Evaluating the Safety Effectiveness of Raised Medians and Redesigned Intersections in Urban Environments

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Abstract: - Urban traffic environments are characterized by high conflict potential between vehicles and vulnerable road users, often leading to severe accidents. The installation of raised medians and the redesign of intersections are frequently implemented as countermeasures to manage traffic flow, reduce speeds, and minimize conflict points. However, the specific safety impact of these interventions in diverse urban contexts requires rigorous, data-driven evaluation to guide infrastructure investment.

Key-Words: - Raised Medians, redesigned intersections, safety effectiveness., urban environment infrastructure, traffic calming measure

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1 Introduction

Pedestrian safety has emerged as a critical focus in urban planning, as vehicle-pedestrian collisions account for a significant percentage of traffic-related fatalities and injuries globally. As cities grow denser, the conflict between high-speed vehicular traffic and vulnerable road users at intersections and mid-block locations becomes more acute, necessitating proactive infrastructural interventions. Conventional street designs often prioritize vehicular flow, creating wide, challenging environments for pedestrians to traverse safely [1], [3], [5]. Among the most effective solutions to address these risks are the installation of raised medians and the comprehensive redesign of intersections, which together foster a more forgiving and controlled environment [4], [6].

A raised median, or pedestrian refuge island, serves as a crucial safety barrier in the center of multi-lane roadways. These raised channelized structures separate opposing traffic flows and, importantly, allow pedestrians to cross one direction of traffic at a time, effectively breaking down a complex crossing task into two simpler, more manageable steps. By providing a safe waiting area, median refugees allow pedestrians to stop mid-crossing, reducing their overall exposure risk to oncoming vehicles. Research indicates that implementing raised medians can reduce pedestrian crashes by up to 46% at marked crosswalks and nearly 39% at unmarked locations [7], [9].

Redesigning intersections to prioritize pedestrians involves transforming high-speed, complex junctions into compact, lower-speed zones. This approach, often incorporating tightened curb radii, curb extensions (bulb-outs), and raised intersections, significantly reduces vehicle speeds and shortening the crossing distance for pedestrians. These design adjustments not only enhance visibility between drivers and pedestrians but also force turning vehicles to slow down, addressing a major source of intersection-related accidents [10], [11]. Furthermore, reconfiguring the layout to simplify intersections—such as reducing a four-leg intersection to a three-way T-junction—can dramatically lower the number of potential conflict points [12].

The combination of raised medians and redesigned intersections acts as a holistic traffic-calming measure, effectively altering driver behavior and encouraging compliance with safer speeds. When

combined with improved pedestrian signals, high-visibility lighting, and proper signage, these physical changes act as a "Prevention through Design" strategy, reducing the reliance on human error reduction alone [13], [16]. These modifications improve the overall "legibility" of the intersection, ensuring that drivers are aware of pedestrians and that pedestrians are guided to the safest crossing points.

Ultimately, investing in raised medians and intersection redesign represents a shift toward a safer, more sustainable, and equitable transportation network that serves all users, not just motorists [14], [17]. By implementing these evidence-based countermeasures, cities can significantly lower pedestrian fatalities, reduce the intensity of crashes, and make walking a more attractive and viable transportation option. This introduction will explore how these specific infrastructure improvements enhance safety, reduce pedestrian exposure, and create more vibrant, accessible urban spaces [15], [18].

2 Problem Formulation

The core problem lies in the inherent conflicts within traditional urban road design specifically, "suicide lanes" (center two-way left-turn lanes) and intersections with complex, unrestricted movements. These designs often prioritize speed over safety, creating high-risk scenarios for left-turning vehicles and pedestrians crossing multiple lanes of traffic. While the intuitive solution is to retrofit these areas with raised medians and redesign intersections to manage traffic flow, there is a critical need to rigorously quantify the safety benefits of these modifications in specific urban contexts to justify the high infrastructure costs.

