

Reducing Pedestrian and Pedalcycling Injuries Olympia, WA

Olympia, WA offers an excellent quality of life, especially in terms of transportation options for a city of about 50,000 residents. According to the city, there are 42 miles of bike lanes and trails in the city, and over 50% of its streets are lined with sidewalks (Bicycle Master Plan, 1). All things considered, Olympia seems like a safe place to live with excellent human-powered transportation infrastructure. However, data provided by the Washington State Department of Transportation reveals that in the last 10 years, there have been nearly 700 reported collisions between motor vehicles and pedestrians/cyclists. To put that number in perspective, a resident of Olympia is more than twice as likely to be hit by a car when walking or riding a bike than they are of being a victim of robbery or rape. There have been 5 fatal collisions in the last 10 years, meaning Olympia's residents are about as likely to be murdered as they are to be killed by a car when walking or cycling (City-data, 1). This paper looks for solutions to reduce the injuries and fatalities of pedestrians and pedalcyclists, using available research literature and new geospatial analysis, in an effort to determine where best to spend the city of Olympia's limited resources with an emphasis on safety.

The city of Olympia spends roughly \$250,000 a year on sidewalks, an amount which builds about 1/2 of a mile of sidewalk annually. While the city does have an active Sidewalk Program, it needs more than \$54 million dollars to add sidewalks to 100% of its arterial and feeder roads alone (Olympia Sidewalk Program, 2). The city also spends about \$200,000 a year on bicycle facilities, and has outlined 3 phases of projects for improving cycling in Olympia. However, the Priority 1 projects are estimated to cost at least \$13 million dollars, and Priority 2 and 3 projects are expected to each cost roughly the same, an additional \$26 million (Olympia Bicycle Master Plan, 40). Clearly, there is a significant funding gap between what the city needs, and what it can currently afford.

The city of Olympia has plans for improving pedestrian and pedalcycling facilities, but these plans are weighted in favor of certain priorities. The *2003 City of Olympia Sidewalk Program* was tasked with taking an inventory of sidewalks in the city, and prioritizing where to fill-in missing gaps. The plan ranks streets for future improvement based on their proximity to schools, parks, community centers, and commercial shopping. Its stated goal is to "increase transportation options and improve safety" (1). However, the plan only looks at sidewalks as a means to achieve the goal of increased pedestrian safety. The *Olympia Bicycle Master Plan of 2008* outlines multiple steps for increasing cycling and safety, however it mostly focuses on adding bike lanes and 'sharrows,' or added road paint to "raise driver and bicyclist awareness" about sharing stretches of road (33). While worthwhile, neither of these methods (e.g. more sidewalks, more bike lanes) would be the most effective way to increase the safety of pedestrians and cyclists in Olympia.

The approach that US cities tend to use for increasing the safety of cyclists and pedestrians is often very predictable: bike lanes and sidewalks. However, in *Cycling Safety on*

Bikeways vs. Roads, John Pucher talks about the benefits of using traffic calming measures as a more effective way to reduce risk (2). Pucher calls for a "multi-faceted approach that includes... traffic calming of residential neighborhoods [and] urban design oriented to people and not cars" (3). In his journal article *Making Walking and Cycling Safer: Lessons from Europe*, Pucher expands on this thesis and calls for a European approach to transportation priorities. Pucher cites safety data comparing the US to countries like Germany and the Netherlands, and finds that these countries have 1/10th the number of pedestrian and pedalcyclist injuries found in the US, namely because of their superior infrastructure (13). Pucher calls upon planners in the US to implement the following:

[to] improve the transportation infrastructure used by pedestrians and bicyclists: auto-free pedestrian zones, clearly marked crosswalks, pedestrian and bicycle traffic lights, intersection modifications, sidewalks on both sides of all streets, bicycle streets, bike lanes, and bike paths (18).

