Transition Zone Design Final Report

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Transition Zone Design

FINAL REPORT
Our Mission

We provide services to the transportation community through research, technology transfer and education. We create and participate in partnerships to promote safe and effective transportation systems.
Research Report
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TRANSITION ZONE DESIGN

Final Report

by

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16. **Abstract**
   The purpose of this report is to document the activities of the research effort and present the findings of the work accomplished. Transition zone is the area in which it is communicated to drivers that the roadway environment is changing (i.e., from rural to built-up) and that their speed should change as well. This study evaluated treatments that could advise drivers to this. Based on the study findings, it is recommended to add additional speed warning sites to such transition zones.

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EXECUTIVE SUMMARY

Rural roadways are designed to move traffic efficiently between towns. An issue that has not been given adequate attention is the manner with which transitions occur when a rural roadway enters a built-up area and speeds along the roadway are reduced. Motorists on these rural roadways have expectations of high speeds and continued flow, while motorists and pedestrians in the built-up areas often anticipate slower moving traffic. A transition zone on the roadway can be used to make motorists aware of the need for reduced speeds in order to accommodate these different needs and expectations.

The concept of transition zones has been addressed in recent research but there is still a lot to be done. A transition zone is the area in which it is communicated to drivers that the roadway environment is changing (i.e., from rural to built-up) and that their speed should change as well. It is not only important that speeds are reduced in this zone but that the reduction is maintained. Some guidelines and treatments exist, but a better understanding of the issues and application for transition zones is desired. The objective of this project is to identify and evaluate possible treatments for such zones and determine their effectiveness. The results of this study provide the first step in developing a basic guidance for designing high-to-low speed transition zones.

The literature review undertaken showed that even though quite a few studies have been recently published on transition zones there is still a lot to be done in the area. Existing studies review current knowledge on the subject, considering that many aspects of transition zones have yet to be defined or studied. Each location is unique and needs its own unique solution. Similarly, treatments are unique and are more suited for some areas over others. An issue of importance is the creation of clearly defined rural and built-up zones so the driver can recognize the point at which they are no longer on the rural segment and when they have entered the built-up area.

The Study Advisory Committee (SAC) was utilized to evaluate available treatments identified through the literature and rank them based on their potential effectiveness in reducing speeds. The use of a series of warning signs and pavement markings were considered as the most appropriate and easiest to implement and evaluate, since several of the other treatments were expensive to install or difficult to implement.

Four locations were identified for implementation and evaluation of the selected treatments. Before and after speed data was collected at various points throughout the
transition zone. The data was reduced to use only free flowing vehicles and various speed metrics were utilized to determine the effectiveness of each treatment implemented.

The results from the evaluations of the warning signs at two locations indicate the positive effects of the transitional speed limit warning signs. For the most part, speeds have been reduced around 2 mph at each location and the percent of vehicles traveling over the speed limit has been reduced as well. The data indicate that this treatment has decreased speeds and improved safety, as desired. The treatment did not cause drastic changes in speed, but for such small cost and little to no maintenance, it was deemed effective. Similar conclusions were also reached from evaluations of pavement markings with all speeds reduced around 4 mph with decreases in variation. Spin Alert signs were also evaluated at one location and did not show any additional gains when placed with the warning signs, and thus their effectiveness could be limited.

It is recommended that the additional speed warning signs be implemented in all transition zones. This could be considered as the low-cost standard treatment of transition zones. There are some indications that the pavement markings could have an additional benefit in reducing speeds. It is therefore possible to augment the warning signs with this treatment in cases where additional emphasis in the transition zone is required.
INTRODUCTION

Rural roadways are designed to move traffic efficiently between towns. An issue that has not been given adequate attention is the manner with which transitions occur when a rural roadway enters a built-up area and speeds along the roadway are reduced. Motorists on these rural roadways have expectations of high speeds and continued flow, while motorists and pedestrians in the built-up areas often anticipate slower moving traffic. To accommodate these different needs and expectations, motorists in the rural areas need to become aware of the upcoming areas and need for reduced speeds, and hence there is a need for a transition zone before entering the built-up area.

Speed differences are not the only issues designers face in connecting these two areas. There are also contextual, geometric, and safety issues that must be solved. Contextually, the areas should blend together, but not so much that the driver does not comprehend the change. Changes in geometric elements require a gradual transition and they should be communicated to the driver through changes in the surroundings. For example, changes in the cross section elements along a roadway should be developed gradually and communicated accordingly to the driver with noticeable elements. These challenges and differences are often not addressed, leaving a single point at which everything suddenly changes. It is believed that a transition zone between these two environments could help drivers adjust their speed accordingly and communicate to them the roadway changes. With this accomplished, it would be possible to eliminate safety hazards due to excessive speeding through built-up areas.

The concept of transition zones has been addressed in recent research but there is still a lot to be done. There are suggestions in the guidelines by the American Association of State Highway Transportation Officials (AASHTO) with respect to transition zones but these are limited only to the placement of curb and gutter and speed limit signs (AASHTO, 2004). However, a study by Stamatiadis et al. has proven these inadequate (2004). The study documented a need for design guidelines and practices to be used in reducing speeds along rural roadways as vehicles enter built-up areas.

A transition zone is the area in which it is communicated to drivers that the roadway environment is changing (i.e., from rural to built-up) and that their speed should change as well. It is not only important that speeds are reduced in this zone but that the reduction is maintained. As indicated, some guidelines and treatments have been examined, but a better understanding of the existing issues and application for transition zones is desired. The objective of this project is to identify and evaluate possible
treatments for such zones and determine their effectiveness. The results of this study provide the first step in developing a basic guidance for designing high-to-low speed transition zones. This final report summarizes the evaluations conducted and provides guidance for establishing transition zone designs.
LITERATURE REVIEW

Background

Past research has identified several Speed Reduction Techniques (SRTs) for transition zones and it is anticipated that a better reference guide can be established through an examination of these treatments. To achieve this, the fundamentals of transition zones must be identified.

Transition zones have two objectives: communicate to drivers the need for speed reductions and achieve and maintain the needed speed reduction. The National Highway Traffic Safety Administration (NHTSA) found that speeding has been attributed to 31 percent of all fatal crashes (NHTSA, 2009). In order to increase safety through built-up areas, it is crucial to reduce speeding not only within the town itself but on the roadways leading into the built-up area. This is the goal of the transition zone. Currently these transitions are only identified by “reduced speed ahead” signs and the lower speed limit regulatory signs.

Both the Pennsylvania and New Jersey Departments of Transportation (2008) have created transition zone design guides in their Smart Transportation Guidebook. The guidebook recognizes that speed reduction is a primary purpose of the zones and emphasizes the need for proper design. Designs such as lane narrowing, gateways, and roundabouts are mentioned to achieve speed reductions but it is not known to what degree they could be effective. There is also a lack of information on design considerations for each or guidance on the applicability of each treatment for transition zones. There is still much to be developed and evaluated for developing a complete manual or guidance on transition zone design.

