Evaluation of High Visibility Crosswalks Using Video Analytics

Prepared for:
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FEHR PEERS

AMAG
REIMAGINE TRANSPORT ANALYTICS

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Introduction

Bellevue's Vision Zero traffic safety initiative is rooted in the Safe System approach that considers safe speeds, safe people, safe vehicles, and safe streets. The Safe System approach is further supported through civic leadership, building a culture of safety, developing partnerships, and leveraging data to reach the goal of zero deaths and serious injuries on Bellevue's streets. As part of Bellevue's Vision Zero goal, the city has begun installing high visibility crosswalks—a documented safety countermeasure—at signalized intersections throughout the community. Figure 1 shows an example of a high visibility crosswalk in Downtown Bellevue.

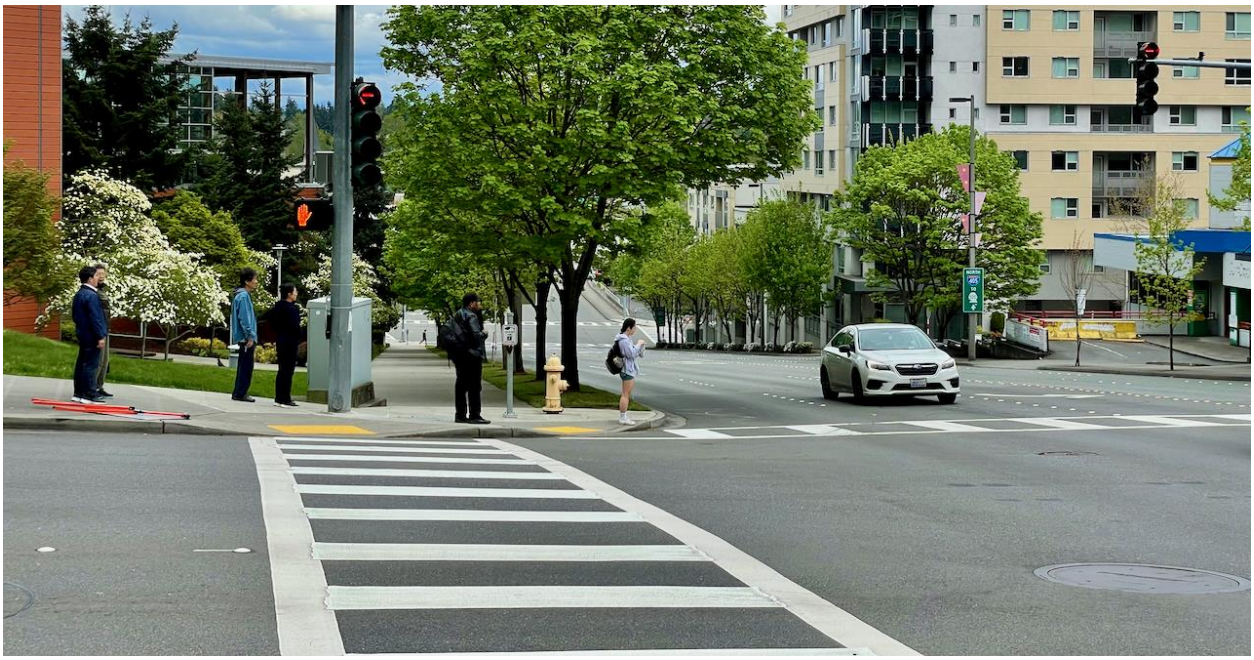

Figure 1 – High Visibility Crosswalk at NE 4th Street and 110th Avenue NE

Consistent with the Safe System approach, Bellevue is leveraging new partnerships with Advanced Mobility Analytics Group (AMAG), Amazon Web Services, T-Mobile, Ouster, Outsight, and Fehr & Peers to provide an in-depth, data-driven analysis of the effectiveness of high visibility crosswalks. This report summarizes the findings of the high visibility crosswalk analysis.

Study Location and Analysis Methods

To identify potential safety benefits of high visibility crosswalks, a before-and-after analysis was performed at the Bellevue Way/NE 8th Street intersection in Downtown Bellevue. This location was selected since it has a combination of high vehicle and pedestrian volumes. Figure 2 shows the before (July 2022) and after (October 2022) configuration of the crosswalks at this intersection.

Figure 2 – Bellevue Way/NE 8th Street Intersection Before and After High Visibility Crosswalk Installation

The safety analysis was performed using video analytics, which uses a high-resolution camera and algorithms powered by artificial intelligence and big data analytics to automatically detect, identify and track of moving objects in the videos of road and intersection users. The images in Figure 3 are direct output from the video analytics camera. Figure 3 shows the trajectories of road users detected at the Bellevue Way/NE 8th Street intersection.