Pucher cites data supporting the installation of the following at intersections:

- Zebra crosswalks (sometimes raised and extra wide) with highly visible striping, usually with special overhead illumination and sometimes with flashing yellow lights to alert motorists
- Pedestrian-activated crossing signals, both at intersections and at mid-block crosswalks
- Pedestrian refuge islands for crossing wide streets (19)

Pucher would also like to see:

- Special intersections that allow bicyclists to pass waiting cars and proceed directly to the front; bicyclists also get an advance green light, so they can clear the intersection before the cars get started
- Special traffic lights for bicyclists at intersections, usually with priority signaling for bikes
- Special bicyclist-activated traffic signals at key intersections (20)

Pucher also cites data supporting traffic calming, including the installation of physical barriers (e.g. roundabouts, curves, road narrowing, etc.) and reducing speed limits. Pucher states:

The most important safety impact of traffic calming is the reduced speeds of motor vehicles. That is crucial not only to the motorists' ability to avoid hitting pedestrians and bicyclists, but also to the survival of non-motorists in a crash. For example, the British Department of Transport finds that the risk of pedestrian death in crashes rises from 5% at 20mph to 45% at 30mph, and 85% at 40mph (21).

As revealed by Pucher, many of the best methods to increase safety for pedestrians and cyclists don't focus on sidewalks and bike paths. Yet, the paradigm of transportation planners (and walkers and bikers) remains the same.

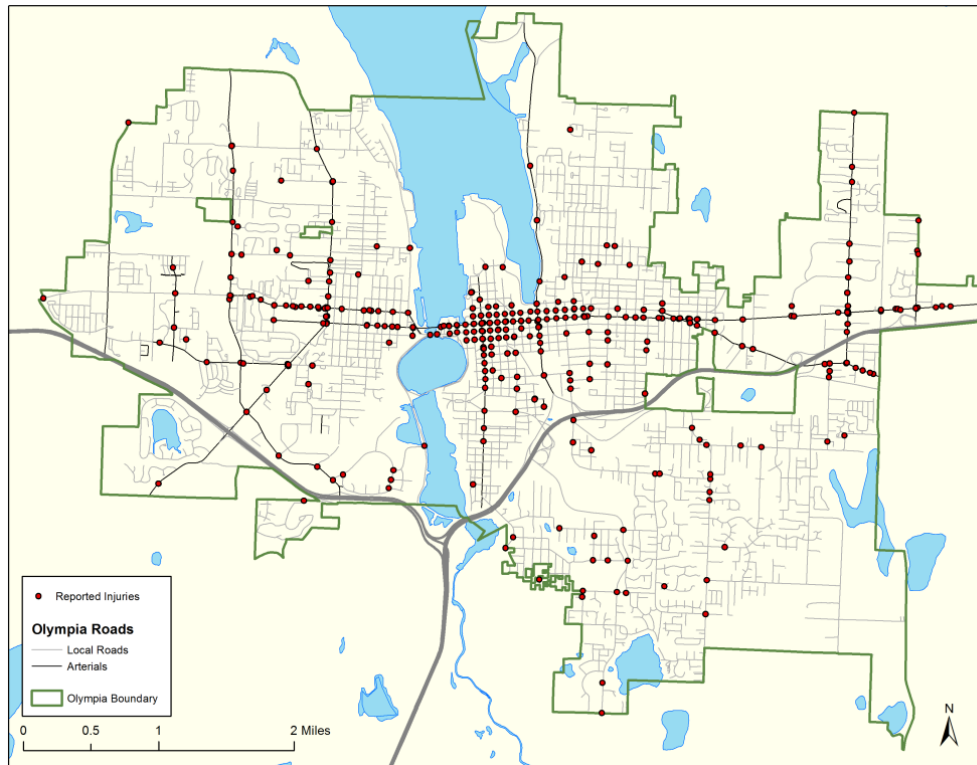
In An Accident Waiting to Happen: a Spatial Approach to Proactive Pedestrian Planning, Schneider et al. reveal that planners' and citizens' perceptions of "dangerous areas" are often incorrect when compared to actual safety data (3). While perceptions often don't match up with reality, that doesn't mean perceived danger is meaningless. Where there is overlap of perceived danger and measured danger, municipalities should concentrate their efforts and funds for mitigation (11). Where there is perceived danger, but no measured collisions, it is possible that pedestrians and cyclists have altered their routes to avoid perceived problem areas, thus reducing injuries (12). In *Making Walking and Cycling Safer*, Pucher reveals that over 2/3 of all bicycle trips are for recreational purposes and not daily utilitarian trips (e.g. work commute, groceries, etc.), reflecting that cyclists are often avoiding busy commercial areas, perhaps because of safety concern (11).