Transition zones must accomplish several goals in addition to their main objective of reducing speeding traffic as rural roadways enter built-up areas. The transition zones should consider the roadway geometry, context of the community, and the two environments (i.e. rural and built-up) that the transition will be joining. Each transition zone could be unique to the built-up area and should be designed in such a way that considers the culture and elements already included in the environment of the area. Like any other aspect of the roadways system, each location must be designed within the context of its community (Stamatiadis et al., 2000).

It is also important to identify the most appropriate elements for a transition zone. Such elements can be used individually or combined to achieve the desired speed
reduction. Elements include, but are not limited to, design, geometry, environment, and treatments. Transition zone treatments must address the issues discussed above and do so in the appropriate area. The treatment must cause the speed reduction to take place before the built-up area is reached; otherwise it has failed at its purpose. It is desired that the speed reduction be fully reached in the transition zone, before entering the town or city. This creates two other zones with purposes relating to speed reduction. The rural area directly before the transition zone should bring awareness to the driver of the speed reduction about to take place and the built-up area after the transition zone requires the maintenance of that speed. Thus, there are three physical zones in which the driver should be affected and where treatments can be applied. These zones are shown in Figure 1.

The physical definition of a transition zone can be rather difficult and depends on many elements of a specific area. First, there is the desired speed reduction. A larger reduction in speed will take more time thus requiring a longer transition zone. Also, the type of treatment will have an effect on the transition zone length. Some treatments such as the placement of signs may require minimum space while a roundabout or central island would take up a larger area. The transition zone definition is also unique to each specific location. Access points, pavement transitions, and other contextual factors should be taken into account when defining a transition zone.
Transition Zone Issues

The purpose of transition zones is to increase safety in built-up areas by reducing speeding along the rural roadways traversing them. In order to reduce speeding, motorists’ speeds must be reduced in accordance to the reductions in the speed limits. It is therefore essential to better understand the various speed issues prior to defining transition zones.

Often speed is referred to as a general term without identifying the type of speed utilized. There are three definitions for speed: posted speed (or speed limit), design speed, and operating speed. Posted speed is the most frequently used type for speed-related research. These studies tend to focus more on how the speed limit affects drivers than other issues that could be related to the effects of design speed. Operating speed, the speed at which or below 85 percent of motorists drive on a given corridor, is most commonly measured as a result of a study. Finally, design speed is the speed at which geometric elements of the roadway are designed for safe operation. The relationship between these three speed metrics is not well documented but it is desired that they will not be drastically different. It has become questionable as to whether design speed is of much use as it is used today. Replacing design speed with operating speed has recently been recommended (Hauer, 2000). Additionally, TRB Special Report 214 discusses the differences between design and operating speed (Mason and Mahoney, 2003). It was found that when these two are drastically different, problems with design consistency may arise. For this reason, the use of operating speed to control design elements has been suggested for urban areas (Poe et al., 1996). Thus, the decision to use design speed in the future, concerning the manner with which has been used in A Policy in Geometric Design of Highways and Streets, or the Green Book, should be reevaluated (Krammes, 2000). The definitions and types of speeds are an important consideration when dealing with transition zones, where speed is the basis of the study.

In rural areas, operating speed is even more of a concern. It has been found that drivers will more often disregard the speed limit on roads with high design speeds (Stamatiadis et al., 2004). Drivers are more likely to speed when the roadways allow them to drive faster while still feeling comfortable and in control. Therefore, it is best to choose a design speed that is desired to match the operating speed and posted speed as well. The design speed and roadway geometry control driver expectations and comfort. If the design speed encourages speeding, it will be much more difficult to
reduce the operating speed of motorists. This almost certainly will reduce the effectiveness of transition zones at reducing speeds as drivers enter built-up areas. Stamatiadis et al. found that roads transitioning from rural to built-up area lack design guidance. There is a need for increased visual and physical elements that cause the driver to understand the need for a change. Also, little is done for the transition area, since most of the design of these roadways focus on either the built-up area or the rural area. In the end, there is a need for direction in terms of the design and design speed of such transition zones.

As mentioned earlier, the transition zone design can be broken into three areas, speed reduction awareness, active speed reduction, and speed maintenance area. However, communication with drivers must take place throughout the entire corridor. Drivers not only must perceive the upcoming speed reduction, but the required reduction must be communicated as well. Often the speed limit is simply lowered and unaccompanied by other changes so drivers are unaware of the severity of the impending speed reduction. The driving environment and elements must communicate to drivers how the roadway is to be driven, and that includes speed.

More recently, roadways are being designed so that drivers can understand the requirements and expectations for their operation. “Reading” the road, if it is designed correctly, can communicate expectation such as speed with drivers often better than signs or markings. Many of the roadways elements used to achieve this feeling are often geometric designs, such as horizontal or vertical shifts or curves, cross section widths, and traffic calming measures. This concept of a “self-explaining” or “self-enforcing” road is achieved through the implementation of a visual design approach to explain the roadway function and speed to users (Lamm et al., 2005). For example, wide, flat, and open roadways communicate high speed to a driver while windy, hilly roadways communicate lower speeds and caution. With such elements, safety and mobility can be addressed while communicating desired operational speeds. The selected design speed, as recommended through the Green Book, will not correspond to the desired operational speeds, regardless of the posted speed limits when such aspects of roadway design are not considered. (Misaghi and Hassan, 2005).

**Speed Reduction and Communication Techniques and Considerations**

The selection of SRTs for a given transition zone is critical, since they influence and control speeds. Several of the treatments have been tested in the past and the
findings from past research are discussed in the following. There are a number of studies that have tested most of these treatments and added to the common understanding of their use.

**Traffic-Calming Techniques**

There has been much focus on speed control and traffic-calming measures. This is especially true in urban and built-up areas. Past research has shown that speed reductions could be associated with crash reductions (Poe et al., 1996). Many of the SRT’s that are considered to be traffic-calming techniques could also be considered for use in transition zones. Traffic calming has been a main point of interest for the Institute of Transportation Engineers (ITE), and numerous manuals for guidance concerning means of traffic calming have been published. One such ITE publication discusses traffic-calming techniques and their effectiveness at reducing speeds and increasing communication with the driver (Ewing, 1999). The publication emphasizes that each site should be considered alone and that for a specific location many considerations are evaluated when selecting a treatment. Even once a treatment is chosen, its geometrics and spacing are crucial for the treatment effectiveness.

Though traffic-calming measures contribute to the basis for SRT’s, not all are necessarily the best alternatives for transition zones. Traffic calming techniques have two objectives: reduce speed and decrease traffic volumes. This often applies to residential areas, in terms of reducing volumes or improving transit or pedestrian capabilities, and such treatments may not be as beneficial in transition zones (Kamyab, Andrle and Kroeger, 2002). Rural roadways require a different approach than urban roadways and therefore all traffic calming devices may not be appropriate. However, there are still many that are most beneficial in achieving speed reductions as vehicles transition from rural to built-up areas.

