

# ROAD SAFETY AUDIT

Station Avenue at White's Path/Workshop Road

Town of Yarmouth

Final  
October 5, 2023

Prepared For:  
MassDOT



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CAPE COD  
COMMISSION

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## Background

The Federal Highway Administration (FHWA) defines a Road Safety Audit (RSA) as the formal safety examination of an existing or future road or intersection by an independent, multidisciplinary team. The purpose of a Road Safety Audit is to identify potential safety issues and possible opportunities for safety improvements while considering all roadway users. As part of the Massachusetts Department of Transportation’s (MassDOT) guidelines, RSAs are required for Highway Safety Improvement Program (HSIP) eligible locations and should be conducted prior to the development of the 25 percent design submission or prior to the submission of a Draft Environmental Impact Report (DEIR) for a project of regional impact. The RSA evaluates the intersection of Station Avenue at White’s Path/Workshop Road in the Town of Yarmouth as shown in Figure 1.

The Cape Cod Commission (CCC), serving as the regional planning agency for the fifteen towns on Cape Cod, has reviewed many transportation locations over the years during various processes, including the Regional Transportation Plan, the Transportation Improvement Program, and Developments of Regional Impact, considering the existing safety issues and potential improvements. CCC staff have updated the High Crash Locations report most recently in 2022. CCC staff reference the High Crash Locations report and dashboard to prioritize locations for future Road Safety Audits within the region. The High Crash Locations report also serves as a resource for transportation safety professionals looking to make strategic investments to improve safety in the region.

Based on the 2022 Barnstable County High Crash Locations report, the intersection of Station Avenue at White’s Path/Workshop Road was ranked #47 due to the total number of crashes (15 crashes between 2018-2020). This intersection is also one of the primary locations being studied in the ongoing Station Avenue Corridor Study being conducted by the Cape Cod Commission. Additionally, in 2011, the Commission conducted an RSA at Union Street/Station Avenue at the Route 6 Ramp intersections to the immediate north of the Station Avenue at White’s Path/Workshop Road intersection.

## Project Data

The RSA was held on Thursday, October 5<sup>th</sup>, 2023, with representatives from state, regional and local agencies and organizations providing expertise in the engineering, planning, maintenance, transit, and emergency response fields. The RSA was held in-person with pre- and post-audit meetings held at Yarmouth Town Hall. A site visit was conducted at the intersection where the audit team was able to observe traffic operations and existing roadway conditions. Attendees were encouraged to visit the site prior to the audit and to review the collision diagrams and crash summaries to become familiar with the existing safety issues.

A list of the attendees is provided in Table 1 with their contact information provided in Appendix B. A copy of the RSA Agenda can be found in Appendix A.

**Table 1: Participating Audit Team Members**

<b>Audit Team Member</b>	<b>Agency/Affiliation</b>
Kathy Williams	Yarmouth Planning/Community Development
Mark Grylls	Yarmouth Building Commissioner
Nathan Whetten	Yarmouth Senior Project Manager
Amanda Lima	Yarmouth Town Engineer
Jon Sawyer	Yarmouth Fire
Brian Carchedi	Yarmouth Police
Mike Wells	Yarmouth Police
Dakota DelSignore	MassDOT Traffic & Safety
Mojtaba Moharrer	MassDOT District 5
Jason Walters	MassDOT District 5 Projects
Isabella Alves	MassDOT District 5
Kevin Pierre Noel	MassDOT District 5
Michael Medeiros	MassDOT District 5
Ethan Costa	MassDOT District 5
Katherine Jansen	Regional Bicycle Advocate
Colleen Medeiros	Cape Cod Commission
David Nolan	Cape Cod Commission
Evan Costa	Cape Cod Commission
Joyia Smikle	Cape Cod Commission

During the RSA, the team first identified safety issues at the intersection. An in-person field visit to the study area followed. The audit team then finished the meeting by determining appropriate short, medium, and long-term countermeasures for the safety issues discussed.

## Project Location and Description

### *Study Area Roadways*

#### Station Avenue

Station Avenue is classified as an urban principal arterial running in the north-south direction. Station Avenue serves as an important connection between Route 6 and Route 6A to the north as well as Route 28 to the south. Station Avenue carries a wide variety of users as it provides access to commercial, residential, and industrial areas as well as several Dennis-Yarmouth Regional schools. To the north of White’s Path, Station Avenue is under MassDOT jurisdiction while to the south of White’s Path, Station Avenue is under the Town of Yarmouth’s jurisdiction. On Station Avenue, the posted speed limit is 40 miles per hour to the north of the intersection through the Route 6 interchange ramps and 35 miles per hour to the south of the intersection through the commercial area. There is an approximate four-foot-wide sidewalk on the east side of Station Avenue south of the intersection and a crosswalk is located across the northern leg of Station Avenue at the signalized intersection with White’s Path along with the corresponding pedestrian signal equipment. There is also a small section of sidewalk located just outside of the RSA study area to the north, along the western side of Station Avenue, in the vicinity of the Route 6 eastbound ramps and Route 6 overpass. There are no bicycle facilities provided on Station Avenue, however, to the south of the RSA study area, the Cape Cod Rail Trail crosses over Station Avenue via a bridge structure and there is also a trail head and associated parking area that provides access to the trail from Station Avenue. To the south of the RSA location, there is a two-way left turn lane (TWLTL) that stretches from just south of the White’s Path intersection to just north of the intersection of Station Avenue at Old Town House Road. The Cape Cod Regional Transit Authority (CCRTA) does not have any routes that utilize Station Avenue, however micro transit (Smart Dart) from the CCRTA has been observed on the corridor.

#### White’s Path

White’s Path is a two-lane roadway which runs east to west between Station Avenue and North Main Street. White’s Path is classified as an urban minor arterial under Town of Yarmouth jurisdiction that provides access to commercial and industrial areas. As White’s Path approaches the signalized intersection at Station Avenue, there is a 15-foot shared left-through lane and a 13-foot channelized right turn lane. There is a four-foot-wide sidewalk along the southern side of White’s Path within the study area. There is a marked crosswalk across White’s Path with pedestrian signal equipment and refuge islands at the Station Avenue intersection. There are no bicycle facilities on White’s Path. The posted speed limit for this section of White’s Path is 30 miles per hour.

#### Workshop Road

Workshop Road, to the west of Station Avenue, is a two-lane roadway that allows access to several commercial properties. Workshop Road is an important connection for commercial trucks to the Yarmouth Septage Plant and Yarmouth-Barnstable Regional Commercial Transfer Station as well as the Town of Yarmouth Disposal Area. Workshop Road is classified as a local road but is not a public

throughway due to restricted access at the transfer station. There are no pedestrian or bicycle facilities along Workshop Road. There is no posted speed limit on Workshop Road.

### ***Study Area Intersection***

#### **Station Avenue at White's Path/Workshop Road**

Station Avenue at White's Path/Workshop Road is a four-legged signalized intersection. The intersection experiences frequent congestion due to its proximity to the Route 6 interchange system at Exit 75 and the high volume of traffic that Station Avenue experiences at peak periods throughout the day. At the intersection, the northbound approach of Station Avenue consists of an eleven-foot exclusive left turn lane, an eleven-foot through lane and an eleven-foot channelized right turn lane. The Station Avenue southbound approach consists of an eleven-foot exclusive left turn and a shared eleven-foot through-right turn lane. The northbound exclusive left lane and southbound exclusive left lane on Station Avenue both have an approximate storage length of 120 feet. The eastbound Workshop Road approach consists of an eleven-foot exclusive left turn lane and an eleven-foot through-right turn lane. The westbound White's Path approach consists of a thirteen-foot through-left turn lane and a twelve-foot channelized right turn lane. The signal operates with protected-permissive left turn phasing for the exclusive left turn lanes on Station Avenue, followed by a phase for the through movements on Station Avenue and a phase for the eastbound and westbound movements on the minor approaches. The signal also has an exclusive pedestrian phase and in-road bicycle detection loops.

There are four-foot-wide sidewalks on the southeastern side of the intersection with a crosswalk across White's Path and the northern leg of Station Avenue. There are pedestrian islands on the White's Path crossing as the crossing distance is over 100 feet. There is a sidewalk on the western side of Station Avenue to the immediate north of the intersection, which does not connect to the intersection. There are no other pedestrian facilities or on street bicycle facilities at the intersection or approaches.

It is important to note that the intersection of Station Avenue at White's Path and Workshop Road is located about 750 feet to the south of the Route 6 eastbound interchange ramps. The close proximity of the highway interchange directly affects the Station Avenue and White's Path signalized intersection and is a contributing factor to several safety issues noted further, such as lane designations, speeding and congestion.

### ***Crash Data***

Crash reports were supplied by the Yarmouth Police Department and supplemented with crash reports provided by MassDOT. The crash reports were reviewed, and a collision diagram was developed for the study area location. The collision diagram for the intersection is provided in Appendix C.