Taking this research literature into account, this project involved gathering collision data from the Washington State Department of Transportation, geocoding the tabular data and mapping it, and identifying problem areas using a manner of density analysis. The WSDOT data

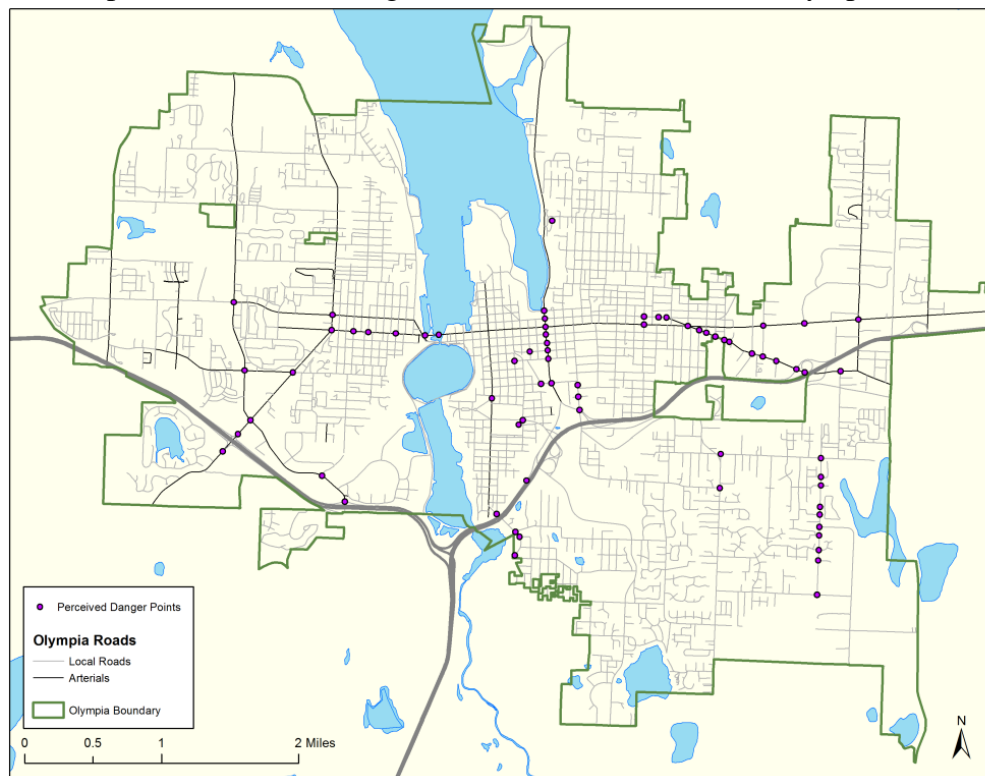
is from a collection time period of January 2001 to August 2011, providing over 10 years of information about collisions in Olympia between automobiles and pedestrians/cyclists. This data was sourced from police reports, which means there was likely a significant amount of underreporting for minor collisions. However, one major benefit of police data is that it tends to be fairly uniform and detailed. The data reflects where the collisions occurred, usually to within one-hundred feet, and whether it was mid-block or at an intersection. There is also severity information, critical to weighting the data points. Since it is also important to keep in mind the wishes and perceptions of the public, as evidenced by the research done by Schneider et al., a non-scientific survey was conducted using a small sample of Olympia residents (both cyclists and pedestrians). At the 2012 Annual WA State Interagency BikeRide, respondents were asked to mark "dangerous areas" on a map, i.e. places where they felt unsafe. This data is used to highlight the significance of areas already deemed "dangerous" via the data, and gives an interesting insight into what can be missed by collision data alone.