A study by Dixon et al. (2008) looked at the traffic calming measures put forth by ITE that would be most beneficial in the use of reducing speeds of vehicles transitioning between rural and built-up areas. An initial review identified the following treatments as appropriate for transition zones:

- curb extensions
- gateways
- center islands
- medians
- roadway narrowing
- roundabouts
- raised intersections
- banners
- street furniture
- reduced number of lanes
- enhanced speed limit signs
- colored pavement
- transverse road markings
- photo-radar speed enforcement.

A few of the treatments were tested through driver simulation and evaluated in transition zone settings. The treatments that were fully simulated include layered landscape, gateway with lane narrowing, median treatment only, median with gateway treatment, and median in series with and without pedestrian crosswalk. It was concluded that the treatments that narrowed the roadway, physically or visually, had the largest impact on the driver and were the most effective at speed reduction.

A similar study focused on low-cost traffic calming devices and gateways (Hallmark et al., 2007). Seven measures were selected and implemented in Iowa including gateways, such as the one seen in Figure 2, speed table, “SLOW” markings, driver feedback sign, tubular markings, and on pavement entrance markings. The treatments had varied effects on speed reduction. Most did not have statistically significant reductions on average speed, and few had a moderate effect. However, it was observed that the percent of drivers operating over the speed limit was reduced, proving the effectiveness of the transition zone.

Figure 2. Gateway example
Optical Techniques

One treatment that has been found to reduce operating speeds without decreasing safety is the optical lane narrowing, which is used often in Europe (Stamatiadis et al., 2000). There are many alternative designs for this technique but the end result is that the lane feels and looks narrower to the driver than it actually is, thus causing them to slow down. Techniques that cause this effect include the removal of centerline striping, planting shrubs and trees by the side of the roadway, reducing lane width while keeping the total width of the lane and shoulder unchanged, painting dragon’s teeth, and painting wider edge lines. The optical narrowing treatments still provide the whole roadway width, thus safety is not compromised while drivers feel the lane is smaller and behave accordingly. Another study reported a 10 percent decrease in 85th percentile speeds at the end of the transition zone as a result of dragon’s teeth and roadside trees (Cartier 2009). The treatment paints notches into the lane giving the feeling of a narrower lane, as seen in Figure 3.

Figure 3. Dragon's teeth

A similar optical treatment is speed bars which can be seen in Error! Reference source not found. White bars are placed perpendicular to the lane and distance between them is reduced approaching the built-up area. This gives the driver the
impression that they are speeding up so they will slow down to feel more comfortable. Optical speed bars are relatively cheap to implement but may require regular maintenance and repainting. Previous research and evaluation of site using this element have shown mixed results regarding effectiveness. Arnold and Lantz (2008) tested these bars in rural villages and found a 3 mph to 9.5 mph reduction in operating speed over a 90-day period. In their study 31 bars were placed over 530 feet with spacing varying between 24 and 12 feet. Another test used the optical speed bars at five locations, of which only two had statistically significant reductions in speed, which were very small (Russel et al., 2010). These bars may not be the most effective treatment but could be worth the small cost.

Figure 4. Speed bars

Roadside features are mentioned as a possible technique in accomplishing lane narrowing but are studied individually as well. The visual complexity of the roadway environment has been found to have an effect on drivers’ attention (Naderi et al., 2006). It was assumed that planting trees along the roadside affects the visual complexity and thus the drivers’ attention. In the past, such practices have been believed to be unsafe in case a vehicle would run off the road. However, recent studies question that assumption. One study found a 46 percent reduction in crash rates once “landscape improvements” were implemented (Mok et al., 2006). A similar study found the
installation of trees and landscaping decreased mid-block crashes between 5 percent and 20 percent (Naderi 2003). It seems the trees make drivers more aware of the environment and could positively impact safety.

Finally, the removal of pavement markings can be another optical treatment. The removal of pavement markings has mainly been implemented in the UK to cause motorists discomfort so they must slow down to navigate the area. This can also be unsafe for motorists who do not slow down. Quimby and Castle (2006) found that in two towns this treatment reduced speeds by 5 mph and 7 mph each. They also discovered that the removal of pavement markings decreased crashes in one town by 35 percent. In the correct circumstances, this treatment could not only reduce speeds but increase safety.

**Horizontal and Vertical Displacement Techniques**

Median islands have also been found to reduce speeds (Figure 5). Shifting the lanes around the island creates horizontal displacements so that the driver must first pay attention to this maneuver and then negotiate the curve. The islands are best designed specifically for a given zone and can vary in shape and size. However, as with any horizontal deflection, the degree of deflection is related to the speed reduction’s magnitude.
Although such a treatment may require future maintenance, it also improves safety by physically separating the two directions of travel. Previous research has found the sharp deflections can reduce operating speed by over 40 percent (Crowley and MacDermott, 2001). Other studies have also found this treatment particularly effective. When using the median island to introduce a two-way-left-turn-lane Stamatiadis et al. (2004) found that operating speeds were reduced 12 percent at the island. Another study also recently determined a 20 percent reduction in crashes at the entrance to towns where median islands have been constructed (Curtis, 2008). These studies seem to conclude that this treatment not only helps reduce speeds but can increase safety as well.

Similar to median islands are horizontal deflections or chicanes, as seen in Figure 6. In the same way that a median island causes a horizontal shift, these treatments cause drivers to slow down in order to navigate the change in alignment. In past experiences, this treatment is best used in combination with at least one other treatment. There are no studies currently that have examined chicanes alone. However, the combination of chicanes and gateways has been found to result in a 7mph and 10 mph speed reduction (Lamberti et al., 2009). A similar study found reductions between 5mph and 13mph where chicanes were combined with another treatment such as traffic islands, gateways, and textured surfaces (Country Surveyor’s Society, 1994). Overall, this seems to be a good treatment to combine with other such treatments to not only reduce speeds but also attract drivers’ attention to the changing environment.
Another geometric design that has been considered for transition zones is the roundabout. Such structures slow vehicles down, without making them stop, and safety and mobility are both increased. Studies have found that roundabouts decrease all crash types by 38 percent and injury crashes by 76 percent on average (Retting et al., 2001). The same study found that this design also has the ability to reduce fatal and incapacitating injury crashes by 90 percent. Though they may present difficulties in navigation at first, the roundabout is a solid treatment that can reduce crashes and speeds at the same time.

Optical lane narrowing has been mentioned above but there is also physical lane (and road) narrowing that has been studied as a traffic-calming device. Similar to optical lane narrowing, lane and road narrowing also make drivers more aware and raise their caution so they reduce speed and pay more attention to their driving. The Country Surveyor’s Society (1994) found that with lane narrowing, speeds were reduced by 12 mph on average. However, other than this, no additional research has been completed on this treatment. In a community with heavy truck traffic this treatment could also present a safety problem due to the large vehicles having to navigate the narrower lane widths.

The road diet is another speed reduction treatment that could be applied in transition zones. A road diet is the reallocation of roadway width to reduce the number of travel lanes and possibly result in reductions of excessive speeding. The only
requirement to complete this treatment is removal of old and installation of new pavement markings. This concept is relatively new and a small body of research findings is available. However, the findings indicate that this treatment is beneficial. One such study found that the average speed reduction was less than 5 mph but the average reduction in excessive speeding was 70 percent (Knapp and Rosales, 2007).