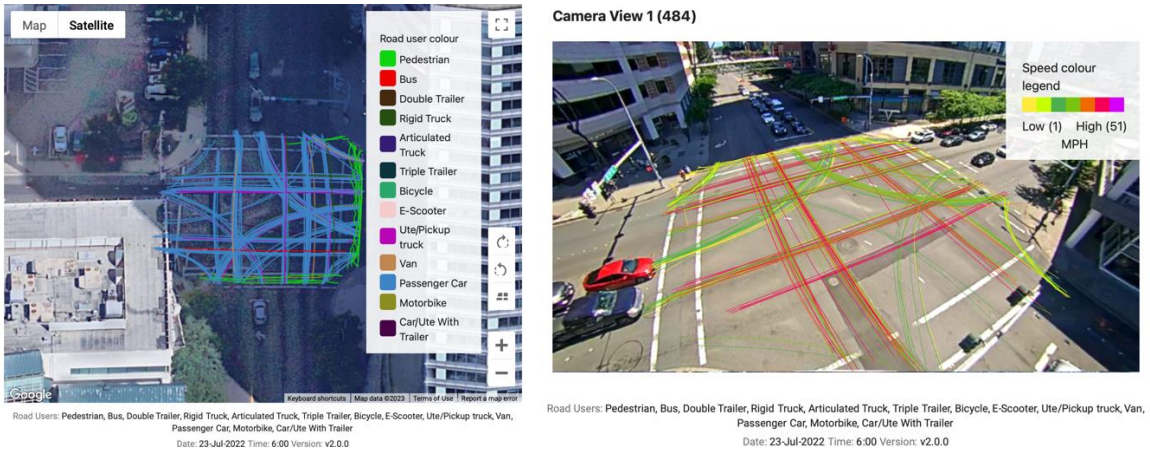

Figure 3 – Bellevue Way/NE 8th Street Intersection Vehicle Trajectories as Identified by Video Analytics

Video analytics is an unparalleled tool for evaluating the safety benefits of high visibility crosswalks since it can continuously monitor conditions (and can derive conclusions in several weeks in some conditions) and investigate the interactions of thousands of vehicles, pedestrians, bicycles, and other road users. Video analytics can therefore observe more subtle shifts in road user behavior that are not evident with traditional methods, such as reviewing crash reports or more sporadic direct observation of a location. A key output provided by video analytics are "conflicts."

A conflict is defined as a safety event of interest that occurs between two or more road users (such as vehicle with vehicle, vehicle with pedestrian, or vehicle bicycle/scooter) that has a proven relationship to crashes. It's important to note that the relationship between conflicts and crashes does not require the presence of evasive actions (such as heavy braking or swerving). Post-encroachment time is one metric to identify these events of interest which measures the time elapsed between road user "a" leaving a crossing point and road user "b" arriving there.

For this study, Bellevue partnered with Advanced Mobility Analytics Group to leverage their SMART Road Safety Analytics Platform. A screenshot of the SMART platform is shown in Figure 4.