#### Station Avenue at White's Path/Workshop Road

The intersection of Station Avenue at White's Path/Workshop Road experienced 15 crashes over the three-year study period (2018-2020). During the three-year study period, eight (53%) crashes were rear-end crashes, four (27%) crashes were angle crashes, and three (20%) were sideswipe, same direction crashes. Five of the eight rear-end crashes occurred on the southbound approach of the intersection. There were no fatal injuries reported at this intersection during the three-year study period.

Of the 15 observed crashes at this intersection during the study period, there was one injury crash, 13 crashes resulting in property damage only, and one crash reported as unknown injury severity. Over 50% of the overall crashes at the intersection occurred during the months of September and October, with other months such as November and December showing high percentages. This indicates that the crashes occurred outside of the congested summer peak while school was back in session. Most of the observed crashes occurred during the peak morning commute (8-10 AM) and the peak afternoon commute (2-4 PM), a combined 58% percent of crashes occurred during those peaks. About 93% of crashes occurred during daylight hours, with 71% occurring during clear conditions and 79% occurring under dry conditions.



Figure 1: Locus Map



## Audit Observations and Potential Safety Enhancements

The Road Safety Audit Team met in-person to discuss existing conditions, safety issues and potential countermeasures. The data that was reviewed included a crash summary, collision diagram, the RSA prompt list, a series of bar graphs depicting safety trends found at the intersection and a summary of FHWA Proven Safety Countermeasures (PSC), all of which are included in Appendix C.

The following safety issues and potential enhancements were identified through the discussions with the Road Safety Audit team. Several of the issues require further study and engineering to determine the feasibility of implementing enhancements.

### Safety Issue #1: Geometric Design

#### **Observations:**

The RSA team noted during the site visit that there are several issues related to turn lane storage and lane widths. At this intersection, the crashes observed were rear-end (53%), angle (27%), or sideswipe, same direction (20%). Participants noted that these crashes may be due to short storage lengths and smaller lane widths. Both approaches on Station Avenue seem to have insufficient turn lane storage lengths, as well as on the White's Path approach. On the northbound approach of Station Avenue, northbound vehicle queues regularly block the left and right turn lanes. Additionally, the southbound left turn lane is regularly blocked by Station Avenue southbound through vehicles.



**Image 1: Left lane is blocked by the queues in the through travel lane on Station Avenue northbound.**

On White's Path, the westbound right turn lane is not well-defined and was noted by participants to be blocked by congested traffic. It was also noted that the northbound stop bars on Station Avenue are not aligned and are offset by approximately twelve feet. Additionally, there are minimal shoulders on Station Avenue at the signalized intersection making it difficult for vehicles to pull over for emergency vehicles.

Audit participants noted the large footprint of this intersection and discussed how it may contribute to instances of red-light running. The geometric design of the existing traffic islands for the channelized right turn lanes in the northbound and westbound directions were noted to be small and create a hazard at night as they are not visible. Additionally, there is a large striped gore area surrounding the existing traffic island in the southeast quadrant of the intersection which allows vehicles a space to bypass vehicles queued in the northbound through lane.

### Enhancements:

- Evaluate extending the storage length of the exclusive left lane on the northbound and the southbound approach of Station Avenue.
- Evaluate extending the storage length of the channelized right turn lane on the northbound approach of Station Avenue.
- Construct larger pedestrian refuge islands in the existing striped gore areas to reduce the amount of space available at the stop lines.
- Evaluate measures to tighten intersection geometry (e.g., removing slip lanes, reducing curb radii, alignment) to reduce the overall footprint of the intersection.
- Add wider shoulders on Station Avenue, adding room from emergency services.
- Evaluate the possibility of formally converting the northbound right turn only lane on Station Avenue to a shared through-right lane (note that this improvement would require coordination with any work done at the Route 6 interchanges).

### Safety Issue #2: Traffic Signal and Lighting

#### Observations:

There were issues observed with the protected/permissive left turn signal heads. The "Doghouse" signal head for permissive/protected left turns for the southbound left turn lane on Station Avenue appeared to have a short green time, and participants noted that red light running had been observed at this intersection. Crash #10 involved a southbound vehicle who ran a red light and struck a vehicle exiting Workshop Road. Participants also noted that the signal timing also seemed short for the exclusive pedestrian phase.

RSA participants noted that the “doghouse” signal head may cause confusion as motorists see a green ball in the southbound left turn lane which may wrongly convey to motorists that the lane can continue through (despite there being one receiving lane on Station Avenue departing the intersection). Additionally, the red signal indication is lit at the same time as the green arrow indication within the “doghouse” signal head. It was also noted that signal visibility is affected by the presence of large trucks on the corridor. There are no supplemental signal heads on the poles of the mast arms.



**Image 2: Signal head have LEDs burned out and are missing retroreflective backplates.**



**Image 3: Ambulance observed during the RSA utilizing the emergency pre-emption system without a confirmation beacon.**

The traffic signal seemed to be operating as effectively and was recently adjusted according to Town Staff, however, the intersection does experience regular congestion. The proximity to the Route 6 interchange ramps and the nearby schools during drop-off/pick-up times is attributed to the congestion.

RSA participants noted that some of the signals had several LEDs out, making the green lights less visible. The emergency pre-emption at the intersection appeared to be functioning during the site visit as the RSA team watched an ambulance make use of the system heading northbound on Station Avenue. The emergency pre-emption system, however, is missing the white flashing confirmation.

During the site visit, there were two streetlights observed at the intersection, however one appeared to have a broken bulb and to be not receiving power. It was noted that lights from the surrounding businesses caused glare issues at this intersection. Participants also noted that there were glare issues during the day, and that the backplates on the signals were not retroreflective. One of the crash reports mentioned that glare was an issue, as well as 93% percent of crashes occurred during the daytime.

**Enhancements:**

- Consider replacing the "doghouse" style signal heads with flashing yellow arrow signal heads to effectively communicate the protected/permissive phasing of the Station Avenue exclusive left turn lanes.
- Install a secondary signal head on the mast arm pole in both Station Avenue northbound and southbound directions.
- Replace the broken LEDs in the signal heads.
- Install missing flashing white indicator beacon for the emergency pre-emption system.
- Review and update signal timings, including clearance intervals and the pedestrian phase, to conform with latest standards.
- Consider signal coordination if there is future signalization at the Route 6 interchange ramps.
- Consider alternative intersection control strategies, including a roundabout.
- Evaluate the lighting conditions at the intersection; check to see if current streetlights work and provide enough light.
- Confirm with local businesses that their lighting does not impact the visibility of the intersection.
- Add retroreflective backplates to the signal heads at the intersection.

### Safety Issue #3: Pavement Markings and Signage

#### **Observations:**

Pavement markings and signage were another noted issue for the travel lane assignments on Station Avenue. Drivers headed both north and south on Station Avenue experience some confusion as to lane assignments.

During the site visit, participants witnessed a through vehicle that had gotten stuck in the southbound left turn only lane. The vehicle then proceeded to cut off vehicles in the through-right lane when the light changed to merge back into the correct lane on Station Avenue southbound. While in the northbound direction, a vehicle was noted to travel straight using the right turn only lane that transitions into a striped gore area. The pavement markings do not extend far enough for them to make an effective decision on selecting the appropriate travel lane for their desired movement. The team noted during the site visit that existing turn lane regulatory signage (R3-7 series) were either too close to the intersection to be effective or in was in the wrong location. On Station Avenue, the northbound “Left Lane Must Turn left” (R3-7) sign and the northbound “Right Lane Must Turn Right” signs are two of the signs that were noted to be ineffective based on position as there are often lengthy vehicle queues. Crashes # 1, 9, 11, and 13 show that drivers must make last minute decisions to change what lane they are in due to lack of advanced notice and driver confusion.

Participants noted that drivers incorrectly use the two-way left turn lane (TWLTL) as a travel lane heading in both directions. It was noted by participants that vehicles use the TWLTL to execute last minute maneuvers to continue through the intersection heading north. There is a sign located in the southbound direction for the start of the TWLTL but there is no sign in the northbound direction to indicate where the TWLTL ends. Additionally, the TWLTL to the south of the intersection does not taper off to create a formal northbound left turn lane pocket.

During the RSA field visit, it was observed that there was existing W4-2 lane drop warning signs that were inadvertently located on Station Avenue immediately north of the intersection in both directions. These signs may cause confusion to drivers who may think that two through lanes are allowed on Station Avenue approaching or departing the signalized intersection from the north. The southbound W4-2 sign



**Image 4: “Left Lane Must Turn Left” sign on Station Avenue northbound.**



**Image 5: Vehicle cutting off vehicles in the through-right lane attempting to merge in from the southbound left lane.**



**Image 6: Existing W4-2 lane drop signs that were inadvertently located on Station Avenue.**

(coming from the Route 6 interchange ramps) is not supported as the road opens to two lanes as motorists approach the intersection. The southbound W4-2 sign may cause drivers to inadvertently switch into the left turn only lane, thinking the right lane is ending. The roadway width where the northbound W4-2 is located (north of the White' Path intersection) is wide enough to support a small section of two through travel lanes, however there are no formal lane markings.