Concerning safety, Huang et al (2005) found that road diets reduced crash risk by 20 percent to 40 percent. Road diets seem to be beneficial for reducing speeds but more research would need to be done to determine their benefits in transition zones.

Raised humps or raised crosswalks can also be used for speed reduction. The idea is pretty simple; the vertical deflection causes the driver to slow down or otherwise be made very uncomfortable. Even though this is a popular traffic calming technique, it would be better intended for corridors with slower speeds such as neighborhoods. However, Charlton and Baas (2006) found that such humps could reduce operating speeds by 21 percent in transition zones so the treatment could still be considered.

Rumblewave surface is a treatment that uses vertical displacement to cause discomfort if driven over too quickly, similar to raised humps or crosswalks. The surface is a wave with crest to sag difference of about 3 inches (7mm) and distance between crests of about 1 foot (0.35 meters). Waves are placed for lengths of up to 65 feet (20 m) and they are placed on both directions of travel. An issue with this treatment is the ability to plow them, meaning they may not be the best option for colder climate regions. In the UK, the Department for Transport (2006) found speed reductions between one percent and five percent with this treatment, one of which was in a transition zone. More research and a better understanding of this treatment would be desired if implemented.

**Signage**

Speed feedback signs are electronic signs measuring speed and displaying it for the driver that could be used in transition zones. Hallmark (2007) evaluated such speed feedback signs and found that when paired with a temporary median they significantly reduced speeds. Though drivers may get used to the sign, they will always be reminded of the speed limit, as well as their own speed, making this treatment great for long-term effectiveness. A study by Farmer et al. (1998) found that such signs reduced speeds on average by 4.3 mph even 12 months after installation. Another study found a speed reduction of 6 mph at both the sign and downstream (Donnel and Cruzado, 2008).
Speed activated speed limit signs are similar to the speed feedback signs. Though they sound similar, speed activated speed limit signs display “slow down” along with the speed limit when activated by speeding motorists, instead of simply the driver’s speed. These treatments have been mostly implemented in Europe and Canada with an up to 80 percent change in percent of drivers speeding (Winnett et al., 2002). The study also found causality crash reductions of 34 percent (± 8 percent) where speed activated speed limit signs were installed.

Transitional speed limits are often used in transitional types of zones and must be considered here as well. These are often known as step down speed limits. A middle speed (ex. 40 mph) is inserted between large transition areas of speed limits (ex. 50 mph to 30 mph). They have not been shown to be very effective but should still be considered due to their low cost. Previous research found that transition speed limit signs have little to no effect on reducing mean speed, speed dispersion, or the percent of motorists speeding (Hildebrand et al., 2004). Such signs are generally used if the decrease is over 25mph so that the change is gradual, less abrupt. This treatment may also be better suited if implemented with other treatments.

Finally, gateways are often placed at the side of the road to indicate the change or transition. Any element that introduces a built-up area can be referred to as a gateway. The gateway treatment refers to signage that visually cues the driver to the approaching built-up area. Herrstedt et al. (1993) found an 11 percent reduction in mean speed and a 15 percent reduction in percent of drivers operating over 5 mph over the speed limit with the gateway treatment. Other studies have found that while the gateway is an effective treatment, they are often more effective when coupled with other treatments (Charlton and Baas, 2006).

**Treatment Comparisons**

One of the most beneficial publications on transition zones can be found in NCHRP Synthesis 412 (Forbes et al. 2011). This publication reviews most of the treatments discussed above. The report includes a survey, which was used to determine the most accepted and effective treatments for transition zones. The extensive survey was issued to members of the AASHTO Standing Committee of Traffic Engineering from all DOT’s. Based on the results of the surveys, 14 primary transition zone treatments were chosen and recommended. The treatments are divided into four categories: geometric design, traffic control devices, and road surface treatments. These treatments are shown and described in
Table 1. Each treatment is also discussed more fully, including speed reduction statistics, and with other studies in Appendix A. Treatments that were excluded from the NCHRP Synthesis 412 include converging chevrons, speed tables, pavement legends, rumble strips with raised profile, dragon’s teeth, combs, overhead information signs, and colored pavements. Though some of these other treatments could be helpful, the ones presented above were decided to be the most reasonable and effective.
<table>
<thead>
<tr>
<th>Picture</th>
<th>Treatment</th>
<th>Description</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Central Island/ Raised Median" /></td>
<td>Central Island/ Raised Median (type of geometric design)</td>
<td>Raised narrow islands are placed between the two directions of travel. The raised island is implemented to create a horizontal deflection that causes drivers to slow as they navigate the road.</td>
<td>Study found that this design reduced speeds about nine percent. Effective in lowering both operating and 85th percentile speeds.</td>
<td>Cost can be medium to high to build physical median. Presents potential hazards for single motor vehicle crashes.</td>
</tr>
<tr>
<td><img src="image2" alt="Roundabout" /></td>
<td>Roundabout (type of geometric design)</td>
<td>Roundabouts are one-way circular intersections with islands in the center. Approaching roads splinter off on each side and must yield upon entering.</td>
<td>Roundabouts slow vehicles down without the need for stop lights or stop signs and efficiently moves vehicles through the intersection.</td>
<td>Cost for this design is pretty high, as is the property necessary. Could be difficult for drivers to navigate at first.</td>
</tr>
<tr>
<td><img src="image3" alt="Road /Lane Narrowing" /></td>
<td>Road /Lane Narrowing (type of geometric design)</td>
<td>Roads or lanes are narrowed causing the driver to have to slow down and pay more attention at this feature.</td>
<td>Traffic is forced to slow in order to navigate the narrowing of the road.</td>
<td>There is a medium to high cost and present crash potential for large vehicles.</td>
</tr>
<tr>
<td><img src="image4" alt="Road Diets" /></td>
<td>Road Diets (Type of geometric design and traffic control)</td>
<td>A road diet is the redistribution of pavement in order to allocate more space for pedestrians and vehicles turning left.</td>
<td>Road diets decrease speeds by 5mph on average and reduce accidents. This feature improves bicycle safety as well.</td>
<td>The number of travel lanes is reduced for through traffic.</td>
</tr>
<tr>
<td>Chicanes or Horizontal Deflections (type of geometric design)</td>
<td>Chicanes cause the driver to navigate a shift in horizontal alignment.</td>
<td>Deflections cause motorists to slow down to navigate. Speed reduction is proportional to severity of deflection.</td>
<td>Medium to high cost to build. They could increase single vehicle crashes.</td>
<td></td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td></td>
</tr>
<tr>
<td>Countdown Speed Signs and Markers (Traffic Control Device)</td>
<td>Speed signs begin with three stripes then have two, then one as the driver approaches the built-up area to indicate that the speed is changing.</td>
<td>The signs countdown to bring more attention to the speed reduction. They don’t cost much.</td>
<td>Public exposure and repeated exposure is needed for any significant result.</td>
<td></td>
</tr>
<tr>
<td>Speed Feedback Sign (Traffic Control Device)</td>
<td>This is an electronic sign placed beside the road to make drivers aware of the speed limit and their current speed.</td>
<td>The sign show drivers not only the speed but also their speed for comparison. Drivers often slow for a time.</td>
<td>The cost of signs can be medium and are only effective when in place.</td>
<td></td>
</tr>
<tr>
<td>Speed Activated Speed Limit Sign (Traffic Control Device)</td>
<td>Speed activated signs light up when a car approaches that is going over the speed limit telling the driver the speed limit and to slow down.</td>
<td>It was found that significant reductions in speeding vehicles are the result of these signs.</td>
<td>The signs can be costly especially if the place they are needed has no current power supply.</td>
<td></td>
</tr>
<tr>
<td>Transitional Speed Limits (Traffic Control Device)</td>
<td>To change to a slower speed, multiple speed signs between the two speeds step down so the change is less extreme.</td>
<td>The cost of this measure is low and helps slow cars over a longer stretch of road.</td>
<td>This measure has little effect on reducing speeds in transition zones.</td>
<td></td>
</tr>
<tr>
<td><strong>Removal of Pavement Markings (Travel Control Device)</strong></td>
<td><strong>Optical Speed Bars (Traffic Control Device)</strong></td>
<td><strong>Speed Humps/ Raised Crosswalks (Surface Treatment)</strong></td>
<td><strong>Rumblewave Surface (Surface Treatment)</strong></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>-----------------------------------------------------</td>
<td>--------------------------------------</td>
<td></td>
</tr>
<tr>
<td>A European practice is to remove pavement markings to cause discomfort for motorists.</td>
<td>Bars are placed perpendicular to the roadway and exponentially decrease in space to make the driver feel as though they are speeding up.</td>
<td>Vertical deflections cause discomfort to drivers so they must slow down as they cross them.</td>
<td>This surface is like closely spaced speed humps with a sinusoidal profile and causes discomfort for drivers.</td>
<td></td>
</tr>
<tr>
<td>The discomfort caused by the removal of markings causes motorist to slow down to navigate the area and costs only a little.</td>
<td>The cost is low for this device. It also causes cars to slow between 3 and 9 mph on average.</td>
<td>The cost of these is medium and they reduce speeds an average of 21 percent and rarely cause crashes.</td>
<td>This surface treatment makes drivers have to slow down to handle the rolling road. Average speeds were somewhat reduced.</td>
<td></td>
</tr>
<tr>
<td>This could also be confusing for motorists and cause accidents in the towns they are used in.</td>
<td>Cost to maintain the markings can add up and after a while they may become ineffective.</td>
<td>This measure can cause problems if motorists are not given sufficient warning.</td>
<td>The cost is medium to high as are cost to maintain, also a winter weather hazard.</td>
<td></td>
</tr>
</tbody>
</table>
Gateways (Roadside Feature) | Gateways are placed beside transition zones to indicate that the road is changing character and they will need to as well. | The cost can be low (or high) and have shown to reduce speed some. | These signs have not been proven to either increase or decrease safety. |  