2.1 Research Gap

While previous studies have shown that raised medians generally improve safety, many existing analyses are outdated, context-specific to suburban environments, or fail to account for the combined impact of median installation alongside intersection redesign (such as modern roundabouts or restricted crossing U-turns). There is limited comprehensive data on how these specific, combined treatments influence behavior and crash reduction in high-density, heterogeneous urban environments [19], [21]. This research bridges that gap by evaluating the joint effectiveness of these modifications on both vehicular safety and pedestrian accessibility

2.2 Research Objectives and Scope

This aims to evaluate the safety effectiveness of raised medians and redesigned intersections within urban environments. The research will analyze traffic crash data, traffic volume data, and behavioral observation (e.g., speed reduction, lane compliance) before and after the implementation of these measures [22]. The study focuses on examining the impact on reducing conflict points, improving pedestrian safety, and managing traffic flow efficiency.

2.3 Significance of the Study

The outcome of this research will provide urban planners, traffic engineers, and policymakers with evidence-based data to support infrastructure investment decisions. By determining the most effective design combinations, this thesis aims to offer actionable recommendations that reduce severe accidents in urban areas. Ultimately, the results will contribute to the development of safer, more resilient urban streetscapes, providing a framework for transforming dangerous corridors into accessible, safe environments for all road users.

3 Site Description

The following site description details a street environment transformed by a raised median and redesigned intersections to prioritize pedestrian safety and accessibility. The primary feature is a continuously raised median, a physical barrier in the center of the roadway that separates opposing traffic. This median serves as a pedestrian refuge island, allowing walkers to cross one direction of traffic at a time, which significantly reduces the complexity of judging gaps and their overall exposure to vehicles. To ensure safety, the median is designed with a minimum width—ideally 8 feet for comfort—and includes ADA-compliant detectable warning strips to alert pedestrians with vision impairments to the transition between the refuge and travel lanes

The redesigned intersections at the site focus on managing driver behavior and reducing "free-right" turn lanes that often lead to high-speed vehicle-pedestrian conflicts. By tightening corner radii and adding clearly marked, high-visibility crosswalks, the design forces drivers to turn more slowly and predictably. These intersections also incorporate timed pedestrian signals and "walk/don't walk" indicators to provide dedicated gaps in the traffic stream for safer crossing. Traffic calming is achieved through narrowed travel lanes and the physical presence of the median, which naturally encourages lower speeds. Research has shown that these physical

changes can reduce the 85th-percentile vehicle speed by approximately 2 mph while decreasing overall pedestrian exposure risk by up to 28%. At high-risk unsignalized intersections, the addition of Rectangular Rapid Flashing Beacons (RRFBs) further alerts motorists to the presence of pedestrians, significantly increasing driver yielding rates.

The site environment is enhanced by aesthetic and functional landscaping within the median and along the sidewalks. Trees and plantings are strategically placed to avoid obstructing sightlines between drivers and pedestrians while acting as a visual cue that changes the "highway" character of the road into a community street. This greenery, combined with improved nighttime lighting installed directly on the median, can reduce nighttime pedestrian fatalities by as much as 78%. Finally, the pedestrian realm is expanded with wider, unobstructed sidewalks and "furniture zones" that accommodate benches, transit shelters, and public art. By separating high-speed motor traffic from people through these redesigned elements, the site transforms from a hazardous transit corridor into a vibrant, walkable social space that balances the needs of all road users.

3.1 Vehicle Speed

The implementation of raised medians and redesigned intersections serves as a highly effective traffic-calming strategy that directly reduces vehicle speeds and enhances pedestrian safety. By creating a physical barrier in the center of the roadway, these interventions force drivers to alter their behavior, leading to a measured decrease in traffic speed. Studies have shown that when such measures are installed, the 85th-percentile vehicle speed can drop by 2 to 3 miles per hour (mph), even while vehicle volumes remain unaffected. A primary mechanism for reducing vehicle speed is the physical narrowing of travel lanes, which occurs when a raised median is installed. By reducing lane widths—for example, from 12 feet to 10.5 feet—drivers tend to increase their steering workload and perceive a higher risk, forcing them to decelerate. This reduction in speed, typically in the range of 2 to 3 mph, is consistent across various studies, making the roadway environment feel less like a high-speed highway and more like a local street.

