Reducing Pedestrian Delay at Half Signals in the City of Portland, OR

Striving to increase safety and decrease delay for pedestrian trips

Report by
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Executive Summary

In an effort to reduce pedestrian delay and increase pedestrian safety, the City of Portland, Oregon is in the process of reviewing and modifying the signal timing at half-signals. Thus far, 25 out of 47 half-signals have been made more responsive to pedestrians. Signals were adjusted using a variety of techniques including taking the signal out of coordination, increasing the permissive period, and reducing the minimum green time. Changes made resulted in a 25.3% reduction of the overall maximum pedestrian delay for the signals adjusted. The reduction in pedestrian delay at these crossings may result in increased foot trips and higher rates of pedestrian compliance with the pedestrian signal indications (*1*).

Background

In 2009, the City of Portland adopted a climate action plan with the goal of reducing carbon emissions to 40% below 1990 levels (*2*). To reach this goal, eighteen objectives were established, each contributing to the reduction of carbon emissions. Of these objectives, the sixth is to "reduce per capita daily vehicle-miles traveled (VMT) by 30 percent from 2008 levels" and is expected to account for 5% of the decrease in emissions (*2*).

Decreasing VMT is expected to come from reducing drive-alone trips and increasing trips made utilizing car pools, public transit, bikes, and foot. Trips made by foot are anticipated to change from 4% of the mode split in 2009 to 7.5% by 2030 (*2*).

Destinations identified as most likely reached from home by foot include grocery stores, restaurants, bars, other neighborhood businesses, parks, schools and public transit stops (*3*). Reaching these destinations often involves crossing one or more streets including busy arterials. As part of decreasing VMT, the City of Portland has worked to make trips made by foot safer and quicker. One component of this effort includes adjusting the operation of pedestrian crossings at the city's forty-seven half signals.

Figure 1: Proposed Mode Split 2009 vs. 2030 (Source: City of Portland, Climate Action Plan 2009)

Reducing pedestrian delay has been found to increase pedestrian compliance with the pedestrian signal (*4*). Studies have shown that when pedestrian wait-times are below 30 seconds, compliance is significantly better (*4,5*). One study of signalized mid-block crossings in Florida found that when minimum green times were 30 seconds, 98% of pedestrians waited for the walk indication to cross (*5*). As minimum green times increased, compliance decreased, and the instances of pedestrians being trapped at the center line while crossing increased (*5*). An increase in compliance is likely to increase safety as pedestrians trapped at center line are at higher physical risk than those waiting on the sidewalk to cross.

In Portland the most common configuration of these signals is a four-way intersection where the two approaches not controlled by the signal indications are controlled by stop signs. Other configurations include T and offset T intersections. The purpose of these signals is to provide a protected pedestrian crossing and they are typically used on pedestrian routes to schools and transit stops that cross busy arterials.

Figure 2: A Typical Half Signal in Portland

These signals remain green unless a pedestrian indicates a desire to cross the street by pressing a pedestrian push button located at the entrance to the cross walk. This call initiates the pedestrian phase, changing the vehicle signal to a red indication and providing a walk indication on the pedestrian signal. Due to the simple nature of the signal timing for these signals, many of the half-signals in Portland have not had the timing adjusted in over ten years and the delay for pedestrians between placing a call to cross the street and receiving a walk indication can be as high as 70 seconds. This large amount of delay has the potential to both discourage pedestrian trips and cause high rates of pedestrian signal non-compliance crossing the intersection when Do Not Walk is indicated on the pedestrian signal head.

The proximity of these signals to popular destination makes reducing pedestrian delay at these crossings a good method to reduce barriers to pedestrian trips. This contributes to Portland's Climate Action goal of reducing VMT while also improving pedestrian safety by encouraging higher rates of pedestrian compliance at the crossings. The following sections discuss the methods used to adjust the half-signals in Portland and the results of these adjustments.

Methods

The half-signals in Portland can be separated into two categories: free and coordinated. The methods used to reduce delay at each intersection were dependent on the category. Each is discussed below.