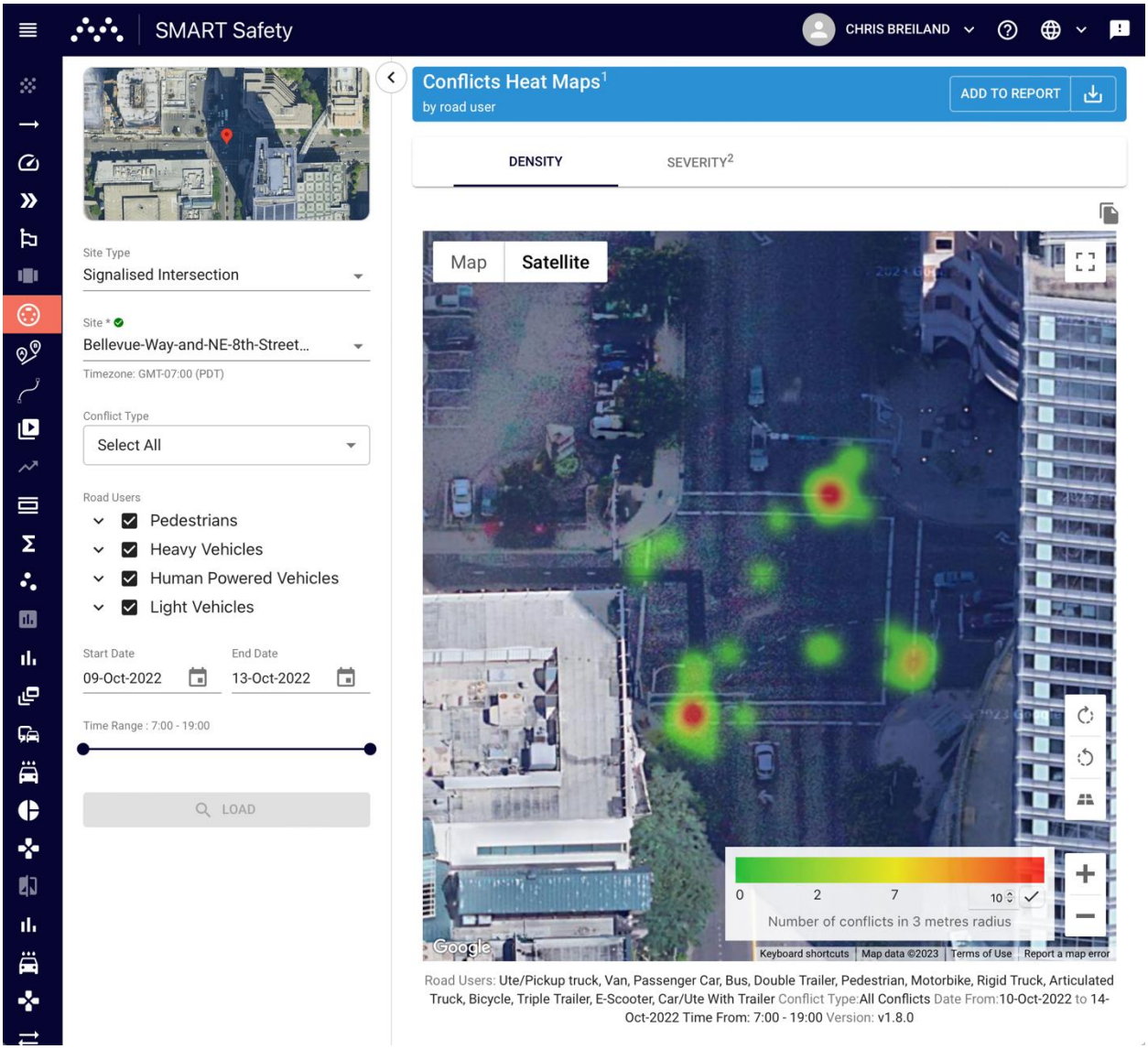

Figure 4 – Screenshot of the SMART Road Safety Analytics Platform Showing Conflict Areas at Bellevue Way/NE 8th Street

Evaluation Results

Using the SMART Road Safety Analytics Platform, road user conflicts were evaluated before and after the installation of high visibility crosswalks at the Bellevue Way/NE 8th Street intersection:

- **Before Period:** July 25-July 29, 2022
- **After Period:** October 10-October 14, 2022

To ensure adequate lighting for accurate video detection, the analysis was limited to the hours of 7AM-7PM.

Based on the SMART Road Safety Analytics Platform the average hourly flows in the before and after period are summarized in Table 1. These results show similar total vehicle flows during the before and after period. Pedestrian flows are 14% lower in October compared to July, which is logical given the difference in weather. Note that there were an inconsequential number of bicycles and scooters identified during the analysis periods.

Table 1: Before and After Period Vehicle and Pedestrian Flows at Bellevue Way/NE 8th Street

Period	Total Vehicles	Total Pedestrians
Before (July 2022)	2,176 vehicles/hour	350 pedestrians/hour
After (October 2022)	2,219 vehicles/hour	300 pedestrians/hour
Difference	+2%	-14%

Note: Data summarize weekday conditions between 7AM and 7PM
Source: AMAG, 2022; Fehr & Peers, 2023.

Using the flow data, the SMART Road Safety Analytics Platform can calculate conflict rates that normalize differences in total flows. The before and after conflict rates per 1,000 road users are presented in Table 2. Total observed conflicts are presented in Table 3.

Table 2: Before and After Conflict Rates at Bellevue Way/NE 8th Street

Period	Right Angle	Opposing Approaches	Rear End	Pedestrian
Before (July 2022)	0.176	0.039	0.137	0.033
After (October 2022)	0.141	0.035	0.156	0.014
Difference	-20%	-10%	+14%	-56%

Source: AMAG, 2022; Fehr & Peers, 2023.

Table 3: Before and After Conflict Totals at Bellevue Way/NE 8th Street

Period	Right Angle	Opposing Approaches	Rear End	Pedestrian
Before (July 2022)	27	6	21	5
After (October 2022)	20	5	22	2
Difference	-26%	-17%	+5%	-60%

Source: AMAG, 2022; Fehr & Peers, 2023.

Specific to pedestrian conflicts, the results in Table 2 show a strong reduction in pedestrian-vehicle conflict rate after the installation of high visibility crosswalks. However, the total number of conflicts in Table 3 is relatively small (although there is there is a notable reduction in total observations as well). Table 2 also shows more modest reductions in the right angle and opposing approaches conflict rates and in increase in rear end conflict rates. These results are interpreted in more detail in the next chapter.