Mapping the raw data points indicates that a majority of injuries in Olympia to pedestrians and cyclists occur at intersections, thus intensifying the need to look at solutions beyond simply adding sidewalks and bike-lane striping. The research literature supports improving intersection facilities as a viable way to reduce collisions, as evidenced by the successes of Germany and the Netherlands in Pucher's *Lessons from Europe* article. For instance, the *Olympia Bicycle Master Plan* states the city has only one signal detection marker for cyclists, located on eastbound Legion Way at the Plum Street intersection (39). There are over 90 traffic lights in the city, and the city has already recognized that solutions like this could significantly improve safety (19).

Map 1.0 - Reported Injuries in Olympia, WA Between Autos and Pedalcyclists/Pedestrians



Map 1.1 - Perceived Dangerous Areas for Residents of Olympia, WA



- Numerically, more pedalcyclists are hit by automobiles, although resulting in less-severe injuries
- Fewer pedestrians are hit by automobiles, but with more-severe injuries
- Most collisions with pedestrians/cyclists occur at intersections, and during the day

In map 1.0, a simple plotting of the collisions shows a fairly dense grouping in Olympia's downtown area (east of the Puget Sound). Over two-thirds of the 685 total collisions happened at intersections, and two-thirds of the collisions were with pedalcyclists. Viewers will also notice a line of collisions running along 4th Ave from the west side of town to the east. There are also overlapping points at other major intersections in town, but this map only shows geographic spread, and not density.

In map 1.1, the survey data is also simply plotted to show a general picture of what intersections Olympia residents find "dangerous." There were 86 responses, and the points are fairly spread out around the city. There is no clear overlap of the reported data and the user data upon initial inspection.