In both cases, the pedestrian crossing distance was measured and the pedestrian clearance interval was adjusted to meet current Manual on Uniform Traffic Control Devices (MUTCD) standards for crossing times that allow for a person traveling at a speed of 3.5 feet per second or faster to traverse the intersection within the pedestrian clearance interval. Also, the red change interval was removed where existing signal timing included a red change interval that followed the pedestrian phase. A buffer interval of at least 3 seconds after the end of the pedestrian clearance and prior to the vehicle green was ensured.

At intersections with an overhead internally illuminated flashing warning sign, the operation of the sign was adjusted to ensure uniform operation across the city. In some cases this also helped reduce delay. This reduction was due to eliminating existing operational logic that required the overhead sign to flash for ten seconds before terminating the vehicle phase.

<u>Free</u>

- Reduce the existing minimum green time for the approaches controlled by the signal.

Intersections running free all had minimum green times of 30 seconds or greater before adjustment. Due to the short existing cycle lengths and federal pedestrian interval requirements shortening cycle length to reduce pedestrian delay was not feasible without causing unacceptable increases in vehicle delay. In many cases, existing minimum green times were chosen as a measure to reduce vehicle delay in the case that a pedestrian push button malfunctioned and the pedestrian phase was called unnecessarily every cycle. Reducing minimum green times were made with the acceptance of this risk and view that civilian notifications of malfunctioning pedestrian push buttons would allow any extra vehicle delay due to equipment failure to be kept at a minimum.

<u>Coordinated</u>

Intersections with coordinated signals were adjusted using one or more of the below techniques:

- Evaluating traffic volumes to determine the appropriate times of the day to remove the intersection from coordination (set free).
- Increasing the permissive window.
- Adjusting the time of day/day of week schedule to make the signal more responsive during the times of day/days of the week when pedestrian traffic is

heavy. This may include increasing the permissive window, placing a recall on the pedestrian phase or setting the signal free during these times/days.

Evaluation of traffic volumes is important when determining whether or not to take a signal out of coordination. This is due to the potential increase in vehicular delay that may occur when setting a signal free. When traffic volumes are high the cumulative vehicular delay will cause an increase in vehicle emissions. This increase is likely to offset the reduced carbon emission facilitated by the increase in pedestrian trips and must be considered. Methods used to evaluate a coordinated signal are presented in the following case study.

Case Study: N. Lombard St. and N. Delaware Ave

N. Lombard St. is a major east-west arterial in North Portland and servers as a crucial route for both commercial and personal vehicle traffic. N. Delaware Ave. is a residential street and serves local vehicle, bike and pedestrian traffic. This pedestrian crossing provides an important pedestrian connection to bus stops on both the north and south sides of N. Lombard and to an elementary school one block north of Lombard on Delaware.

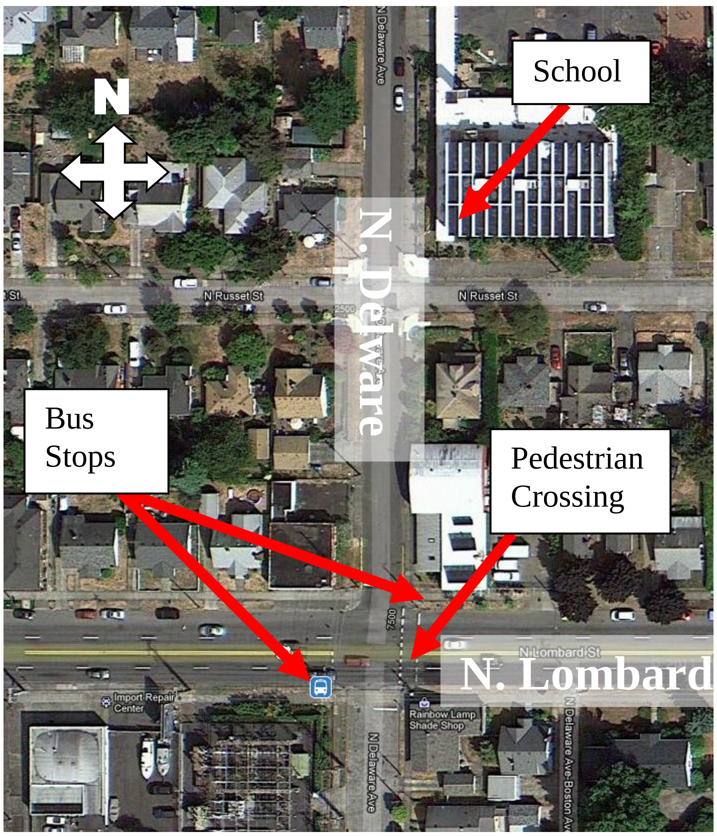

Figure 3: N. Lombard St and N. Delaware Ave.