On White's Path, the right turn lane is not formally marked as a turn lane, despite having the signage and right turn arrow marking of a right turn only lane. The channelized right turn from White's Path onto Station Avenue yield sign and "shark teeth" yield pavement markings are located before the marked crosswalk while the yield sign and "shark teeth" markings for the Station Avenue northbound channelized right turn are located after the marked crosswalk. The location of these yield markings for both channelized right turn lanes should be assessed, and better aligned with the yield point for vehicles and merging traffic. Participants also noted that the right turn yield sign from Station Avenue onto White's Path was damaged.

As previously noted, the existing traffic islands for the channelized right turn lanes are small and difficult to see at night. There are currently no existing reflective object warning signs on the traffic islands.

**Enhancements:**

- Extend the current pavement markings for the storage lanes on Station Avenue.
- Add lane markings for the right turn only lane on White's Path.
- Mark auxiliary lanes in the northbound direction on Station Avenue where there is an existing lane drop sign.
- Conduct a signage inventory on current signage to assess if correct in location or if needs removal or replacement.
- Consider installing an MUTCD R10-12 "Left Turn Yield on Green" sign overhead on the signal mast arms to inform users of the left turn lane signal phasing on Station Avenue.
- Install MUTCD R3-8 series intersection lane control signage at the intersection for all approaches.
- Review the existing TWLTL signage and install additional signage as necessary.
- Remove the existing W4-2 lane drop sign in the southbound direction on Station Avenue (north of White's Path).
- Evaluate existing lane assignments for Station Avenue approaches and consider modifications as needed, including the potential for two through lanes.
- Taper the TWLTL to create a more easily identifiable left turn pocket northbound on Station Avenue.



- Consider the placement of the yield signs and markings on the channelized right turn lanes for optimal and consistent location.
- Consider installing supplemental lane assignment signage affixed to the mast arm overhead for the Station Avenue approaches.
- Add MUTCD (OM1-1) reflective signage for the pedestrian islands to make them visible in low light and at night.

#### Safety Issue #4: Access Management

##### **Observations:**

Near the intersection there are two curb cuts for the Mobil gas station at the southwest corner of the intersection. These curb cuts cause conflict when vehicles take left turns out of the gas station. Vehicles using these curb cuts resulted in two of the observed crashes, # 9 and 11. The curb cut for Mitsubishi and the Mid-Cape Pet Supply store on Workshop Road is difficult to enter in and out of given its proximity to the intersection. The uniqueness of this curb cut can also provide issues for trucks taking right turns from Station Avenue into this driveway as the turn radius needed is small.



**Image 7: Vehicle attempting to merge into the through lane after making a left from the Mobil station.**

##### **Enhancements:**

- Coordinate with the Mobil gas station to revise the site driveway(s) to restrict movements only due to proximity to the signal.
- Encourage Mobil Gas to install signage encouraging patrons to use the driveway that exits onto Workshop Road to make left turns heading north on Station Avenue.

#### Safety Issue #5: Multi-Modal Accommodations

##### **Observations:**

Although there were no crashes observed at this intersection involving bicycles or pedestrians during the study period, RSA participants made note of the lack of pedestrian and bicycle accommodations. There are minimal sidewalks at the intersection. Sidewalks are present along the eastern side of Station Avenue continuing onto the southern side of White's Path. At the intersection, there are small receiving areas of sidewalk in the northeast and northwest corners of the intersection, but the ramps do not have tactile warning pads.



**Image 8: Push button sign mentioning countdown timers, which are not present.**

Additionally, there is a small section of sidewalk to the north at the Route 6 eastbound ramps. There is a desired use dirt path on Station Avenue that has formed from where the sidewalk stops between the Route

6 eastbound ramp and White's Path. At the signal, crosswalks are not present in all directions, leaving pedestrians with challenges crossing Workshop Road and the northbound approach on Station Avenue. The crosswalks that do exist at the signal are not in compliance with current ADA standards.

During the site visit, the RSA team noted that the pedestrian push button signs that are present do not correspond with the current pedestrian equipment that is present at the signal. The signs mention countdown timers, which are not present. There are also no pedestrian push buttons or pedestrian signals for pedestrians trying to cross the two channelized right turn lanes in the northeast or southeast quadrants. Pedestrians crossing the channelized right turns must wait for vehicles to yield in order to enter the marked crosswalk. During the site visit, the RSA team noticed that there was sand as well as debris built up on the existing sidewalks and curb ramps around the intersection.



**Image 9: No pedestrian equipment on the sidewalk in the southeast quadrant to allow pedestrians to start the pedestrian phase.**

Participants noted that bicyclists have a hard time taking lefts at the intersection as well as that the southbound shared through-right lane can be problematic for cyclists, leading to them potentially getting clipped by drivers taking right turns. The signal loops for bicycles are not marked, yet there is signage present for them. Shoulders approaching the intersection narrow forcing bicyclists using the shoulders to merge into traffic. There are no bike lanes present in this area, however, there is a nearby rail trail connection to the south of the intersection where the Cape Cod Rail Trail crosses over Station Avenue.

#### **Enhancements:**

- Widen the existing sidewalks at the intersection to meet current standards.
- Install sidewalks on the west side of Station Avenue, providing a connection to the existing northern sidewalk.
- Add missing crosswalks and pedestrian signal equipment for all approaches at the intersection.
- Reconstruct existing curb ramps at the intersection to meet current ADA standards.
- Install pedestrian countdown timers to be consistent with signage.
- Consider removing the channelized right turns or incorporating the channelized right turns into the signal operations to increase pedestrian safety for the northeast and southeast crosswalks which do not operate under the exclusive pedestrian phase.
- Maintain the existing sidewalk facilities to keep them clear of sand and debris.
- Evaluate installing bike boxes at the intersection.
- Add pavement markings for the bicycle detection loops.

- Consider the addition of bike lanes and/or separated bike lanes on Station Avenue.

#### Safety Issue #6: Speed and Driver Inattention

##### **Observations:**

Station Avenue is a significant north-south connector and White's Path as well as Workshop Road provide access to important industrial and commercial areas. Posted speed limits through this intersection are rather high which may be a contributing factor to the number of rear ends observed. The straight roadway alignment and proximity to the Route 6 interchange could be contributing to higher speeds on Station Ave. Audit members also noted this is a transition area between differing roadway types and between a residential and commercial area. Drivers going faster during the offseason may contribute to the higher percentage of crashes occur outside of the summer season as the congestion is lower. There is also a significant number of crashes with a contributing factor of inattention at this intersection, distracted driving as well as drivers unfamiliar with the intersection's layout could be the cause of this. It was also observed in the field that drivers take the northbound right turn from Station Ave to White's Path at high speeds.



**Image 10: 40 mile per hour speed limit sign to the immediate north of the intersection.**

##### **Enhancements:**

- Evaluate existing speed regulations and consider revising speed regulations for Station Avenue in the vicinity of the intersection, once other countermeasures related to speed reduction have been implemented.
- Coordinate with Yarmouth Police Department to enforce distracted driving laws including the hands-free law.
- Consider implementing traffic calming measures to encourage slower speeds through the intersection. Evaluate the current vehicle speeds along Station Ave to use as a baseline in selecting potential speed management countermeasures.
- Consider adding speed management countermeasures in the vicinity of the interchange (markings, flex posts temporary median).



## Summary of Road Safety Audit

The final part of the RSA included the discussion of potential safety enhancements to address the identified safety deficiencies. There were a range of safety enhancements including both short-term, low-cost improvements as well as long-term and higher cost recommendations. Table 2 presents a summary of the estimated time frames and preliminary costs associated with these potential safety enhancements.

Table 3 presents a summary of the Road Safety Audit observations and enhancements to assist in the design and/or implementation of potential improvements elicited during the RSA process. It is also recommended that any design process for more involved geometric changes include further analysis and public input. Safety payoff estimates are subjective judgement of the potential effectiveness of the potential enhancement.

