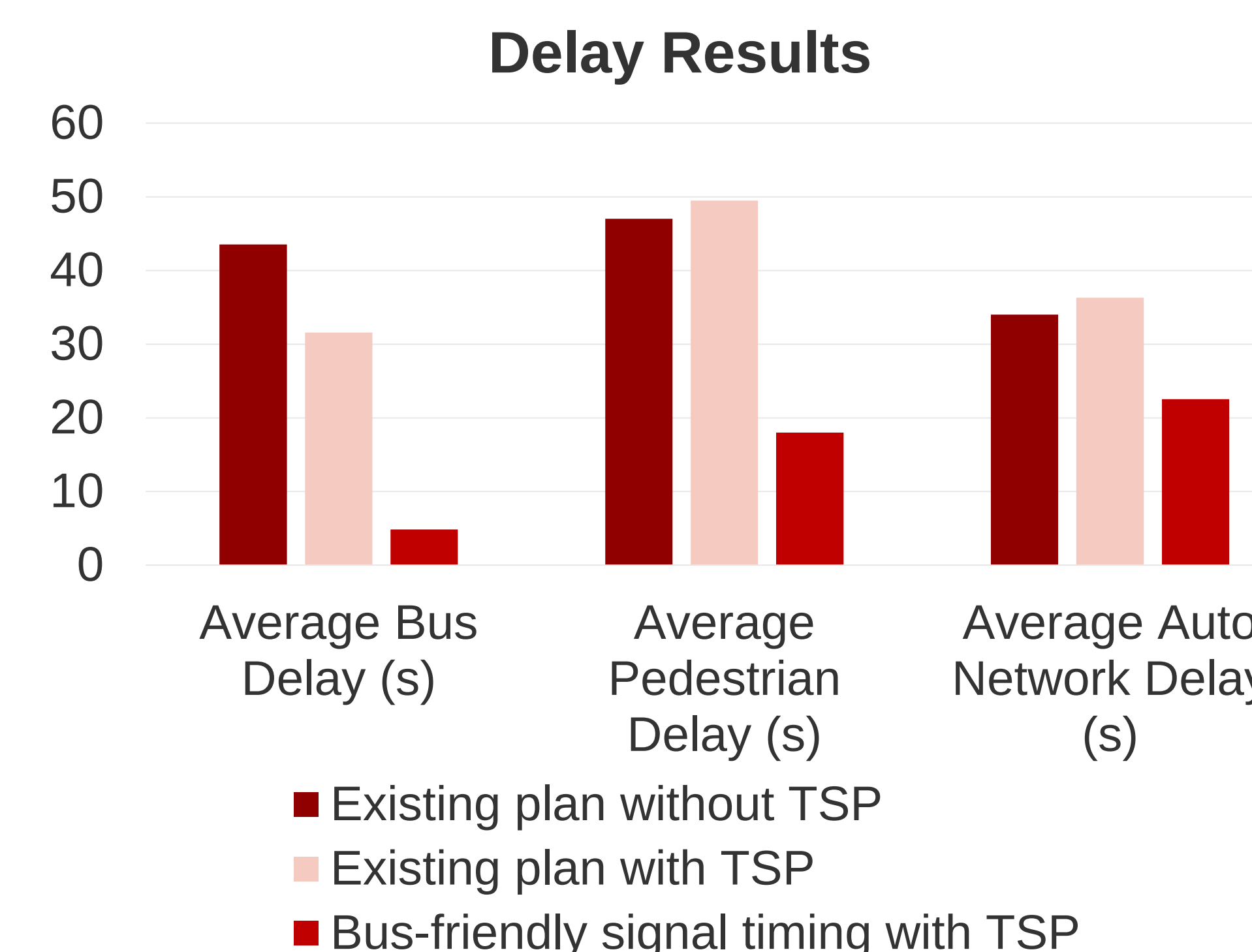


Figure 6. Bus, Auto, and Pedestrian Delay Results for Each Alternative

TSP-Friendly Intersection Layout

- For TSP to be effective, we first moved the two near-side stops to the far side (see Figure 1). Far-side stops they allow the advance notice necessary for Green Extension.
- A second needed layout change is to add short left-turn pockets to the South Huntington Ave approaches. When a vehicle turns left, they block through vehicles, including buses, causing long bus delays.
- The left turn pockets can be very short – long enough to hold 1 car so that buses and other thru traffic can bypass it. This change will not affect the protected bike lanes, and only two parking spaces will be lost.

Results

The corridor was simulated using PTV Vissim. Three alternatives were tested: existing, existing with TSP overlayed, and the proposed timing plan with TSP and TSP-friendly intersection layout. The weighted average delay results for both intersections, periods and directions have been summarized in Figure 6.

Discussion and Conclusions

- From the results, we found that while adding TSP alone reduces bus delay to some extent, TSP coupled with TSP-friendly traffic signal timing and a TSP-friendly intersection layout can make bus operations almost free from traffic delay.
- Also, pedestrian delay, averaged over all crosswalks, falls dramatically with the proposed timing and TSP. With concurrent crossings and such low average delay, pedestrian compliance is bound to improve substantially. It is noteworthy that if TSP is merely overlaid on the current timing plan, pedestrian delay actually worsens.
- Lastly, simply adding TSP increases auto delay by just a little. However, because the proposed timing plan is so much more efficient than the current plan, auto delay falls a lot, even though buses have the power to interrupt the signal cycle for up to 20 s.

Traffic Signal Coordination

On corridors with closely-spaced intersections (quarter mile or less), signals are sometimes coordinated. We tested coordinating the two signals for buses, but it turned out that because of how frequent the Route 39 service is, coordination would actually worsen delay for buses (and cars as well) because once a bus interrupts the cycle, the signals often don't have time to get back in sync before another bus arrives at the intersection.

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