The AM peak vehicle volumes on N. Lombard are 769 veh/hr eastbound and 759 veh/hr westbound. The PM peak vehicle volumes are 890 veh/hr eastbound and 739 veh/hr westbound.

Using the most recently available traffic count data a 24-hour weekday volume profile was created for N. Lombard and evaluated for times of day at which the signal could be taken out of coordination while minimizing the effect on vehicular delay (Figure 4). Evaluation of the intersection involved using the volume profile to assess a reasonable volume above which coordination was beneficial. In this case, approximately 575 veh/hr was chosen and engineering judgment was used to determine if acceptable delay was caused when running the intersection free below this volume. The analysis found that during weekdays the signal could run free from 10:00 PM to 6:00 AM. The signal was also set free from 3:00 PM – 3:30 PM in order to make it more responsive during heavy pedestrian activity caused by the end of the school day. In addition, the signal was taken out of coordination on Sundays and until 10:00 AM on Saturdays.

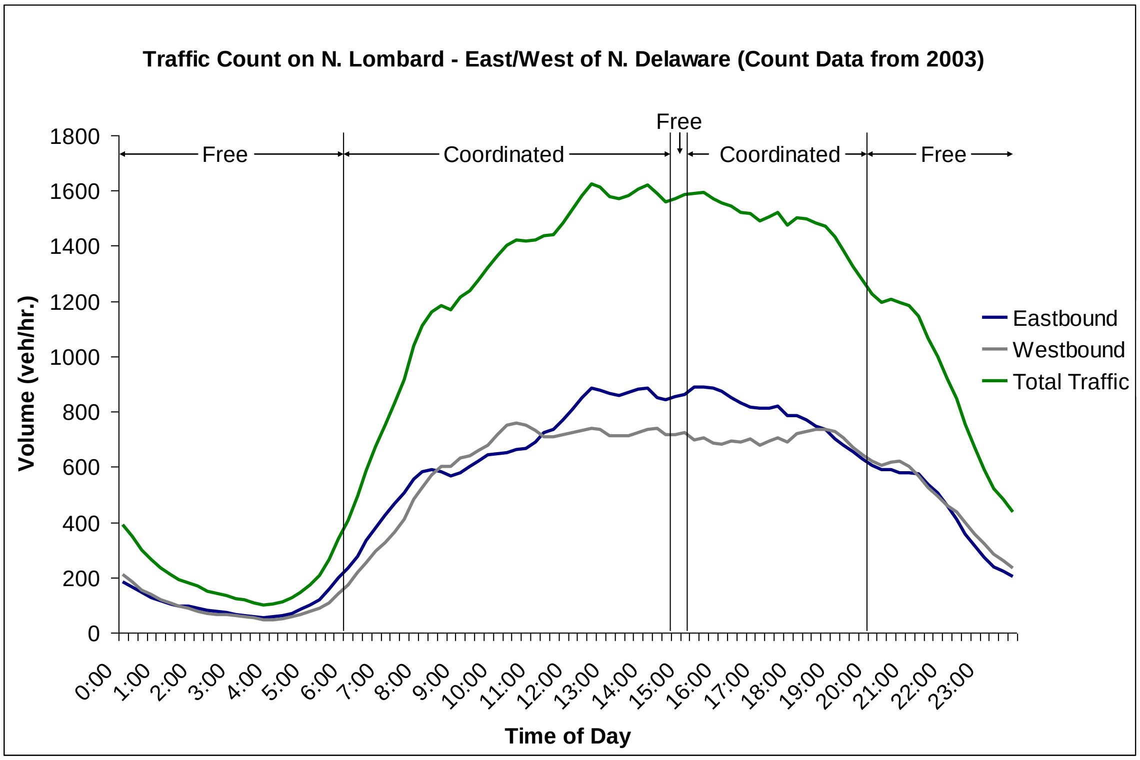

Figure 4: Volume Profile for N. Lombard at Delaware and Weekday Coordination Times

In addition to adjusting the times and days that the signal was coordinated and free, the permissive period was increased from 10 seconds to 20 seconds when in coordination. When operating in coordination, this change reduced the calculated maximum delay by 15.5%. When operating free, the maximum calculated delay was reduced by 77.5%. Formulas used to calculate delay are presented in the results section.