A recent research effort resulted in NCHRP 737 that attempted to address some of the issues relative to the work to be completed here (Torbic et al., 2012). The report presented a methodology for assessing rural to built-up transitions and identified potential treatments for such locations aiming to address problems. Field studies aiming to address the safety and operational impacts of roundabouts, transverse pavement markings, and welcome signs were conducted. The study developed and included a process for evaluating conditions and similar information as that provided in NCHRP Synthesis 412. The study concluded that additional work is needed and there is a need for national design guidelines for such areas.

Summary

The purpose of a transition zone is to transition drivers safely from a rural roadway through a built-up area. This is done with SRT’s and has been the focal point of most literature concerning transition zones. It has been found that certain SRT’s are better for speed maintenance and some are better for speed reduction while still others may be better at alerting drivers of the approaching transition. When designing a transition zone, a single treatment may be used but it has also been found beneficial to combine treatments. SRT’s are discussed often throughout the literature so that others may better understand the treatments’ uses and their effects. This literature review also focuses heavily on these treatments while also including other vital transition zone information. Even though quite a few studies have been recently published on transition zones there is still a lot to be done in the area. The literature review looks at existing knowledge on the subject, considering that many aspects of transition zones have yet to be defined or studied.

Not all recommended treatments would benefit any given transition zone. Each location is unique and needs its own unique solution. Similarly, treatments are unique
and are more suited for some areas over others. The previous descriptions of the 14 treatments provide a basis on how each should be implemented and where they should be implemented. One of the final aspects of transition zones that must be addressed is the creation of clearly defined zones. A clearly defined transition zone also means clearly defined rural and built-up zones. It is important for the driver to recognize the point at which they are no longer on the rural segment and when they have entered the built-up area. Treatments such as signage, pavement markings, geometrical shifts, and the surroundings should communicate these changes to the driver as well as the need to reduce their speed. In the past, changes such as the addition of curb and gutter have not been sufficient to communicate this to the driver (Stamatiadis et al. 2004). This is why these other treatments are so vital to the effectiveness of transition zones.

In conclusion, there are a number of studies that examine the transition from rural roadways to built-up zones, and the treatments used to accomplish this transition. There are also some positive findings on how effective some of these treatments can be in such zones. However, there is still very little knowledge on the subject and lack of published manuals or guides pertaining to transition zones.
METHODOLOGY

Treatments Studied

A set of 16 treatments was selected for further evaluation as part of this study based on the findings of the literature review. The treatments chosen were those recommended by NCHRP Synthesis 412 and were shown in
Table 1 along with two more suggested in the literature. These 16 treatments are as follows:

- Median Islands
- Roundabouts
- Road/lane narrowing
- Road diets
- Chicanes or horizontal deflections
- Countdown speed signs
- Speed feedback signs
- Speed activated speed limit signs
- Transitional speed limits
- Optical speed bars
- Removal of pavement markings
- Speed humps
- Rumblewave surface
- Gateways
- Optical lane narrowing
- Roadside vegetation.

Each of these treatments was further researched and additional detail was provided regarding information such as cost, benefits, disadvantages, pictures, and known safety and speed benefits of each treatment (Appendix A). The 16 treatments outlined above were presented to the Study Advisory Committee (SAC). The members of the SAC are typically selected based on their familiarity with the topic to be researched, their expertise in the areas that could be addressed by the research, geographic coverage of the state, and their ability to provide insight and guidance on the various research activities. SAC members work closely with the research team in developing the work tasks and they facilitate identification of locations for field-testing of research activities.

The members of the SAC for this study were practicing engineers with several years of experience in the areas of traffic operations, highway safety, roadway design, and planning. The research team decided to utilize the expertise of the panel to evaluate and rank possible treatments and identify those that could have the greatest impact on reducing speeds at the transition zones.
The SAC members were asked to rate each treatment’s effectiveness and appropriateness. The description of each possible treatment shown in Appendix A was available to the SAC members to facilitate the scoring and provide a systematic basis for their evaluations. The rating considered appropriateness of the treatment for application in any of the three zones (i.e., awareness, transition, and maintenance). A Delphi-approach was utilized in scoring the possible treatments. SAC members were asked to review the material provided and score each treatment. A meeting was called where a short presentation of each treatment was given, the initial scores were collected and discussion followed to address the rationale for the choices and address any questions or issues regarding the treatment. A second scoring round ensued where the final ratings for each treatment were recorded. Full rating results can be found in Appendix B. The prominent treatments for each of the three areas are summarized below.