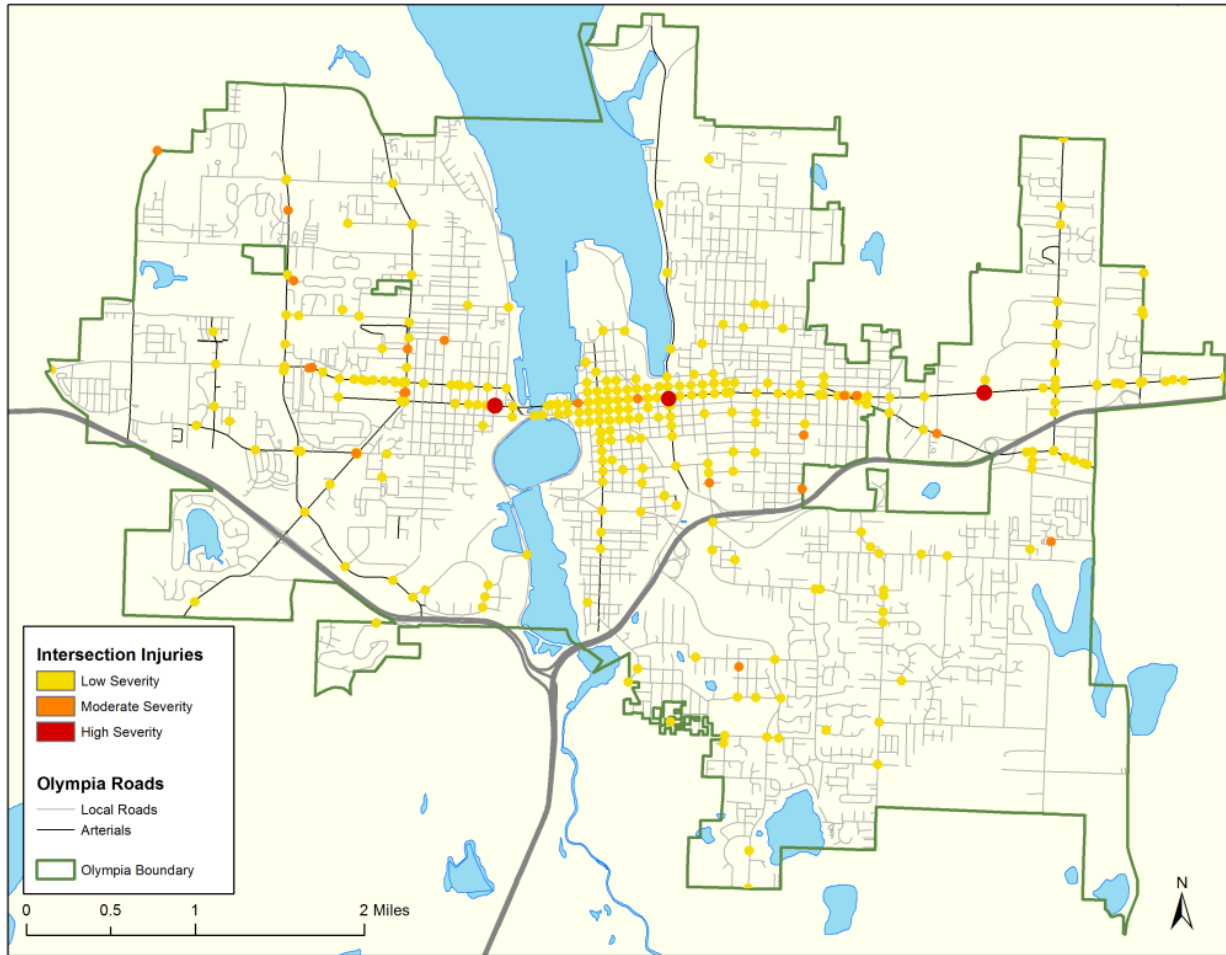
In order to make sense of this data, a series of analyses were conducted to group the points, weight them, and determine the most severely dangerous intersections. The statistical tools available in ArcGIS were IDW (Inverse Distance Weighted), Kernel Density Analysis, Hot Spot Analysis (Getis-Ord G_i^*), and Point Density Analysis. All of the analysis tools were run on both sets of data (reported and perceived) to find out which method best grouped and weighted the data points.

The reported accident data came with ‘severity’ information, rating the nature of the injuries to pedestrians and pedalcyclists. In order to analyze this information, the textual severity descriptions were converted to numbers, weighted as follows on a ranking scale:

Severity	Numeric Score
No Injury	1
Possible Injury	2
Evident Injury	4
Serious Injury	6
Fatal Injury	10

IDW and Kernel Analysis both allow for weighting, and essentially came up with the same results, which were superior to the results of the Hot Spot Analysis tool. IDW was ultimately chosen because of the superior visualization options. In Phillips' *Quantitative School Bus Stop Risk Assessment of Redlands California*, the author goes through the various methods for analyzing dangerous points, and settles on kernel Analysis and IDW as the best choices, far superior from a visual standpoint to Hot Spot Analysis (25). Hot Spot maps tend to give too much information, and in this case the majority of the area of the output rasters covered non-road surfaces. Map 2.0 shows the “most dangerous intersections” in Olympia, weighted by the severity of injuries to a combination of pedestrians and pedalcyclists.

Map 2.0 - IDW Weighted Points Showing Dangerous Intersections in Olympia, WA



Unfortunately, the citizen-generated “perceived” data did not have a severity ranking. As such, IDW and Kernel Analysis were no better than a more simple Point Density analysis in grouping and visualizing the points. Since it’s an apples to oranges comparison, the reported data and “perceived data” analyses are on different maps. The "perceived danger" data was mapped for density, and can be seen in map 2.1.