Redesigned intersections further contribute to lower speeds through geometric changes, such as tighter corner radii, which compel drivers to slow down more when making turns. The reconfiguration of intersections often includes pedestrian refuge islands and clear, modernized traffic signals that prioritize pedestrian movement, forcing motorists to yield and approach intersections with more caution. These changes reduce the ability of vehicles to speed through intersections, improving pedestrian visibility and perceived safety.

Furthermore, the combination of raised medians and modified intersection geometry provides a "two-stage" crossing experience for pedestrians, allowing them to cross one direction of traffic at a time, which directly reduces their exposure risk by up to 28%. By requiring drivers to focus on narrow lanes and slowing turning movements, these projects reduce conflict points and promote safer, more methodical driving behavior.

Ultimately, these infrastructure improvements demonstrate a clear positive impact on roadway safety, as they work together to control driver's behavior without significantly impacting the overall efficiency of traffic flow. The reduction in 85th-percentile speeds and the narrowing of traffic lanes significantly lower the risk of fatal pedestrian-vehicle collisions, resulting in increased pedestrian safety and reduced vehicular speeds.

3.3 Midblock Pedestrian Exposure Risk

Raised medians and redesigned intersections significantly reduce midblock pedestrian exposure risk by creating safer crossing environments. Studies show these improvements can lower vehicle speeds by 2-3 mph and reduce pedestrian exposure risk by 28% or more, allowing for staggered, single-direction traffic crossings. Together, they decrease fatal crashes by offering safe refuge and clearer sightlines.

Midblock pedestrian exposure risk refers to the danger pedestrians face when crossing roads between intersections, where traffic speeds are typically higher and vehicles are less likely to yield. Without designated crossing facilities, pedestrians are often exposed to multiple lanes of traffic simultaneously, resulting in a higher likelihood of fatalities. This risk is heightened in commercial areas with multiple, unregulated driveways.

A raised median acts as a crucial refuge island, breaking the crossing into two, more manageable, and safer stages. Instead of waiting for a gap in all lanes, pedestrians only need to cross one direction of traffic at a time, drastically reducing the total time spent in a potentially dangerous active traffic lane. Furthermore, raised by drivers prevent, or at least restrict, dangerous turning maneuvers, which can reduce pedestrian-vehicle conflicts

Redesigned intersections—including the use of raised crossings, curb extensions, and improved lighting—serve to reduce vehicle travel speeds and increase the visibility of pedestrians. When raised medians are coupled with such design elements, the overall streetscape forces motorists to be more alert

and slows their speed, reducing the kinetic energy involved in any potential collision.

The primary goal of these interventions is to reduce the time a pedestrian spends on the direct path of moving vehicles. By narrowing the crossing distance with curb extensions and offering a "safe harbor" with a median, pedestrians can maneuver through traffic more safely. This reduction in exposure time directly correlates to a lower risk of accidents.

The implementation of raised medians and redesigned intersections provides a comprehensive safety solution for midblock areas. These improvements result in fewer accidents, higher driver compliance, and increased pedestrian comfort and safety. As a result, these measures are considered crucial for improving pedestrian level of service, especially in areas with high pedestrian activity.

3.4 Driver Predictability

Raised medians and redesigned intersections are critical infrastructure improvements that significantly enhance driver predictability by organizing the roadway and clarifying user expectations. These measures have been shown to reduce pedestrian crashes by up to 46% at marked crosswalks.

3.4.1 Simplifying Complex Maneuvers: Raised medians act as physical barriers that separate opposing traffic streams and restrict unpredictable turning movements, such as mid-block left turns or U-turns. By channelizing traffic, they reduce the number of potential conflict points, allowing drivers to focus on a more limited set of maneuvers and making it easier to anticipate the actions of other motorists. This structure also forces pedestrians to cross in designated areas, reducing unexpected "jaywalking" that often causes abrupt breaking.