**Table 2: Estimated Time Frame and Costs Breakdown**

Time Frame		Costs	
Short-Term	<1 Year	Low	<\$10,000
Mid-Term	1-3 Years	Medium	\$10,001-\$50,000
Long-Term	>3 Years	High	>\$50,000

Table 3: Potential Safety Enhancement Summary

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Geometric Design	Evaluate extending the storage length of the exclusive left lane on the northbound and southbound approach of Station Avenue	Medium	Long-Term	High	MassDOT/Town of Yarmouth
Geometric Design	Evaluate extending the storage length of the channelized right turn lane on the northbound approach of Station Avenue	Medium	Long-Term	High	Town of Yarmouth
Geometric Design	Construct larger pedestrian refuge islands in the existing striped gore areas to reduce the amount of space available at the stop lines	Medium	Mid-Term	Medium	Town of Yarmouth
Geometric Design	Evaluate measures to tighten intersection geometry (e.g., removing slip lanes, reducing curb radii, alignment) to reduce the overall footprint of the intersection	Medium	Long-Term	High	Town of Yarmouth
Geometric Design	Add larger shoulders on Station Avenue, adding room from emergency services	Medium	Long-Term	High	MassDOT/Town of Yarmouth
Geometric Design	Evaluate the possibility of formally converting the northbound right turn only lane on Station Avenue to a shared through-right lane	Medium	Long-Term	High	MassDOT/Town of Yarmouth
Traffic Signal/Lighting	Consider replacing the "doghouse" style signal heads with flashing yellow arrow signal heads to effectively communicate the protected/permissive phasing of the Station Avenue exclusive left turn lanes	High	Mid-Term	Medium	Town of Yarmouth
Traffic Signal/Lighting	Install a secondary signal head on the mast arm pole in both Station Avenue northbound and southbound vehicles	High	Mid-Term	Medium	Town of Yarmouth
Traffic Signal/Lighting	Replace the broken LEDs in the signal heads	Medium	Short-Term	Low	Town of Yarmouth
Traffic Signal/Lighting	Install missing flashing white indicator beacon for the emergency pre-emption system	Low	Short-Term	Low	Town of Yarmouth

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Traffic Signal/Lighting	Review and update signal timings, including clearance intervals and the pedestrian phase, to conform with latest standards	High	Short-Term	Low	Town of Yarmouth
Traffic Signal/Lighting	Consider signal coordination if there is future signalization at the Route 6 interchange ramps	Medium	Long-Term	High	MassDOT/Town of Yarmouth
Traffic Signal/Lighting	Consider alternative intersection control strategies, including a roundabout	High	Long-Term	High	MassDOT/Town of Yarmouth
Traffic Signal/Lighting	Evaluate the lighting conditions at the intersection; check to see if current streetlights work and provide enough light	Medium	Short-Term	Low	Town of Yarmouth
Traffic Signal/Lighting	Confirm with local businesses that their lighting does not impact the visibility of the intersection	Low	Short-Term	Low	Town of Yarmouth
Traffic Signal/Lighting	Add retroreflective backplates to the signal heads at the intersection	Medium	Short-Term	Low	Town of Yarmouth
Pavement Markings/Signage	Extend the current pavement markings for the storage lanes on Station Avenue	High	Mid-Term	Medium	MassDOT/Town of Yarmouth
Pavement Markings/Signage	Add lane markings for the right turn only lane on White’s Path	Low	Mid-Term	Medium	Town of Yarmouth
Pavement Markings/Signage	Mark auxiliary lanes in the northbound direction on Station Avenue where there is an existing lane drop sign	Medium	Mid-Term	Medium	Town of Yarmouth
Pavement Markings/Signage	Conduct a signage inventory on current signage to assess if correct in location or if needs removal or replacement	Medium	Short-Term	Medium	Town of Yarmouth
Pavement Markings/Signage	Consider installing an MUTCD R10-12 “Left Turn Yield on Green” sign overhead on the mast arms to inform users of the left turn lane signal phasing on Station Avenue	Medium	Short-Term	Low	Town of Yarmouth
Pavement Markings/Signage	Add MUTCD R3-8 series intersection lane control signage at the intersection for all approaches	Medium	Short-Term	Low	MassDOT/Town of Yarmouth
Pavement Markings/Signage	Review the existing TWLTL signage and install additional signage as necessary	Medium	Short-Term	Low	Town of Yarmouth

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Pavement Markings/Signage	Remove the existing W4-2 lane drop sign in the southbound direction on Station Avenue (north of White’s Path)	Low	Short-Term	Low	MassDOT/Town of Yarmouth
Pavement Markings/Signage	Evaluate existing lane assignments for Station Avenue approaches and consider modifications as needed, including the potential for two through lanes	High	Long-Term	High	MassDOT/Town of Yarmouth
Pavement Markings/Signage	Taper the TWLTL to create a more easily identifiable left turn pocket northbound on Station Avenue	High	Mid-Term	Medium	Town of Yarmouth
Pavement Markings/Signage	Consider the placement of the yield signs and markings on the channelized right turn lanes for optimal and consistent location	Medium	Short-Term	Low	Town of Yarmouth
Pavement Markings/Signage	Consider installing supplemental lane assignment signage affixed to the mast arm overhead for the Station Avenue approaches	Medium	Short-Term	Low	Town of Yarmouth
Pavement Markings/Signage	Add MUTCD OM1-1 reflective signage for the pedestrian islands to make them visible in low light and at night	Low	Short-Term	Low	Town of Yarmouth
Access Management	Coordinate with the Mobil gas station to revise the site driveway(s) to restrict movements only due to proximity to the signal	High	Mid-Term	Medium	Town of Yarmouth
Access Management	Encourage Mobil Gas to install signage encouraging patrons to use the driveway that exits onto Workshop Road to make left turns heading north on Station Avenue	Medium	Mid-Term	Low	Town of Yarmouth
Multi-Modal Accommodations	Widen the existing sidewalks at the intersection to meet current standards	Low	Mid-Term	High	Town of Yarmouth
Multi-Modal Accommodations	Install sidewalks on the west side of Station Avenue, providing a connection to the existing northern sidewalk	Medium	Long-Term	High	Town of Yarmouth
Multi-Modal Accommodations	Add missing crosswalks and pedestrian signal equipment for all approaches at the intersection	High	Mid-Term	High	Town of Yarmouth

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Multi-Modal Accommodations	Reconstruct existing curb ramps at the intersection to meet current ADA standards	Medium	Mid-Term	Medium	Town of Yarmouth
Multi-Modal Accommodations	Install pedestrian countdown timers to be consistent with signage	High	Short-Term	Medium	Town of Yarmouth
Multi-Modal Accommodations	Consider removing the channelized right turns or incorporating the channelized right turns into the signal operations to increase pedestrian safety for the northeast and southeast crosswalks which do not operate under the exclusive pedestrian phase	High	Long-Term	High	Town of Yarmouth
Multi-Modal Accommodations	Maintain the existing sidewalk facilities to keep them clear of sand and debris	Low	Short-Term	Low	MassDOT/Town of Yarmouth
Multi-Modal Accommodations	Evaluate adding bike boxes at the intersection	Medium	Mid-Term	Medium	Town of Yarmouth
Multi-Modal Accommodations	Add pavement markings for the bicycle loops	Low	Short-Term	Low	Town of Yarmouth
Multi-Modal Accommodations	Consider the addition of bike lanes and/or separated bike lanes on Station Avenue	High	Long-Term	High	Town of Yarmouth
Speed/Driver Inattention	Evaluate existing speed regulations and consider revising speed regulations for Station Avenue in the vicinity of the intersection, once other countermeasures related to speed reduction have been implemented	Medium	Mid-Term	Low	MassDOT/Town of Yarmouth
Speed/Driver Inattention	Coordinate with Yarmouth Police Department to enforce distracted driving laws including the hands-free law	Medium	Short-Term	Low	Town of Yarmouth
Speed/Driver Inattention	Consider implementing traffic calming measures to encourage slower speeds through the intersection	High	Mid-Term	Medium	MassDOT/Town of Yarmouth
Speed/Driver Inattention	Evaluate the current vehicle speeds along Station Ave to use as a baseline in selecting potential speed management countermeasures	Medium	Short-Term	Low	MassDOT/Town of Yarmouth

Safety Issue	Potential Safety Enhancement	Safety Payoff	Time Frame	Cost	Jurisdiction
Speed/Driver Inattention	Consider adding speed management countermeasures in the vicinity of the interchange (markings, flex post temporary median)	Medium	Mid-Term	Medium	MassDOT

## Appendix A. RSA Meeting Agenda

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# Agenda

## Road Safety Audit

Yarmouth, MA

Station Ave @ White's Path Intersection

Meeting Location: Yarmouth Town Hall

Date: 10/05/2023

Time: 9AM to 11AM

Type of meeting:	High crash location – Road Safety Audit
Attendees:	Invited participants to comprise a multidisciplinary team
Please bring:	Thoughts and enthusiasm!!

9:00 AM	<b>Welcome and Introductions</b>
9:15 AM	<b>Discussion of Safety Issues</b> <ul style="list-style-type: none"><li>▪ Crash history – provided in advance</li><li>▪ Existing geometries and conditions</li></ul>
9:30 AM	<b>Site Visit</b> <ul style="list-style-type: none"><li>▪ Travel to the Station Ave @ White's Path</li><li>▪ Walk as a group and identify areas for improvement</li></ul>
10:00 AM	<b>Discussion of Potential Improvements</b> <ul style="list-style-type: none"><li>▪ Discuss observations and finalize safety issue areas</li><li>▪ Discuss potential improvements and finalize recommendations</li></ul>
11:00 AM	<b>Adjourn for the Day – but the RSA has not ended</b>

### Instructions for Participants:

- Before attending the RSA participants are encouraged to travel through the intersection and complete/consider elements on the RSA Prompt List with a focus on safety.
- All participants will be actively involved in the process throughout. Participants are encouraged to come with thoughts and ideas, but are reminded that the synergy that develops and respect for others' opinions are key elements to the success of the overall RSA process.
- After the RSA meeting, participants will be asked to comment and respond to the document materials to assure it is reflective of the RSA completed by the multidisciplinary team.