Conclusions and Next Steps

The change in conflict rates presented in the previous chapter show the potential benefits of high visibility crosswalks. **Notably, the conflict rate of vehicle-pedestrian conflicts decreased by 56%.** In reviewing the conflict video clips and heat maps, most of the vehicle-pedestrian conflicts were occurring at the northeast corner of Bellevue Way/NE 8th Street in the east-west crosswalk. It is notable that this is the only corner that has a dedicated right-turn lane. Figure 5 shows the difference in the conflict heatmaps in the before and after condition. Note that there are still conflicts in the northeast corner, but there are fewer conflicts in the after condition. Figure 6 shows a sample screenshot of one of the vehicle-pedestrian conflicts identified by the SMART Road Safety Analytics Platform.

Figure 5 – Heat Maps of Conflict Areas at Bellevue Way/NE 8th Street Before (Left) and After (Right) Installation of High Visibility Crosswalks

Figure 6 – Vehicle-Pedestrian Conflict Video Example

The results of the before and after conflict rates also showed reduction in right angle conflicts. In reviewing video clips, some of these conflicts were related to vehicles that had greatly encroached into the crosswalk and then turned in front of an oncoming traffic. While further analysis would be required, the higher visibility crosswalks better signal to drivers to stop further back from adjacent traffic and which might help drivers make more prudent choices as to when to turn. The conflict results also showed a reduction in opposing approaches conflicts. In a review of the videos of conflicts, many of the opposing approach conflicts were also related to the westbound right turn lane from NE 8th Street to Bellevue Way where vehicles make a right-turn in front of oncoming left-turning vehicles. Again, the higher visibility crosswalk may position vehicles farther from the intersection allowing them more time to make avoid conflicting with oncoming traffic.

The results also show an increase in rear end conflicts. However, in reviewing the video, most of the rear end conflicts are related to drivers tailgating at the end of the westbound left turn phase from NE 8th Street to southbound Bellevue Way. There is no reason to suspect that the high visibility crosswalk would change driver behavior related to tailgating on this movement, which appears to be related to the congestion causing drivers to be closer together, not to where the drivers stop.

In summary, there is cursory evidence to suggest that high visibility crosswalks could help reduce the number of vehicle-pedestrian conflicts in busy settings like Downtown Bellevue. The benefit may be particularly pronounced for approaches with dedicated right-turn lanes. High visibility crosswalks may also help to keep vehicles from aggressively encroaching into the intersection which could reduce right angle and opposing approach conflicts, although more data and evidence would be helpful to confirm this finding.

Ultimately, more intersections and a longer time period would be beneficial to draw more definitive conclusions. Other good locations for potential deployment of video analytics to test high visibility crosswalk markings could include the following locations:

- Bellevue Way/NE 4th Street
- Bellevue Way/NE 2nd Street
- Bellevue Way/Main Street
- 108th Avenue NE/NE 8th Street
- 110th Avenue NE/NE 8th Street

Each of these locations has high pedestrian activity, dedicated right-turn lanes, and does not currently feature high visibility crosswalks.

In observing the conflict videos, Bellevue may also want to consider using conflict data to determine potential locations for installing "no right on red" signs at some intersections with high pedestrian volumes and dedicated right turn lanes. Through observing videos of the conflicts, it appears that drivers may not be looking for pedestrians (or opposing traffic) at these locations.

In closing, the ability to quickly review potential conflicts through the SMART Road Safety Analytics Platform is a major benefit to better understanding road safety issues and to evaluate the potential benefits of safety countermeasures. This evaluation highlights the benefits of Bellevue's adoption of the Safe System approach and provides a framework for future partnerships and road safety improvements.

Limitations

While the SMART Road Safety Analytics Platform provides a strong foundation to evaluate the potential benefits of high visibility crosswalks in Downtown Bellevue, there are three limitations worth highlighting.

The first limitation relates to the video camera coverage of the Bellevue Way/NE 8th Street intersection. Specifically, the northwest corner of the intersection is obscured from view and is not fully analyzed by the video analytics software. The results may have provided additional insight if this location were included through either a wider-angle camera or an additional camera mounted at the opposite corner of the intersection. The City of Bellevue, AMAG, Ouster, and Outsight will also be testing LiDAR sensor data in a future phase of this study. LiDAR has a potential benefit over video cameras in that it typically has fewer blind spots.

The second limitation from this study stems from the single intersection evaluated for before/after treatment and the relatively limited timeframe of the analysis. The single week of observations resulted in a relatively small number of observed conflicts (which is good news from a road safety context), which makes it challenging to draw definitive conclusions.

The third limitation from this study is the limited time-period of evaluation which does not account for different weather conditions associated with seasonal changes. A longer duration study would strengthen or refine the conclusions drawn in this report.