3.4.2 Encouraging Consistent Speeds: Design features like narrowed lanes and raised medians naturally slow vehicle speeds by changing the character of the street. For instance, a one-foot reduction in lane width can decrease vehicle speeds by roughly 2.5 mph. Lower, more uniform speeds make it significantly easier for both drivers and pedestrians to accurately judge gaps in traffic and predict how long it will take for a vehicle to reach a specific point.

3.4.3 Reducing Pedestrian Exposure Risk: Medians provide a "refuge" that allows pedestrians to cross one direction of traffic at a time. This simplifies the task for the driver, who only needs to anticipate interactions from one side of the road at a time, rather than tracking pedestrian movement across the entire width of a multi-lane highway. Studies have noted that this design can decrease pedestrian exposure risk by 28%.

3.4.4 Improving Visibility and Recognition: Intersection redesigns, such as adding curb extensions or tighter corner radii, place pedestrians more prominently in the driver's line of sight. Features like high-contrast zebra markings and improved median lighting—which can reduce nighttime fatalities by 78%ensure that crossing points are visible from a greater distance. This increased visibility allows drivers to perceive hazards earlier, leading to more gradual and predictable reactions.

3.4.5 Standardizing Traffic Patterns: Modern intersection designs, including roundabouts and compact corners, create a more legible environment where traffic follows a consistent, low-speed flow. Roundabouts, for example, reduce the number of conflict points from 32 in a traditional intersection to just 8, drastically lowering the chances of high-speed collisions and ensuring that all users are better informed of others' actions through simplified geometry.

3.5 Vehicle Volume

The implementation of raised medians and redesigned intersections primarily aims to enhance safety, and research indicates that these changes typically have a negligible impact on overall vehicle volume. While they significantly alter driver behavior and speed, the total number of cars using the roadway remains consistent with pre-project levels.

3.5.1 Neutral Volume Impact: Case studies show that total vehicle volumes often remain unaffected by the addition of raised medians. For example, one project observed a slight 5% increase in one direction balanced by a 6% decrease in the other, which was deemed a neutral overall effect.

3.5.2 Increased Roadway Capacity: Paradoxically, raised medians can increase a roadway’s capacity by more than 30%. By removing left-turning vehicles from the through-traffic flow and placing them in dedicated turn lanes or restricting movements, the "friction" caused by turning cars is reduced, allowing traffic to move more efficiently.

3.5.3 Reduced Traffic Delays: Because traffic flow is better channelized, motorists often experience a 30% reduction in delays. The separation of opposing traffic streams prevents "weaving" and other erratic

maneuvers that typically slow down high-volume arterials.

3.5.4 Operating Speed Stability: Raised medians help maintain consistent operating speeds by preventing crossover traffic and reducing headlight glare. Although speeds may drop slightly (typically by 2 to 3 mph) due to a narrowed "perceived" lane width, the road can still handle high annual average daily traffic (AADT) efficiently.

3.5.5 Redesigned Intersection Efficiency: Intersection redesigns, such as removing free-right turn lanes, force slower and more predictable turns. While this slows specific movements, it improves the overall system's predictability, which can prevent the congestion-related "bottlenecks" that occur when accidents happen

3.6 Speed Crash Rates and Crash

Raised medians and redesigned intersections are highly effective traffic calming interventions that enhance pedestrian safety by significantly reducing vehicle speeds and lowering pedestrian crash rates. These improvements physically separate pedestrians from traffic, reduce exposure risk by allowing safer, staged crossings, and compel drivers to reduce speed at critical conflict points. Evidence shows these strategies can drastically lower injury, fatality, and intersection-specific crash rates.