## Appendix B. RSA Audit Team Contact List

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## Participating Audit Team Members

Date: October 5, 2023      Location: Yarmouth Town Hall

Audit Team Members	Agency/Affiliation	Email Address
Kathy Williams	Yarmouth Planning/Community Development	kwilliams@yarmouth.ma.us
Mark Grylls	Yarmouth Building Commissioner	mgrylls@yarmouth.ma.us
Nathan Whetten	Yarmouth Senior Project Manager	nwhetten@yarmouth.ma.us
Amanda Lima	Yarmouth Town Engineer	Alima@yarmouth.ma.us
Jon Sawyer	Yarmouth Fire	jsawyer@yarmouth.ma.us
Brian Carchedi	Yarmouth Police	bcarchedi@yarmouth.ma.us
Mike Wells	Yarmouth Police	mwells@yarmouth.ma.us
Dakota DelSignore	MassDOT Traffic & Safety	dakota.d.delsignore@dot.state.ma.us
Mojtaba Moharrer	MassDOT District 5	mojtaba.m.moharrer@dot.state.ma.us
Jason Walters	MassDOT District 5 Projects	Jason.walters@dot.state.ma.us
Isabella Alves	MassDOT District 5	Isabella.q.alves@dot.state.ma.us
Kevin Pierre Noel	MassDOT District 5	kpierrenoel@dot.state.ma.us
Michael Medeiros	MassDOT District 5	Michael.p.medeiros@dot.state.ma.us
Ethan Costa	MassDOT District 5	Ethan.r.costa@dot.state.ma.us
Katherine Jansen	Regional Bicycle Advocate	Katherine.jansen@falmouthma.gov
Colleen Medeiros	Cape Cod Commission	colleen.medeiros@capecodcommission.org
David Nolan	Cape Cod Commission	David.nolan@capecodcommission.org
Evan Costa	Cape Cod Commission	evan.costa@capecodcommission.org
Joyia Smikle	Cape Cod Commission	joyia.smikle@capecodcommission.org

## Appendix C. Detailed Crash Data

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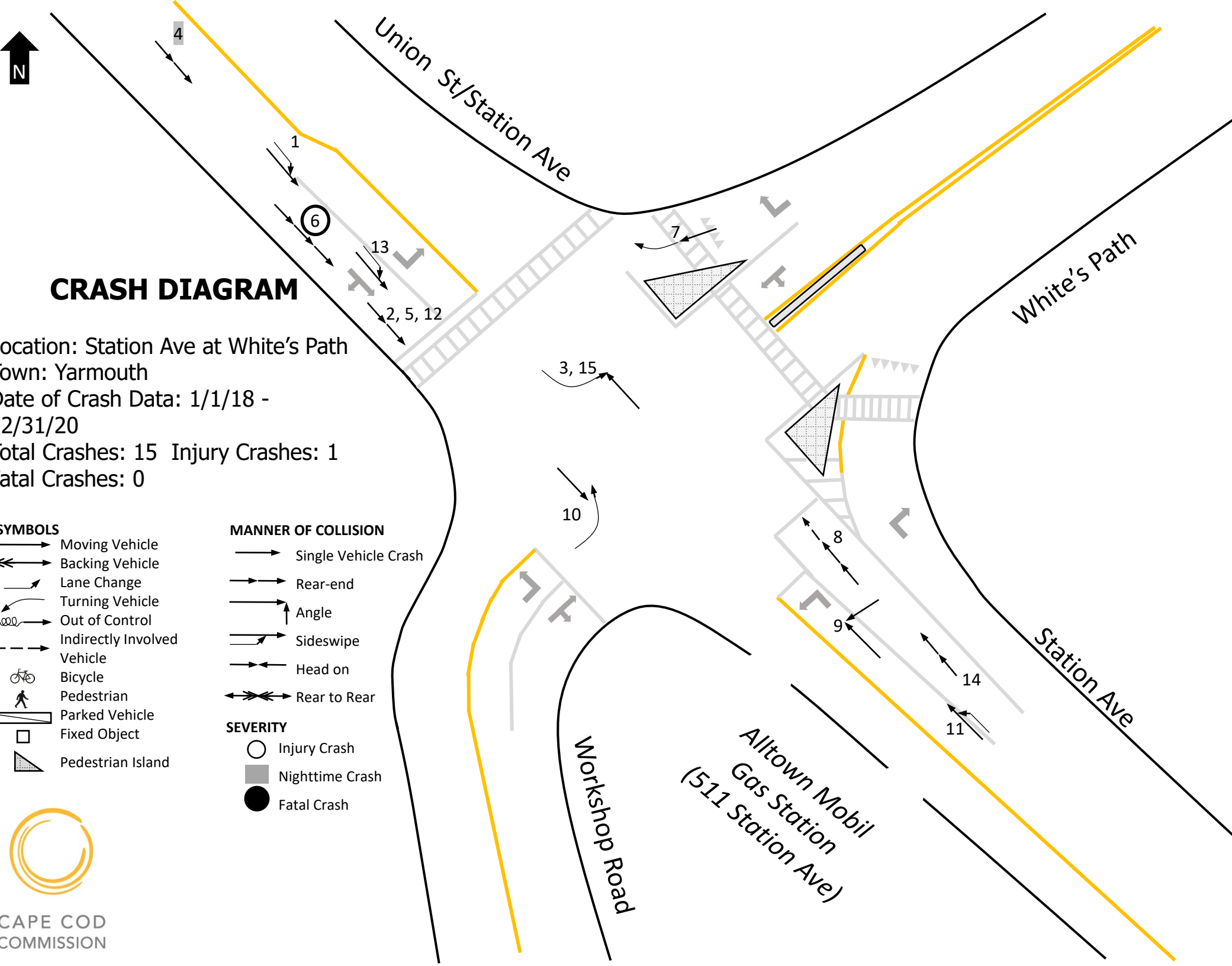
# CRASH DIAGRAM

Location: Station Ave at White's Path  
 Town: Yarmouth  
 Date of Crash Data: 1/1/18 - 12/31/20  
 Total Crashes: 15 Injury Crashes: 1  
 Fatal Crashes: 0

- SYMBOLS**
- Moving Vehicle
  - Backing Vehicle
  - Lane Change
  - Turning Vehicle
  - Out of Control
  - Indirectly Involved Vehicle
  - Bicycle
  - Pedestrian
  - Parked Vehicle
  - Fixed Object
  - Pedestrian Island

- MANNER OF COLLISION**
- Single Vehicle Crash
  - Rear-end
  - Angle
  - Sideswipe
  - Head on
  - Rear to Rear

- SEVERITY**
- Injury Crash
  - Nighttime Crash
  - Fatal Crash

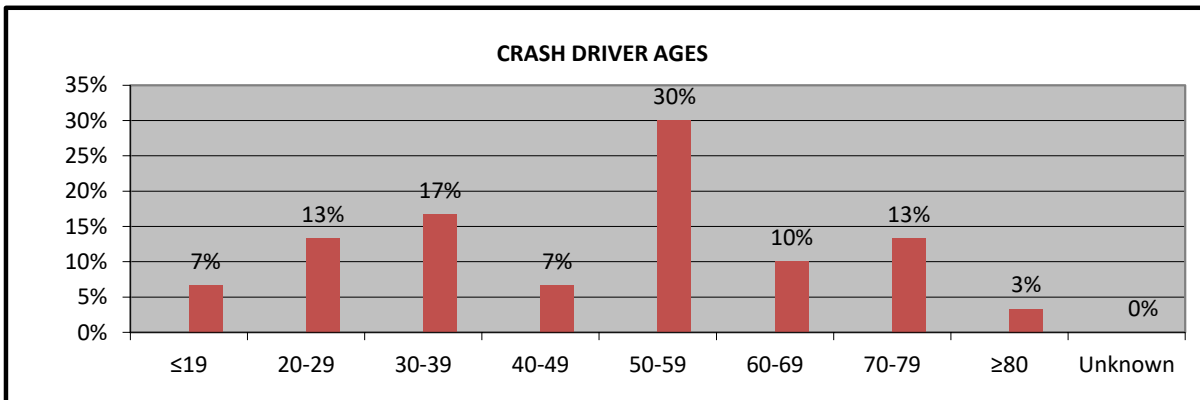
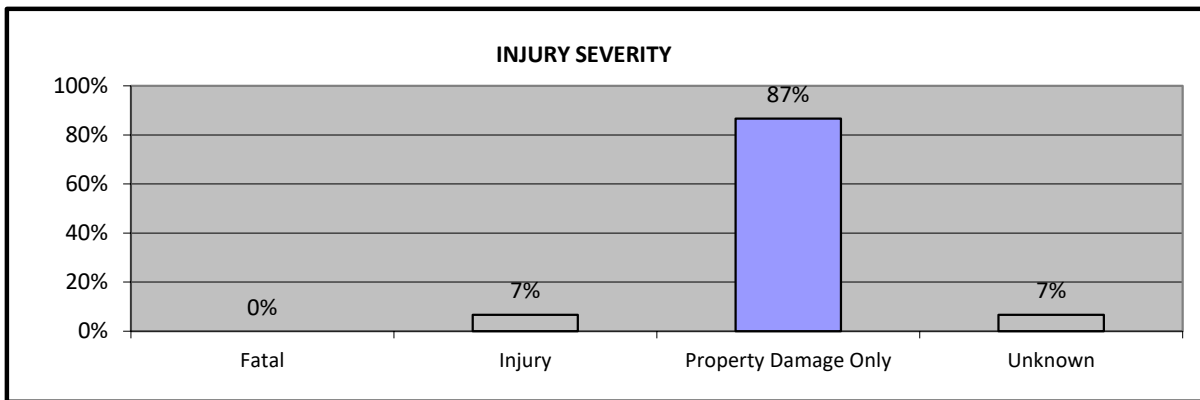
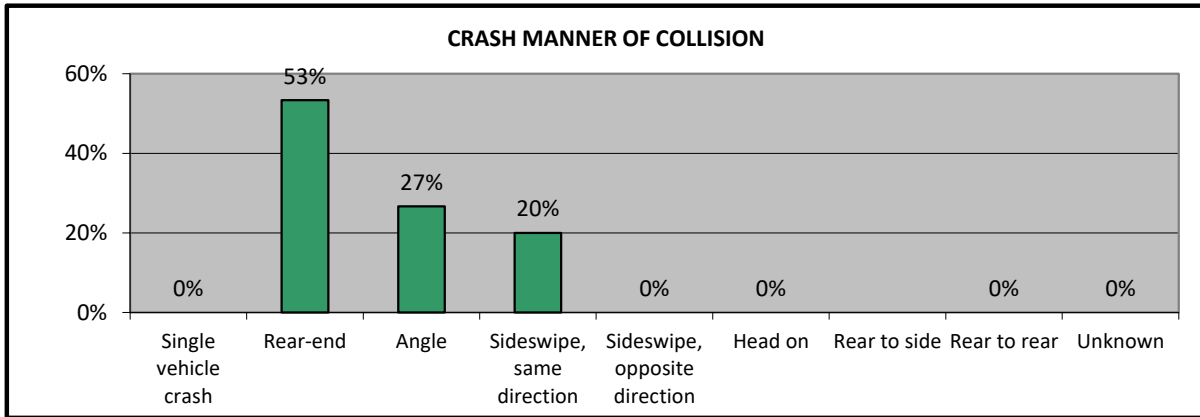