Map 2.1 - Point Density of Perceived Dangerous Intersections in Olympia, WA



Viewers can compare the danger points side-by-side and see that there is some, but not numerous, overlap. However, this result lends itself to some further analysis.

Comparing the “IDW reported results” with the “Point Density perceived results” is an apples to oranges evaluation, but there is clearly a connection between the two: citizen behavior. Collisions go up in areas with high traffic counts, and pedestrians and cyclists avoid areas with heavy auto use. Therefore, normalization of the “perceived data” with its own “severity” index is possible, basing the normalization on measured traffic counts from the city of Olympia. The traffic count data came from a 2009 peak traffic survey conducted by the city of Olympia. The

count represents the number of cars in a two-hour period during peak use. Since the accident severity was converted to a 1 through 10 scale, so was the traffic count data:

Traffic Volumes	Numeric Score
0-360	1
361-720	2
721-1080	4
1081-1440	6
1441-1800	10

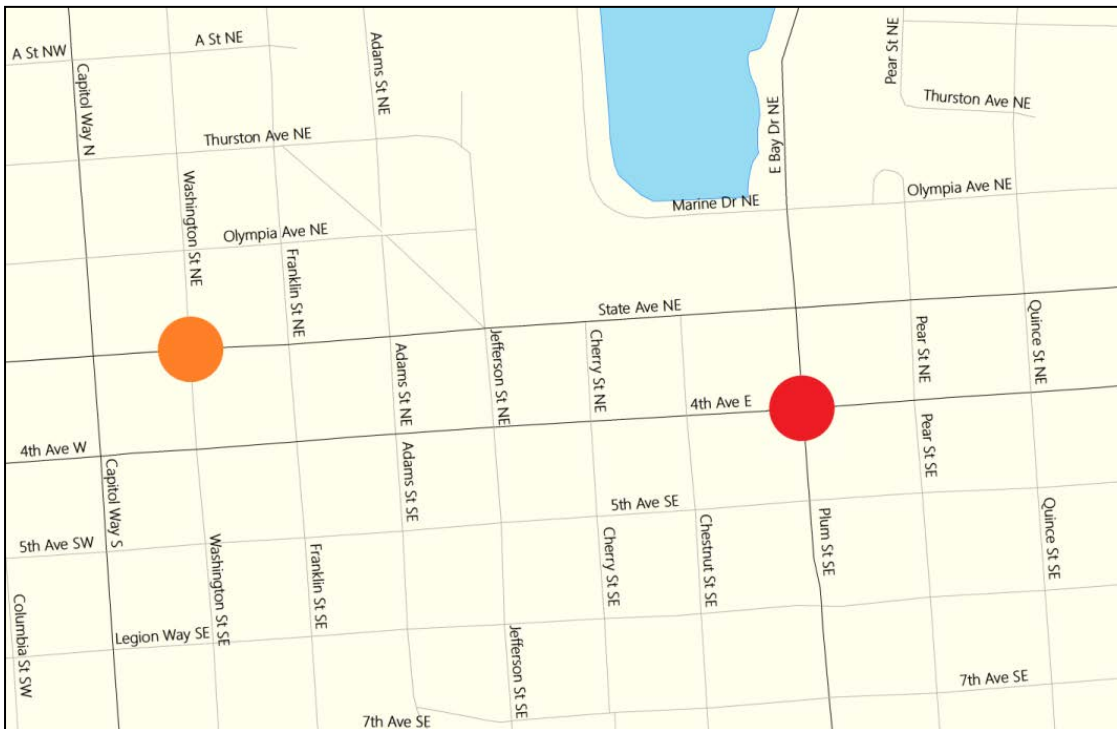
After normalizing, using the raster calculator to combine the perceived data and the reported data yields meaningful results, because the raster values were now in the same range.