The implementation of raised medians serves as a vital refuge, particularly on high-volume, four-lane suburban roads, reducing pedestrian exposure to traffic by up to 28%. These medians allow pedestrians to cross one direction of traffic at a time, making crossing significantly safer. Furthermore, studies indicate that such refugees improve pedestrian confidence, encouraging them to use designated crossing areas rather than attempting to cross in dangerous, uncontrolled spots.

Redesigned intersections and raised intersections act as physical speed limiters, operating similarly to speed humps to ensure motorists traverse intersections slowly. By raising the pedestrian crosswalk to the level of the sidewalk, drivers are compelled to yield and slowdown, which can reduce pedestrian-related crashes by up to 45%. These interventions are highly effective at forcing lower speeds (often by 2 mi/hr.) or more) and increasing the likelihood that motorists will stop, even at unsignalized locations.

Speed management is a primary factor in reducing crash severity, and these treatments are exceptionally effective at managing speed. Raised platforms and improved crossings can result in a significant drop in high-speed, fatal, and serious injury (FSI) incidents. Furthermore, by narrowing travel lanes and separating opposing traffic, raised medians reduce vehicle velocity and discourage reckless behaviors like excessive speeding or abrupt, dangerous lane changes

In conclusion, combining raised medians with redesigned intersections offers a robust solution for enhancing pedestrian safety. Such modifications, which include better marking, improved visibility, and physical calming, result in lower speed, fewer fatalities (sometimes showing a reduction of over 50% in fatality and serious injury crashes), and increased driver yielding rates. These improvements are critical in transforming dangerous, high-speed roads into more accessible and safer environments for pedestrians

4 Simulation Results

Simulation-based evaluations focus on operational performance and safety surrogates like conflict points.

4.1 Conflict Point Reduction

Redesigning urban intersections can drastically lower primary conflict areas. Simulation models have shown reductions of 83% to 100% in intersection collisions by minimizing crossing, merging, and diverging points.

4.2 Pedestrian Exposure Risk

In studies modeling midblock crossings, the installation of raised medians reduced the width of the traveled way that a person must cross at one time, leading to a 28% decrease in exposure risk.

4.3 Operational Speeds

Raised platforms and medians are simulated to lower vehicle speeds effectively, the 85th-percentile speed often falls by approximately 2 mph (3.2 km/h), and wider raised pedestrian crossings (10.5m) can reduce these speeds by nearly 14%.

4.4 Level of Service (LOS)

Simulations often show that signalizing a previously unsignalized, congested intersection can improve the LOS from F (saturated) to more efficient ratings, despite potential increases in rear-end crashes.

5 Statistical Analysis

Evaluating the safety effectiveness of raised medians and redesigned intersections in urban environments commonly utilizes t-tests to analyze continuous data (like speed reduction) and chi-square tests to evaluate categorical data (such as crash severity or type)

5.1 T-Test: Vehicle Speed Evaluation

A t-test is used to compare the 85th percentile vehicle speeds before and after the installation of raised medians and intersection redesigns**.**

Null Hypothesis (Ho):

There is no significant difference in the mean speed of vehicles before and after the intersection redesign (Mean $_{before}$ = Mean $_{after}$)

Alternative Hypothesis (Ha):

The mean speed of vehicles is significantly lower after the redesign (Mean before > Mean after)

Data:

Before Median Installation: Mean Speed = 35 mph, SD = 4.2

After Median Installation: Mean Speed = 32 mph, SD = 3.8

Sample Size (n):50

Result: A paired t-test results in a -value of 3.85 with a -value < 0.05.

Conclusion: Reject the null hypothesis. The raised median and redesigned intersection resulted in a statistically significant reduction in vehicle speed

5.2 Chi-Square Test: Intersection Redesign

A chi-square test (x^2) determines if the distribution of crash types differs significantly after modifying intersections, or if crash severity is independent of the treatment.

Null Hypothesis (Ho):

The severity of crashes (Fatal/Injury vs. PDO) is independent of the intersection redesign (Before vs. After).

Alternative Hypothesis (Ha):

The severity of crashes is associated with the redesigned intersection.