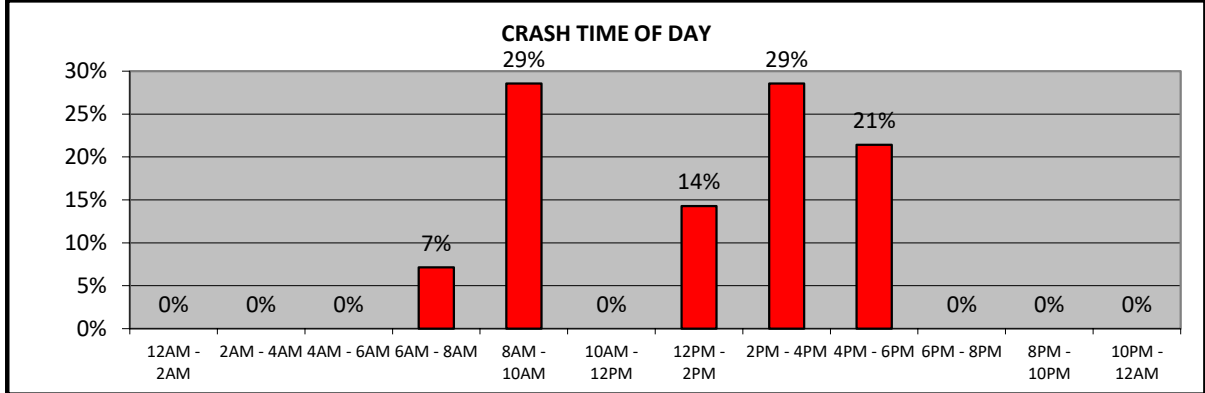
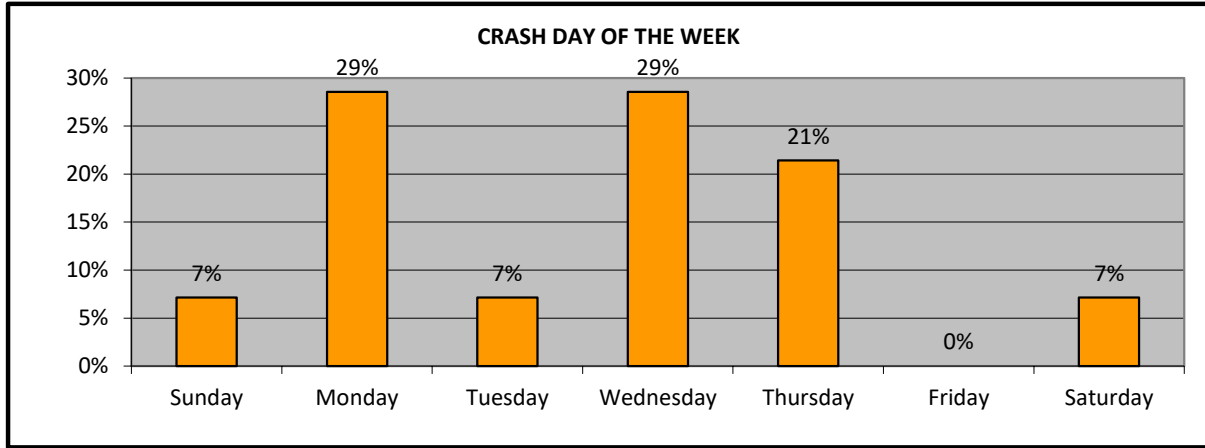
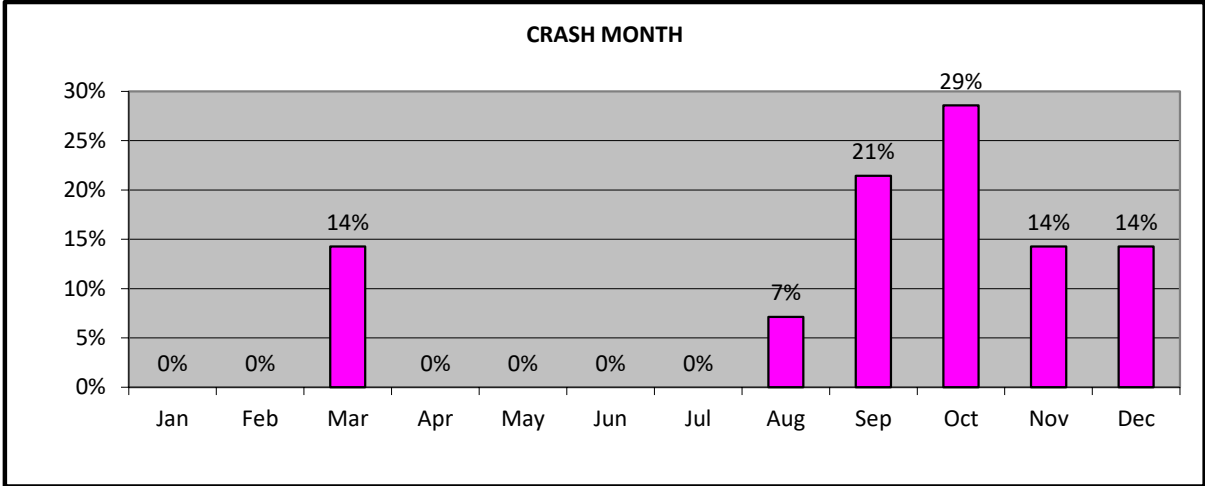
**Crash Data Summary Table**  
Station Ave at White's Path, Yarmouth, MA  
2018-2020