Driver Awareness
- gateways
- speed feedback signs
- optical lane narrowing

Transition Areas
- central islands
- roundabouts
- road diets
- speed feedback signs
- speed humps

Maintenance of Speed Reduction
- road diets
- roadside vegetation
- speed activated speed limit signs

It was also agreed that many of these treatments may be too expensive for implementation on this project and that transitional speed limits would be the most plausible treatment to be implemented.

Four locations were chosen to test these treatments. These locations are:
- KY 185 in Bowling Green
- KY 259 in Brownsville
- KY 69 in Hawesville
KY 3433 in Wilmore

A full description of each location is provided in the following sections. For each location, the use of transitional speed limits and warning signs, pavement markings or a combination of the two was implemented.

Data Collection Process

Travel speeds along the transition zone are used as the metric to evaluate the effectiveness of the treatment applied. There are three main locations of interest concerning the collection of data. First, speed data was needed for free flow traffic prior to the transition zone. In some sites counters were placed before drivers approaching the built-up area could see any indication of the transition zone. The speed limit in this location was 55 mph. Speed data in the 45 mph and 35 mph zones was also collected. Counters were placed just after each transitional speed sign. This set up was applied in most corridors.

The counters used were MetroCount MC5600 Series RSV’s (Figure 7). These counters use rubber tubes positioned across the travel lane to collect data. Each counter has two tubes, of the exact same length attached to valves on the machine to measure speed, headway, axle spacing, time and volume. The other ends of the tubes are tied in a knot and nailed down three feet apart, to the roadway centerline. The tubes are then pulled tight and nailed to the shoulder near the travel lane.

The counters were left out for about ten days before being retrieved. Once they were retrieved and the data had been downloaded, the data was run through several processes. The first process focused on the identification of the free flowing vehicles only, in order to select only those vehicles that drove at free-flow speed conditions, since

Figure 7. MetroCount MC5600 counter
following vehicles do not have the option of selecting their own speed. It was desired to trace vehicles throughout the transition area from the first to last counter to determine relative speed changes. This was deemed more appropriate than simple speed averages at each location, since it provides a more detailed study of the speed profiles of each vehicle traversing the transition zone. In addition, only passenger cars and pick-up trucks were used, since heavy vehicles may not appropriately reflect speed changes.
STUDY LOCATIONS

SAC members had identified four sites to be used for the evaluation of the treatments. The committee reported having speeding issues through these corridors and believed that speed could be affected with the use of such treatments.

KY 259, Brownsville, KY

The corridor of interest in Brownsville runs northwest along KY 259 from the city limits to Mammoth Cave Road. On this downhill approach, the speed limit decreases from 55 mph to 45 mph and finally to 35 mph. This is a two-lane corridor with 12 foot lanes and 11 foot shoulders. The curb and gutter section starts just after the 35 mph speed limit sign. Guardrail is present along most of the corridor next to the shoulder. This layout can be seen in Figure 8.

![Figure 8. Existing signs and counters, Brownsville KY](image)

Signage throughout the corridor was minimal. The only warning sign was a "Reduce Speed Ahead" located 700 feet before the 45 mph speed limit sign. The location of each data collection can be seen in Figure 8 identified as “counter.”
KY 185 Bowling Green, KY

The corridor studied in Bowling Green is KY 185 between the VFW post and the Sugar Maple Square shopping center. The Bowling Green transition zone consisted of step down speed limit signs from 55 mph to 45 mph to 35 mph. This is also a two-lane two-way road with 12 foot lanes and 2 foot shoulders. Curb starts just after the 35 mph speed limit sign. Also, near the 45 mph sign, a median is introduced and reaches a width of 12 feet before the 35 mph sign. This median is, at times, used for a left turn lane within the corridor. The existing conditions can be seen in Figure 9.

![Figure 9. Existing signs and counters, Bowling Green, KY](image)

The existing conditions have a “Reduced Speed Ahead” sign about 850 feet before the 45 mph speed limit sign but no warning for the 35 mph speed limit sign after that. Data collection sites are shown in Figure 9.
KY 69, Hawesville, KY

The corridor of interest in Hawesville was located on KY 69 as vehicles cross the bridge into Kentucky from Indiana. This corridor was recommended due to a safety problem as documented by District 2. There is a 30 mph speed limit sign on the bridge and upon crossing the Kentucky state border, a curve warning sign with a suggested speed limit of 15 mph is placed before the right turn into the town. Prior observations by KYTC indicated that this speed limit was rarely observed. It was decided that a pavement marking indicating the suggested reduction in speed as well as the upcoming curve should be placed on the pavement. The corridor and existing conditions can be seen in Figure 10. At this site, counters were placed both before and after the anticipated location of the new transition zone treatment.

![Figure 10. Existing conditions and counters, Hawesville, KY](image)

The location of the pavement marking and counters can be seen in Figure 10. The study corridor’s cross-section between these two counters is quite uniform. There is one lane in each direction that is 12 feet wide with an 8 foot shoulder, curb, and guardrail as well. Shortly after the corridor, the guardrail ends and sidewalks begin.
KY 3433, Wilmore, KY

Jessamine Station Road or KY 3433 is a rural state owned collector located east of the City of Wilmore in Jessamine County. KY 3433 is a narrow two-lane road with little to no shoulders. The area of interest was approximately one mile from the 55 mph (close to R.J. Corman Railroad Shop) to the 25 mph speed limit sign near to the bridge leading to central Wilmore. Metro-Counts were placed next to each of the four speed limit signs shown in Figure 11. The data was collected from vehicles driving towards the City of Wilmore. At this site four counters were placed at each of the speed limit signs. This was considered appropriate in order to determine the effectiveness of the additional signs and examine the potential of such an implementation.

![Figure 11: Existing conditions and counters, Wilmore, KY](image)

There are no warning signs for the reduced speed conditions and there are two access points from residential areas after the 45 mph and 35 mph speed limit signs.

**Speed Data Collection**

Speed data collection was undertaken at each location to collect data for the periods before and after the installation of each treatment. Some of the counters did not operate for the entire period, since tubes were disconnected, and therefore the analysis period is limited to the common days that all counters were operational. Due to this, the data analysis period was shorter than desired and only a fraction of the data collection period was used. However, the data used was sufficient to perform the required
analysis and statistical tests. The data analysis periods for each location can be found in Table 2 and is detailed below.