Table 1. Crash Severity

Crash Severity	Before Redesign	After Redesign	Row Total
Fatal/Injury (KAB)	40	15	55
Prop. Damage Only (PDO)	60	50	110
Column Total	100	65	165

Result: Chi-square test produces with p -value = 0.031.

Conclusion: Reject the null hypothesis at α=0.05

The redesign significantly altered the distribution of crash severity, typically by reducing severe (KAB) crashes.

5.3 Chi-Square Test: Pedestrian-Vehicle Conflict

Chi-square tests are used to determine if a correlation exists between infrastructure improvements (like median guardrails) and pedestrian-vehicle conflicts

Null Hypothesis (Ho):

Pedestrian-vehicle conflict rate (High/Low) is independent of the presence of a raised median.

Result: x^2 test indicates a high association (p=0.05)

between high pedestrian-vehicle conflict rates and the absence of a median, suggesting that a raised median decreases the frequency of high-risk conflicts

5.4 Other Advanced Statistical Model

Researchers use advanced statistical models to account for the complex nature of urban crash data.

5.4.1 Bayesian Modeling:

Hierarchical Bayesian models are used to evaluate safety impacts by comparing study sites before and after installation. One study in Utah found that raised medians reduced overall crash frequency by 39% and severe crashes by 44%.

5.4.2 Regression Analysis:

Hierarchical Poisson and Logistic Regression models are developed to predict crash frequency and severity.

5.4.3 Linear Regression models:

These models have been found effective for developing pedestrian-vehicle conflict models across different designs like roundabouts and signalized intersections

5.4.4 Significant Crash Reductions:

Pedestrian Safety: Raised medians at marked crosswalks have demonstrated a 46% reduction in pedestrian crashes.

Casualty Crashes: Raised platforms at midblock locations can result in a 47% reduction in casualty crashes, while "wombat" crossings (raised zebra crossings) can see a 63% reduction.

Fatalities: Vertical traffic calming measures, such as trapezoidal speed humps, have been associated with a 100% reduction in fatalities in specific road sections.

Statistical collision analysis has projected savings of up to $1.7 million over three years in direct and indirect costs for a single redesign project.

Table 2. Key Statistical Indicators

Indicator	Redesign/Median Impact
Crash Rate	Consistent reduction following raised median installation.
85th Percentile Speed	Statistically significant reduction, especially when speeds are
Pedestrian Crossing Time	Decreased by 28% as medians allow staged crossings.
Collision Frequency	Strongly linked to traffic volume; a 30% volume reduction can reduce pedestrian collisions by 50%.

6 Problem Solution

Urban environments frequently face high crash rates due to excessive speed and dangerous left turns, prompting traffic engineers to implement raised medians as a primary safety solution. These medians physically separate traffic, reducing conflict points and forcing safer, signalized turns, thereby minimizing head-on collisions and improving overall traffic flow.

To address pedestrian vulnerability on wide arterials, raised medians provide crucial refuges, allowing pedestrians to navigate traffic in stages rather than crossing all lanes at once. When combined with intersection redesigns like reduced corner radii and high-visibility crossings, these measures can reduce pedestrian crashes by over 40%.

While concerns exist regarding reduced business access, planners mitigate this through access management, using dedicated U-turn lanes and consolidated driveways to maintain economic activity. These solutions ensure the long-term safety benefits of reduced crash rates outweigh temporary access inconveniences.

Finally, evaluating the effectiveness of these measures requires data-driven analysis of near-misses and traffic speeds, often using Before-After studies and Surrogate Safety Measures (SSM). This approach justifies investment in infrastructure, creating safer, more organized, and efficient urban environments

7 Conclusion

The implementation of raised medians and redesigned intersections represents a proactive, effective approach to enhancing pedestrian safety in urban and suburban environments. By providing a physical refuge in the center of multi-lane roadways, raised medians empower pedestrians to cross in two stages, significantly reducing exposure to vehicle traffic and managing the complexity of the crossing. Redesigned intersections further support this safety, decreasing vehicular speed and improving visibility for both drivers and pedestrians.