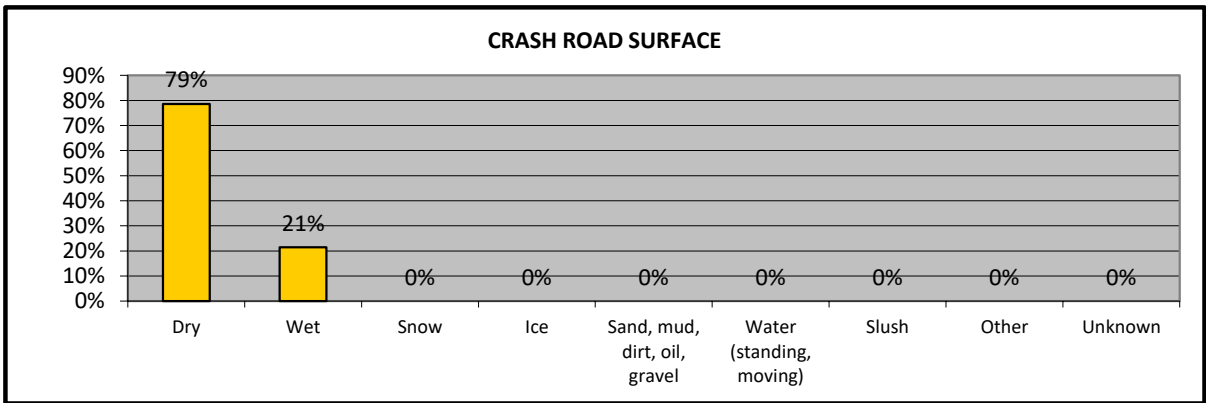
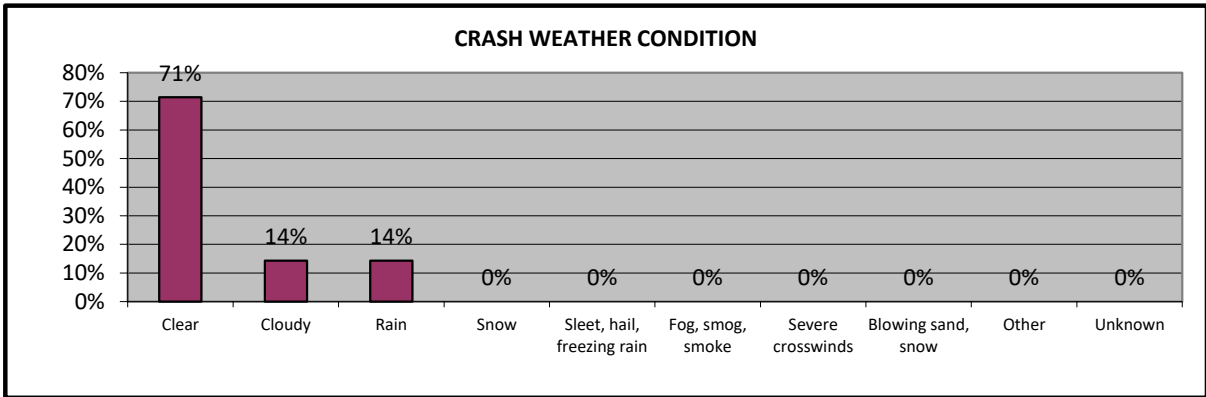
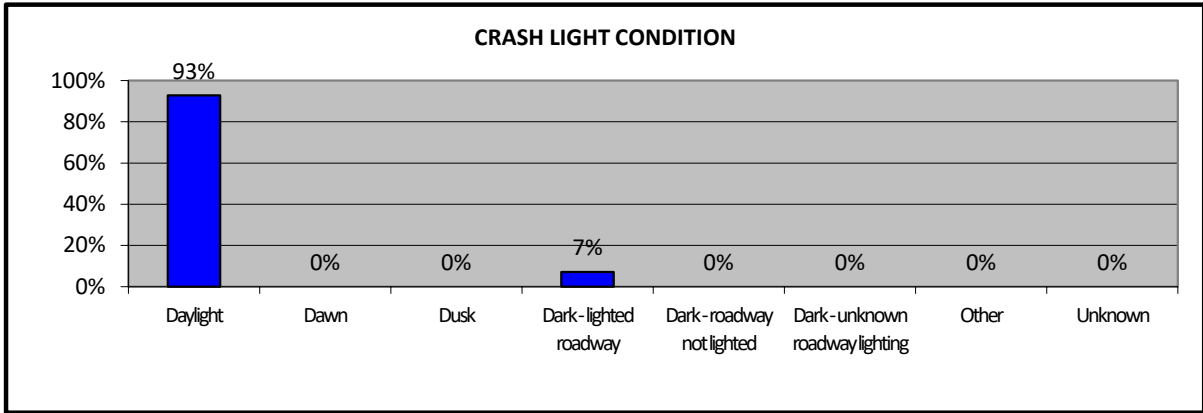
Crash Diagram Ref #	Crash Date	Crash Day	Time of Day	Manner of Collision	Light Condition	Weather Condition	Road Surface	Driver Contributing Code	Driver Distracted By	Injury Severity	D1 Age	D2 Age	D3 Age	D4 Age	Comments
#	mm/dd/yy	Day	hh:mm	Type	Type	Type	Type	Type	Type	Type	#	#	#	#	
1	07/27/18	Friday	5:09 PM	Sideswipe, same direction	Daylight	Cloudy	Dry	Inattention	Unknown	No Injury	73	60			MV2 was stopped in traffic proceeding southbound when MV1, also heading southbound, attempted to switch lanes and sideswiped MV2 in the left rear. No injuries reported.
2	08/20/18	Monday	8:43 AM	Rear-end	Daylight	Cloudy	Wet	Other improper action	Unknown	No Injury	50	20			MV1 and MV2 were traveling southbound on Station Ave, both were stopped at a red light at the intersection of White's Path. MV1 thought the light had changed and began to drive, striking the rear of MV2. No injuries reported.
3	10/01/18	Monday	1:59 PM	Angle	Daylight	Clear	Dry	Unknown	Not distracted	No Injury	26	31			MV2, a tractor trailer truck, was making a left onto White's Path. MV1 was proceeding to the intersection without caution after exiting the gas station, seeing the signal was green and then collided with MV2. No injuries reported.
4	11/15/18	Thursday	5:52 PM	Rear-end	Dark - lighted roadway	Cloudy	Dry	Inattention	External distraction (outside the vehicle)	No Injury	55	72			MV1 and MV2 were traveling southbound on Station Ave. Due to inattention MV1 drove into the rear of MV2. No injuries reported.
5	11/24/18	Saturday	2:29 PM	Rear-end	Daylight	Clear	Dry	Inattention	Not distracted	No Injury	54	18			MV1 was traveling southbound and stopped at the red light when MV2 was traveling southbound collided with MV1. MV2 operator was cited for failure to use care while braking. No injuries report.
6	12/05/18	Wednesday	8:49 AM	Rear-end	Daylight	Clear	Dry	Inattention	Unknown	Non-fatal injury	51	57	43		MV2 and MV3 were slowing or stopped in traffic heading south toward the intersection. MV1 did not stop in time and rear-ended MV2 which resulted in MV2 rear-ending MV3. MV1 stated that the glare from the sun made it hard to see the actions of the vehicles ahead. Resulted in a single injury.
7	03/20/19	Wednesday	5:35 PM	Rear-end	Daylight	Clear	Dry	Inattention	Not distracted	No Injury	39	52			MV2 was stopped on the right turn slipway waiting to turn onto Station Ave from White's Path. MV1 rear-ended MV2, causing minor damage to both vehicles. No injuries reported.
8	03/21/19	Thursday	3:07 PM	Rear-end	Daylight	Clear	Dry	Followed too closely	Unknown	No Injury	25	43			MV2 was stopped at the intersection with an uninvolved vehicle in front heading north on Station Ave. MV1 approached and rear-ended MV2. The unknown vehicle in front of MV2 started and stopped unexpectedly causing MV2 to also stop, leading to MV1 rear-ending MV2. No injuries reported.
9	09/16/19	Monday	1:04 PM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	No Injury	20	34			MV1 turned from the center through lane on Station Ave in front of MV2, with the operator wanting to turn left into the north driveway of the Alltown Gas station. MV2 was in the left turn lane approaching the intersection. Minor damage to the left side of MV1 and minor damage to the right front of MV2. No injuries reported.
10	09/18/19	Wednesday	8:55 AM	Angle	Daylight	Clear	Dry	Disregarded traffic signs, signals, road markings	Unknown	No Injury	19	58			MV2 had a green light and was taking a left from Workshop Rd. MV1 ran the red light going southbound on Station Ave and collided with MV2. Minor damage to both vehicles. No injuries reported.
11	09/22/19	Sunday	9:09 AM	Sideswipe, same direction	Daylight	Clear	Dry	Inattention	Unknown	No Injury	82	33			MV2 was in the left turn lane approaching the intersection to take a left onto Workshop Rd, MV1 was in the northbound lane on Station Ave and attempted to turn into the gas station, MV1 did not look and took an abrupt left hitting MV2. No injuries reported.
12	10/09/19	Wednesday	2:54 PM	Rear-end	Daylight	Rain	Wet	Followed too closely	Not distracted	Unknown	68	52			MV1 was stopped at a red light at the intersection. MV2 traveling southbound on Station Ave rear-ended MV1. The road was wet and MV1 distracted. No injuries reported.
13	10/21/19	Monday	4:12 PM	Sideswipe, same direction	Daylight	Clear	Dry	Failure to keep in proper lane or running off road	Unknown	No Injury	71	58			MV1 attempted to change lanes at the intersection from the left turn only lane to the through lane travelling southbound on Station Ave. When changing lanes, MV1 struck MV2 in the rear drivers side. No injuries reported
14	10/13/20	Tuesday	3:45 PM	Rear-end	Daylight	Rain	Wet	Inattention	Unknown	No Injury	36				MV1 failed to stop and collided into the rear of MV2 approaching the intersection. MV2 was slowing for a turning vehicle before MV1 rear ended MV2. MV2 was a school bus with nine students on board at the time of the crash.
15	12/03/20	Thursday	7:46 AM	Angle	Daylight	Clear	Dry	Failed to yield right of way	Unknown	No Injury	79	61			MV2 was travelling northbound on Station Ave while MV1 was travelling southbound and preparing to turn left onto White's Path. MV1 failed to yield the right-of-way and struck the left side of MV2.