For the final part of the analysis, the reported data was split into individual pedestrian and pedalcyclist groups. These point sets had an IDW applied, and the resulting rasters were combined with the traffic-count normalized perception data rasters, using the raster calculator to simply add the values. The final rasters revealed dangerous intersections, in terms of a combination of reported and perceived danger. Map 3.0 shows the two most dangerous intersections in Olympia for cyclists, red being the most dangerous and orange representing runner-up (both are found on Capitol Mall Drive). Map 3.1 shows the two most dangerous intersections in Olympia for pedestrians (both are in the downtown corridor on main, 1-way thoroughfares, easily the most dangerous part of town in terms of severity of injuries).

Map 3.0 - Most Dangerous Pedalcyclist Intersection in Olympia, WA



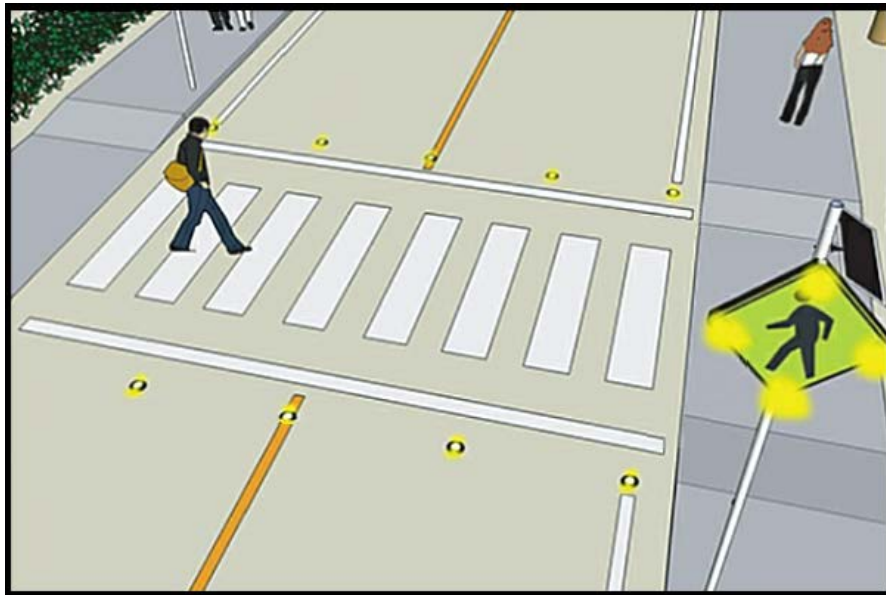
Map 3.0 - Most Dangerous Pedestrian Intersection in Olympia, WA



The data show that intersections are the biggest problem in Olympia in terms of pedestrian and pedalcyclist safety. However, the city of Olympia’s Comprehensive Plan does not address intersection safety in its plans for adding facilities for pedestrians and cyclists, rather focusing only on sidewalks and bike lanes. For the purposes of this project, intersection safety solutions were considered. The solutions that were considered are ranked by Pucher in *Lessons from Europe*. Taking into account the road type for the problem intersections, traffic calming wasn’t an option (speed limits are already at a minimum, and these are main thoroughfares not conducive to physical barriers). Therefore, non-traditional facilities could be considered to reduce collisions and mitigate injuries. To improve the intersections most dangerous for cyclists, a road-paint “bike box” that allows cyclists to queue ahead of cars at traffic lights is the best way to reduce injuries.



For pedestrians, it is not possible to enact some of the methods encouraged by Pucher (pedestrian islands, divided roads) because of the 1-way, narrow thoroughfares that run through downtown Olympia. Therefore, the best solution would be to install lighted signs and embedded, flashing road markers to alerting drivers to the presence of pedestrians.



Ultimately, this project did come up with meaningful results. The most dangerous intersections for both pedalcyclists and pedestrians were discovered, by using the IDW tool and combining the rasters for raw collision data with that of perceived danger areas from citizens. Hopefully these results can be shared with the city of Olympia to affect meaningful and positive change for residents who walk, bike, and drive.

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