Results

Twenty-five of the forty-seven existing half-signals in Portland were examined and adjusted using the methods described above. A map of the location of these signals and those that remain in need of review is presented in Figure 5.

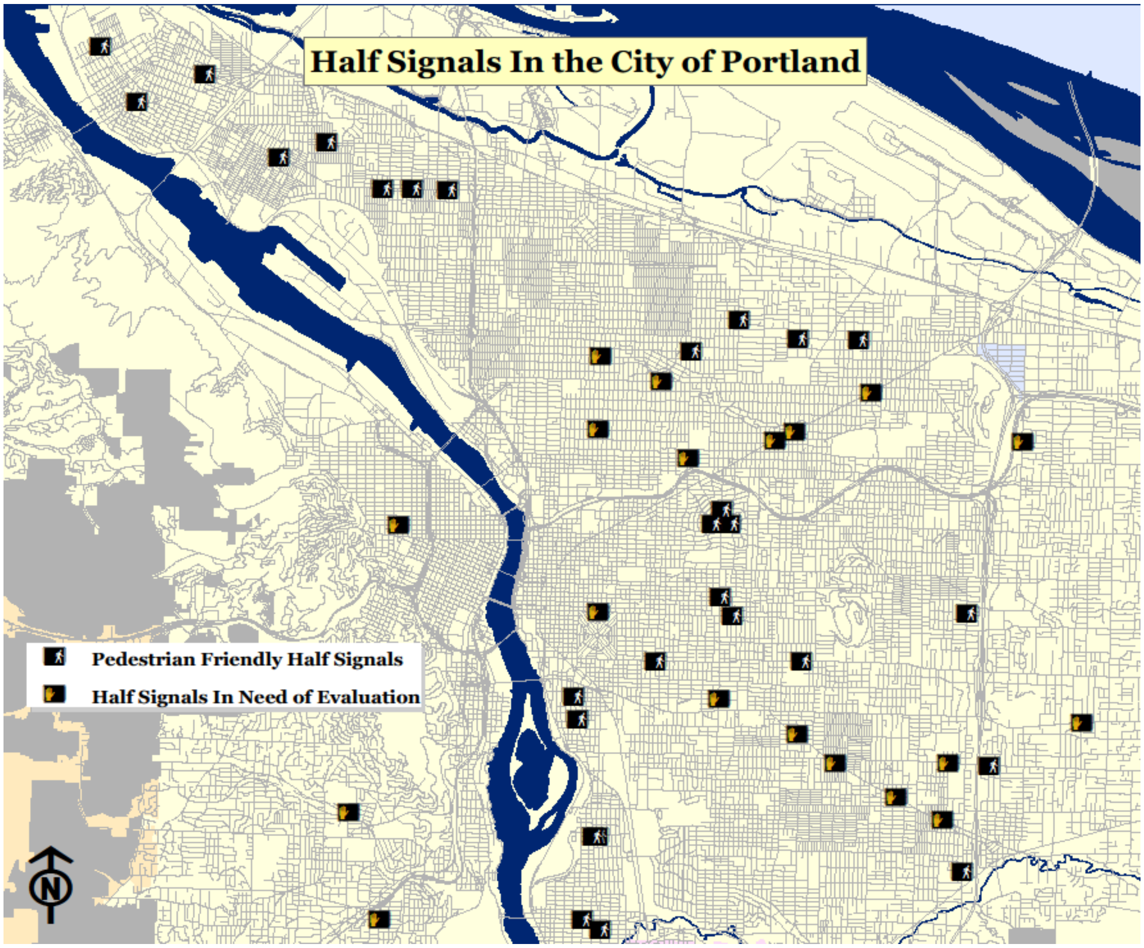

Figure 5: Location and Evaluation Status of Half-Signals in Portland, OR

The 2010 Highway Capacity Manual suggests using the following equation to evaluate pedestrian delay for signals with a pedestrian phase that is actuated, has a pedestrian signal head, and rest-in-walk not enabled:

Equation 1: $d_p=(C-g_{Walk})^2/2C$; where d_p is pedestrian delay in seconds per person, C is the cycle length, and g_{Walk} is effective walk time (*6*).