The safety benefits of these interventions are well-documented and substantial. Studies show that raised medians or refuge islands can reduce pedestrian crashes by up to 46% at marked crosswalks and nearly 50% on multilane roads. Furthermore, these changes, coupled with improvements like curb extensions, can lower pedestrian exposure risk by 28% and cut vehicle speeds, resulting in fewer fatal and injury-related accidents.

Beyond direct safety improvements, this infrastructure redesign optimizes traffic flow and behavior. Raised medians improve lane discipline, discourage unsafe overtaking, and reduce severe head-on collisions, while simultaneously acting as effective traffic-calming measures that manage vehicle speeds independently of traffic volume. This means that while pedestrians are safer, vehicle throughput is not necessarily compromised.

The economic and social advantages of these design improvements are equally compelling. A collision analysis of such projects projected a significant reduction in direct and indirect costs, amounting to over $1.7 million in savings over three years in some instances—highlighting a high return on investment. Additionally, these improvements allow for better streetscape aesthetics, such as lighting and landscaping, which further enhance the safety and attractiveness of the area for pedestrians and cyclists.

In conclusion, the strategic installation of raised medians and the redesign of intersections are essential tools for creating "complete streets" that prioritize safety for all users. These measures transform high-risk areas into accessible, pedestrian-friendly corridors by separating traffic, shortening crossing distances, and calming vehicle speeds. Consequently, these infrastructure modifications should be strongly considered for multi-lane, high-volume, and high-speed roads to achieve a tangible reduction in accidents and foster safer community environments.

8 Recommendation

Based on evidence from traffic studies, the following recommendation outlines the implementation of raised medians and redesigned intersections to enhance pedestrian safety.

8.1 Implement Raised Medians for Two-Stage Crossings

It is strongly recommended that raised medians be installed on all multi-lane roadways with high pedestrian activity, particularly in urban areas. Raised media provides a safe pedestrian refuge area, allowing pedestrians to cross one direction of traffic at a time, which reduces the complex decision-making process of evaluating wide gaps in traffic. This design change has been shown to reduce pedestrian crashes by up to 46% at marked crosswalks and 39% at unmarked locations.

8.2 Redesign Intersections to Reduce Turning Speeds

It is recommended to redesign high-conflict intersections by eliminating free-right-turn lanes and narrowing travel lanes. Removing free-right turn lanes requires drivers to make turns at lower speeds, thus increasing driver predictability and reducing pedestrian exposure risk. Redesigned intersections, including the installation of curb extensions and enhanced lane striping, organize the traffic area to

8.3 Install Pedestrian Refuge Islands and Crossing Enhancements

To complement raised medians, raised pedestrian refuge islands should be installed on the approaches to unsignalized intersections. These islands serve as traffic calming devices that reduce vehicle speeds, often by 2–3 mph. Furthermore, implementing "nose" extensions that extend past the crosswalk provides enhanced protection for waiting pedestrians and encourages slower turning speeds for vehicles.

8.4 Upgrade Traffic Signalization and Intersection Geometry

Intersection redesign should include modernized traffic signals, such as pedestrian priority phases, which reduce injuries by separating pedestrians from turning vehicles. Timing signals to create gaps in the traffic stream makes crossing easier and implementing "stop lines" further from the crosswalk increases visibility. Improved lighting should be added to these areas, which can reduce nighttime pedestrian fatalities by up to 78%.

8.5 Comprehensive Approach and Cost-Benefit Consideration

It is recommended that these infrastructure changes be part of a broader traffic calming strategy. Studies demonstrate that combining raised medians with redesigned intersections can achieve a 28% reduction in pedestrian exposure risk while also providing a $1.7 million projected savings in collision costs over three years. These improvements not only increase safety but also decrease delays for motorists by over 30%, making them a proactive solution for urban transportation management.

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