<table>
<thead>
<tr>
<th>Location</th>
<th>Pre-Treatment</th>
<th>Treatment 1</th>
<th>Treatment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bowling Green, KY</td>
<td>Aug 12 - Aug 15</td>
<td>Sept 30 - Oct 3</td>
<td>Nov 18- Nov 21</td>
</tr>
<tr>
<td>Brownsville, KY</td>
<td>Aug 10 - Aug 13</td>
<td>Sept 28 - Oct 1</td>
<td>--</td>
</tr>
<tr>
<td>Hawesville, KY</td>
<td>Sept 15- Sept 18</td>
<td>--</td>
<td>Nov 18- Nov 21</td>
</tr>
<tr>
<td>Wilmore, KY</td>
<td>May 21 – May 26</td>
<td>June 21 – June 25</td>
<td>July 14 – July 19</td>
</tr>
</tbody>
</table>

- **Brownsville, KY**
  Only data for four days was available due to malfunction of one of the counters (one of the tubes was broken for most of the collection time). However, the collected data was sufficient due to the number of vehicles that could be used in the analysis. For consistency, data for similar days and periods (i.e., Friday through Monday) were also utilized for all counters and both the pre- and after-treatment periods. The pre-treatment analysis dates were August 10 through August 14, and post-treatment analysis dates were September 28 through October 1.

- **Bowling Green, KY**
  It was determined to use only four days of data for this site as well to match the data from the Brownsville site and allow for equitable comparisons. The pre-treatment data analysis dates were August 12 through August 16, and the post-treatment data analysis dates were September 30 through October 3 and November 18 through November 21 for the sign and pavement marking treatments respectively.

- **Hawesville, KY**
  A data analysis period of four days was also used for the Hawesville data so as to keep consistent with the other locations. The pre-treatment analysis period included September 15 through September 18 and the post-treatment period included November 18 through November 21.

- **Wilmore, KY**
  A data analysis period of four days was used for the Wilmore data so as to keep consistent with the other locations. The pre-treatment analysis period included July 15 through July 20 and the post-treatment period included August 18 through August 25.
Data was initially collected to document existing conditions. Transitional speed limit warning signs such as those shown in Figure 12 were then installed. After allowing two weeks for drivers to become accustomed to the new signage, data was collected once again, at the same locations. The counters were left down for over a week at each site and then retrieved.

![Figure 12. Transitional speed limit warning signs](image)

For both Bowling Green and Brownsville, data was collected after the placement of the transitional speed limit warning sign. For the Bowling Green site a second treatment was tested where the newly 35 mph warning sign was removed and a pavement marking reading “SLOW” was installed (Figure 13). Two weeks were allowed for drivers to become accustomed to the treatment and data was once again collected.
Figure 13. "Slow" pavement marking treatment
A low-cost treatment was added at the Wilmore site in addition to the speed reduction warning signs as shown in Figure 12. The treatment included the placement of wind-propelled retro-reflective warning signs (Spin Alert, Figure 14) on the top of the warning signs.

Figure 14: Wind-propelled sign (Spin Alert)

Analysis Process

Several data elements are utilized in the analysis conducted aiming to determine the effectiveness of the treatment. The following metrics are used: mean speed, 85th percentile speed, mean speed of vehicles exceeding the 85th percentile speed, percent of vehicles exceeding the speed limit, percent of vehicles extremely speeding (10 or more mph over the speed limit), reduction in speed from counter to counter, percent reduction in speed from counter to counter, and speed variance. It was also decided that the data should further be analyzed by time as well. Thus, the sub-categories of day, night, week, and weekend were created.

The first task was to track each vehicle through the corridor. This would allow for estimating the speed change for each individual vehicle through the transition zone. To do this, a vehicle’s time and speed would need to be found and matched at all three locations throughout the corridor.

Once each data analysis period had a set of vehicles with speeds recorded at each location, the data could be further divided into day (6 am to 8 pm), night (8 pm to 6
am), weekday, and weekend. In doing this, the data can be further analyzed for patterns and effects for each period of concern.

The excel data analysis pack was used to statistically test the various metrics defined previously. First, the 85th percentile speed was determined for each counter within each dataset. In addition, the percent traveling above the speed limit and percent traveling 10 or more mph above the speed limit were also determined. Appendix C provides the complete results while summaries of the data for each corridor are provided in the next section.

Finally a comparison between pre-and post-treatment of speeds, variance, and other statistics was conducted. Differences were recorded and tested for significance. The tests used to do this are described below.

*Welch’s T-Test*

Welch’s t-test is used to check whether two means are different given both data sets are of different size and variance. This t-test can be used to check whether the difference in mean speeds pre- and post- treatment can be considered significant. This test was performed on each comparison. It is desired that speed be reduced and speed reduction between counters be increased.

*F Test of Equal Variance*

The F test of equal variance is used to test whether the variances of two data sets are the same. For the data here, this test can be used to examine changes in speed variance from before and after the installation periods. A decrease in speed variance indicates that vehicles were traveling closer to the average speed. This is significant for this analysis, since it is desirable to reduce speed differentials in a traffic stream and aggregate most speeds around a single value. Therefore, reduced speed variances are an indication of the possible effectiveness of the treatment, since it can show that the treatment resulted in lower speed differentials and a more uniform speed.
RESULTS

A series of statistical tests were conducted to evaluate the statistical significance of the metrics considered for the analyses discussed in the previous section. These metrics include mean speeds, speed reductions, 85th percentile speeds, and percent of vehicles speeding. The statistical tests of the differences between the means and the standard deviations of the before and after the treatment periods showed that the differences are significant: at the 5 percent level. Also, the data divided by day, night, week, and weekend was analyzed in the same way since it was expected that patterns in the data might be observed. However, these subgroups of data were no different than the total data set and therefore are not displayed here.

KY 259, Brownsville, KY

Overall, the data for this site shows improvements in speed reductions for the Brownsville corridor (Table 3). The addition of the transitional speed limit warning signs appears to be effective. Mean speeds at each of the three counters decreased around 2 mph. There were statistically significant mean speed reductions of 2.69 mph, 1.64 mph, and 2.33 mph at the free flow (counter 1), 45 mph (counter 2) and 35 mph (counter 3) locations, respectively. The data proves that this treatment has been beneficial and statistically significant.

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean Speeds (mph)</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free flow 45 mph 35 mph</td>
<td>1-2 2-3 1-3</td>
</tr>
<tr>
<td>Before</td>
<td>53.48 49.34 41.70</td>
<td>4.15 7.64 11.79</td>
</tr>
<tr>
<td>After</td>
<td>50.79 47.70 39.37</td>
<td>2.66 8.76 11.33</td>
</tr>
</tbody>
</table>

As stated in the literature review, transition zones aim to not only reduce mean speed, but also reduce the amount of vehicles operating at high speeds. To better evaluate this effect due to the transitional speed limit warning signs, additional speed metrics are examined. First, the 85th percentile speed, or operating speed, was examined (Table 4). It was found that the 85th percentile speed was decreased at the 45 mph counter but increased at the other two. Though this is not anticipated there are other statistics that help measure the effect of this treatment on high-speed vehicles.
One such metric is the mean speed for vehicles traveling above the 85th percentile speed. This average was reduced 3.24 mph, 0.84 mph, and 2.91 mph at each the free flow, 45 mph, and 35 mph counters. These decreases are important and demonstrate the effectiveness of this treatment.