Effective walk time is found using:

Equation 2: $g_{Walk}=Walk+4.0$; where *Walk* is the pedestrian walk setting in seconds (*6*)

The above equation does not provide adequate information about delay for pedestrians using half-signals since these signals do not change phases unless actuated by a pedestrian. Instead, the maximum delay for a pedestrian may be used to access the worst case scenario for the signal. For half-signals that run free this delay is calculated using:

Equation 3: d_{max}=G_{min}+Y+R, where d_{max} is the maximum delay in seconds, Y is the yellow change interval for the signalized vehicle phase in seconds, and R is the red clearance interval for the signalized vehicle phase in seconds.

Maximum pedestrian delay at coordinated half signals can be calculated using:

Equation 4: d_{max}=C+Y+R-P where C is the cycle length in seconds, P is the permissive period in seconds and all other terms are defined previously.

Table 1-A in the appendix displays the maximum delay at the half-signals evaluated for this project before and after changes were made.

The changes made reflect a 25.3% overall decrease in maximum pedestrian delay for the adjusted half-signals. As indicated in the methods section, all signals were adjusted to meet current MUTCD standards for the pedestrian clearance interval and, where present, the uniform operation of overhead warning signs was implemented.

Conclusion

Results indicate that the average delay at half-signals adjusted in this project was reduced by between 2.5 seconds and 20 seconds. Maximum pedestrian delay was reduced by between 5 and 40 seconds. These changes will improve pedestrian safety at crossings and help encourage trips by foot to destinations that require the use of these crossings. The cumulative effect of these changes will help the City of Portland achieve its goal of reducing local carbon emissions to 40% below 1990 levels.

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6. *Highway Capacity Manual.* Transportation Research Board. Washington, D.C 2010

Appendix

Table 1-A: Maximum Pedestrian Delay Before and After Adjustment of Half-Signal

Half Signal Location	**Maximum Delay Before Changes (seconds)**	**Maximum Pedestrian Delay After Changes (seconds)**	**Percent Reduction of Max Delay**
N Lombard St & Reno Ave	31	21	32.3%
N Willis Blvd & Wayland Ave	65	25	61.5%
N Lombard St & John Ave	29	29	0.0%
N Lombard St & Hodge Ave	63.5	35.5	44.1%
N Lombard St & Drummond Ave	40.5	35.5	12.3%
N Lombard St & Delaware Ave	64.5	54.5	15.5%
N Lombard St & Fenwick Ave	35.5	35.5	0.0%
N Fessenden St & Burr Ave	33	33	0.0%
NE Mason St & 33rd Ave	65	35	46.2%
NE Alberta Ct & 42nd Ave	35	35	0.0%
NE Prescott St & 54th Ave	69.5	24.5	64.7%
NE Prescott St & 68th Ave	35	35	0.0%
NE Glisan St & 41st Ave	55.6	40.6	27.0%
NE Royal Ct & 39th Ave	55.5	40.5	27.0%
NE Glisan St & Laddington Ct	55.6	40.6	27.0%
SE Hawthorne Blvd & 41st Ave	69.2	60.2	13.0%
SE Division St & 57th Ave	60.6	60.6	0.0%
SE Main St & 92nd Ave	55.2	40.2	27.2%
SE Milwaukie Ave & Bush St	25.6	25.6	0.0%
SE Holgate Blvd & 97th Ave	55.6	40.6	27.0%
SE Cooper St & 92nd Ave	55.6	40.6	27.0%
SE Tolman St & 17th Ave	55.6	40.6	27.0%
SE Milwaukie Ave & Tolman St	55.6	40.6	27.0%
SE Division St & 28th Pl	65.8	50.8	22.8%
SE Milwaukie Ave & Pershing St	55.6	40.6	27.0%