## Crash Data Summary Charts

### Station Ave at Whites Path, Yarmouth, MA









## Appendix D. Road Safety Audit References

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<b>GEOMETRIC DESIGN</b>	
<b>Issue</b>	<b>Comment</b>
<b>A. Speed – (Design Speed; Speed Limit &amp; Zoning; Sight Distance; Overtaking)</b>	
<p>Are there speed-related issues along the corridor? Please consider the following elements:</p> <ul style="list-style-type: none"> <li>• Horizontal and vertical alignment</li> <li>• Posted and advisory speeds</li> <li>• Driver compliance with speed limits</li> <li>• Approximate sight distance</li> <li>• Safe passing opportunities</li> </ul>	
<b>B. Road alignment and cross section</b>	
<p>With respect to the roadway alignment and cross-section please consider the appropriateness of the following elements:</p> <ul style="list-style-type: none"> <li>• Functional class (Urban Principal Arterial)</li> <li>• Delineation of alignment;</li> <li>• Widths (lanes, shoulders, medians);</li> <li>• Sight distance for access points;</li> <li>• Cross-slopes</li> <li>• Curbs and gutters</li> <li>• Drainage features</li> </ul>	
<b>C. Intersections</b>	
<p>For intersections along the corridor please consider all potential safety issues. Some specific considerations should include the following:</p> <ul style="list-style-type: none"> <li>• Intersections fit alignment (i.e. curvature)</li> <li>• Traffic control devices alert motorists as necessary</li> <li>• Sight distance and sight lines seem appropriate</li> <li>• Vehicles can safely slow/stop for turns</li> <li>• Conflict point management</li> <li>• Adequate spacing for various vehicle types</li> <li>• Capacity problems that result in safety problems</li> </ul>	
<b>D. Auxiliary lanes</b>	
<ul style="list-style-type: none"> <li>• Do auxiliary lanes appear to be adequate?</li> <li>• Could the taper locations and alignments be causing safety deficiencies?</li> <li>• Are shoulder widths at merges causing safety deficiencies?</li> </ul>	

<b>E. Clear zones and crash barriers</b>	
<p>For the roadside the major considerations are clear zone issues and crash barriers. Consider the following:</p> <ul style="list-style-type: none"> <li>• Do there appear to be clear zones issues? <ul style="list-style-type: none"> <li>— Are hazards located too close the road?</li> <li>— Are side slopes acceptable?</li> </ul> </li> <li>• Are suitable crash barriers (i.e, guard rails, curbs, etc.) appropriate for minimizing crash severity?</li> <li>• Barrier features: end treatments, visibility, etc.</li> </ul>	
<b>F. Bridges and culverts – (if necessary)</b>	
Are there specific issues related to bridges and culverts that may result in safety concerns?	
<b>G. Pavement – (Defects, Skid Resistance, and Flooding)</b>	
<ul style="list-style-type: none"> <li>• Is the pavement free of defects including excessive roughness or rutting, potholes, loose material, edge drop-offs, etc. that could result in safety problems (for example, loss of steering control)?</li> <li>• Does the pavement appear to have adequate skid resistance, particularly on curves, steep grades and approaches to intersections?</li> <li>• Is the pavement free of areas where flooding or sheet flow of water could contribute to safety problems?</li> <li>• In general, is the pavement quality sufficient for safe travel of heavy and oversized vehicles?</li> </ul>	
<b>H. Lighting (Lighting and Glare)</b>	
<p>It is important to consider to the impacts of lighting. Some specifics include the following:</p> <ul style="list-style-type: none"> <li>• Is lighting required and, if so, has it been adequately provided?</li> <li>• Are there glare issues resulting from headlights during night time operations or from sunlight?</li> </ul>	

**TRAFFIC CONTROL DEVICES**

**Issue**

**Comment**

**I. Signs**

Signage is a critical element in providing a safe roadway environment. Please consider the following:

- Are all current signs visible (consider both night and day)? Are they conspicuous and clear? Are the correct signs used for each situation?
- Does the retroreflectivity or illumination appear satisfactory?
- Are there any concerns regarding sign supports?

**J. Traffic signals**

- If present, do the traffic signals appear to be designed, installed, and operating correctly?
- Is the signal processing the traffic efficiently?
- Is the controller located in a safe position? (where it is unlikely to be hit, but maintenance access is safe)
- Is there adequate sight distance to the ends of possible vehicle queues?

**K. Marking and delineation**

- Is the line marking and delineation:
  - appropriate for the function of the road?
  - consistent along the route?
  - likely to be effective under all expected conditions? (day, night, wet, dry, fog, rising and setting sun, oncoming headlights, etc.)
- Are centerlines, edgelines, and lane lines provided? If not, do drivers have adequate guidance?

<b>ROADWAY ACTIVITY</b>	
<b>Issue</b>	<b>Comment</b>
<p>With respect to roadway activity please consider safety elements related to the following:</p> <ul style="list-style-type: none"> <li>• Pedestrians</li> <li>• Bicycles</li> <li>• Public transportation vehicles and riders</li> <li>• Emergency vehicles</li> <li>• Commercial vehicles</li> <li>• Slow moving vehicles</li> </ul>	

<b>ENVIRONMENTAL CONSIDERATIONS</b>	
<b>Issue</b>	<b>Comment</b>
<b>Weather &amp; Animals</b>	
<p>From an environmental perspective it is important to consider any potential impacts. Most notably is likely to be the impacts of weather or animals, including:</p> <ul style="list-style-type: none"> <li>• Possible effects of rain, fog, snow, ice, wind on design features.</li> <li>• Has snow fall accumulation been considered in the design (storage, sight distance around snowbanks, etc.)?</li> <li>• Are there any known animal travel/migration routes in surrounding areas which could affect design?</li> </ul>	

# MAKING OUR ROADS SAFER

One  
Countermeasure  
at a Time



The FHWA has identified and is promoting widespread use of a set of 28 Proven Safety Countermeasures that can offer significant, measurable impacts as part of any agency's data-driven, systemic approach to improving safety. These strategies are designed to enhance safety on all kinds of roads—from rural to urban, from high-volume freeways to less traveled two-lane State and county roads, from signalized crossings to horizontal curves, and everything in between. Each countermeasure addresses **speed management, intersections, roadway departures, or pedestrians/ bicyclists**—along with crosscutting strategies that address all four safety focus areas.

***Which Proven Safety  
Countermeasures  
Will You Use?***

For more information on this and other FHWA Proven Safety Countermeasures, please visit <https://safety.fhwa.dot.gov/provencountermeasures>.



U.S. Department of Transportation  
**Federal Highway Administration**

**ZERO IS OUR GOAL**  
A SAFE SYSTEM IS HOW WE GET THERE

<https://safety.fhwa.dot.gov/>

# Proven Safety Countermeasures

## SPEED MANAGEMENT



**Speed Safety Cameras**



**Variable Speed Limits**



**Appropriate Speed Limits for All Road Users**

## ROADWAY DEPARTURE



**Wider Edge Lines**



**Enhanced Delineation for Horizontal Curves**



**Longitudinal Rumble Strips and Stripes on Two-Lane Roads**



**SafetyEdge<sup>SM</sup>**



**Roadside Design Improvements at Curves**



**Median Barriers**

## INTERSECTIONS



**Backplates with Retroreflective Borders**



**Corridor Access Management**



**Dedicated Left- and Right-Turn Lanes at Intersections**



**Reduced Left-Turn Conflict Intersections**



**Roundabouts**



**Systemic Application of Multiple Low-Cost Countermeasures at Stop-Controlled Intersections**



**Yellow Change Intervals**

## PEDESTRIANS/BICYCLES



**Crosswalk Visibility Enhancements**



**Bicycle Lanes**



**Rectangular Rapid Flashing Beacons (RRFB)**



**Leading Pedestrian Interval**



**Medians and Pedestrian Refuge Islands in Urban and Suburban Areas**



**Pedestrian Hybrid Beacons**



**Road Diets (Roadway Reconfiguration)**



**Walkways**

## CROSSCUTTING



**Pavement Friction Management**



**Lighting**



**Local Road Safety Plans**



**Road Safety Audit**

## Road Safety Audit References

*FHWA Office of Safety - Proven Safety Countermeasures*, U.S. Department of Transportation, Federal Highway Administration <https://safety.fhwa.dot.gov/provencountermeasures/>.

*Road Safety Audits, A Synthesis of Highway Practice*. NCHRP Synthesis 336. Transportation Research Board, National Cooperative Highway Research Program, 2004.

*Road Safety Audits*. U.S. Department of Transportation, Federal Highway Administration, <https://safety.fhwa.dot.gov/rsa/>

*FHWA Road Safety Audit Guidelines*. U.S. Department of Transportation, Federal Highway Administration, 2006.

*Road Safety Audit*, 2<sup>nd</sup> edition. Austroads, 2000.

*Road Safety Audits*. ITE Technical Council Committee 4S-7. Institute of Transportation Engineers, February 1995.