Table 4. Brownsville before and after 85th percentile speed data

<table>
<thead>
<tr>
<th>Period</th>
<th>85th Percentile Speed (mph)</th>
<th>Mean for Vehicles &gt; 85th Percentile Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free flow</td>
<td>45 mph</td>
</tr>
<tr>
<td>Before</td>
<td>58.0</td>
<td>48.1</td>
</tr>
<tr>
<td>After</td>
<td>54.3</td>
<td>47.70</td>
</tr>
</tbody>
</table>

The percent of vehicles traveling above given speeds can also display the effects a treatment has on a corridor (Table 5). For example, at each counter the percent of vehicles exceeding the speed limit was decreased, as much as 13.4 percent in one case. Even the percent of vehicles exceeding the speed limit as they entered the built-up area was decreased by 6.5 percent. Furthermore, the percent of vehicles excessively speeding, i.e. 10 or more mph over the speed limit, was decreased from 16.2 to 12.4 and 29.3 to 18.0 at the 45 mph counter and 35 mph counter respectively. Traveling at speeds that are much greater than the speed limit is unsafe. By decreasing the percent of drivers doing so, safety is being positively affected.

Table 5. Brownsville before and after speeding percentages

<table>
<thead>
<tr>
<th>Period</th>
<th>Percent &gt; Speed Limit</th>
<th>Percent &gt; Speed Limit +10mph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55mph</td>
<td>45 mph</td>
</tr>
<tr>
<td>Before</td>
<td>38.5</td>
<td>77.5</td>
</tr>
<tr>
<td>After</td>
<td>15.1</td>
<td>72.0</td>
</tr>
</tbody>
</table>

In correlation with reducing extreme speeds, the variance at each counter seems to have decreased in one way or another. The F test for equal variance showed that the variance in mean speed and 85th percentile speed at each counter has been decreased. This signifies that the speed distribution has been tightened, i.e., there are fewer very high and very low speeds. Not only is this safer because it proves a reduction in excessive speeding but also because vehicles speeds are closer together and more uniform.

The results discovered through this analysis indicate that the transitional signs have had a positive effect on the Brownsville corridor. For the most part, speeds have
been reduced, the proportion of motorists speeding has been reduced, and in return safety has been increased.

**KY 185, Bowling Green, KY**

The data analysis for this site showed that many of the speed metrics actually increased from before to after: an unexpected result. However, this could be attributed to possible errors in placing the tubes for the counters. The effectiveness of the transitional speed limit warning signs is not as evident in this site (Table 6). The only notable speed decreases are observed at the free flow counter. The mean speed and mean speed for vehicles over the 85th percentile speed were decreased from 52.85 mph to 50.17 mph and from 59.75 mph to 57.53 mph, respectively. The remaining mean speeds and mean speeds over the 85th percentile speed were increased. However, for some these increases were very small, e.g. the mean speed at the 35 mph counter increased from 37.73 mph to 37.92 mph. With the t-test this increase was found to be significant due to its large sample size. However, in practical terms, this makes no difference. Thus, the treatment had not necessarily worsened roadway operations, though it has obviously not improved them.

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean Speeds (mph)</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free flow</td>
<td>1-2</td>
</tr>
<tr>
<td></td>
<td>1-2</td>
<td>%</td>
</tr>
<tr>
<td>Before</td>
<td>52.85</td>
<td>5.85</td>
</tr>
<tr>
<td>After-Signs</td>
<td>50.17</td>
<td>1.73</td>
</tr>
<tr>
<td>After-Slow</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Furthermore, it was not anticipated that the total reduction in speed over the corridor would increase after the implementation of the treatments. From the first to last counter, speeds decreased 28.78 percent prior to the treatment and only 25.25 percent after its installation. However, from the second (45 mph) counter to the last, the speed reduction increased from 20.36 percent to 22.56 percent. This indicates that although the total reduction in speed may have decreased, more of the reduction occurs between the 45 mph and 35 mph counters. This could signify a higher deceleration rate as the built-up area is reached. This suggests that drivers were possibly more aware of the treatment between these counters than the first two.
Results were also recorded for the “SLOW” pavement marking. Though the mean speed at the 45 mph counter is decreased, the mean speed at the 35 mph counter increased, though by very little. This increase is even less than that observed with the transitional speed limit warning signs. However, due mainly to the large sample size, this increase is still statistically significant. It was also observed that the mean reduction in speed from counter 2 to 3 decreased in both mph and percentage. However, much of this decrease can be attributed to the large decrease in mean speed at the 45 mph counter.

Mean speeds for vehicles traveling over the 85th percentile speed and the 85th percentile speeds were also studied (Table 7). There are different patterns for each of the treatments evaluated. For the additional warning signs the mean speed of vehicles traveling over the 85th percentile speed decreased at the free flow counter, increased at the 45 mph counter, and remained the same at the 35 mph counter. For the “SLOW” pavement marking, this mean decreased at the 45 mph counter and remained the same at the 35 mph counter. The changes observed at the 45 mph counter were statistically different and significant at the 5 percent level, while those at the 35 mph were not different. The 85th percentile speeds followed similar patterns. For the additional warning signs, speeds increased at each counter. However, with the pavement marking, the 85th percentile speeds decreased at the 45 mph counter and increased at the 35 mph counter. The data here does not allow for a comprehensive evaluation of each treatment but in general indicates that the treatments were somewhat effective (at the 45 mph spot) and were able to reduce speeds between the 45 mph and 35 mph signs.

<table>
<thead>
<tr>
<th>Period</th>
<th>Free flow</th>
<th>45 mph</th>
<th>35 mph</th>
<th>Free flow</th>
<th>45 mph</th>
<th>35 mph</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before</td>
<td>57.5</td>
<td>52.5</td>
<td>42.0</td>
<td>59.75</td>
<td>55.10</td>
<td>44.96</td>
</tr>
<tr>
<td>After-Sign</td>
<td>57.8</td>
<td>58.1</td>
<td>44.9</td>
<td>57.53</td>
<td>57.72</td>
<td>44.78</td>
</tr>
<tr>
<td>After-Slow</td>
<td>48.1</td>
<td>42.5</td>
<td></td>
<td>50.46</td>
<td></td>
<td>45.02</td>
</tr>
</tbody>
</table>

The examination of the speeding and excessive speeding statistics shows both positive and negative outcomes (Table 8). Both percentages of vehicles exceeding and exceeding by more than 10 mph of the 55 mph speed limit decreased with the placement of the transitional speed limit warning signs. Though these benefits cannot be attributed to the treatment, they are it is still noteworthy. Unfortunately, the percent of
vehicles exceeding the speed limit at the 35 mph and 45 mph locations increased from 6.2 percent to 12.9 percent and 69.7 percent to 77.4 percent, respectively. This was not anticipated and quite opposite of the results noted at the Brownsville location. However, it was discovered that at the 35 mph counter, the percent of vehicles excessively speeding (>10 mph over the speed limit) was reduced from 5.7 percent to 5.2 percent. From this data it seems that within the corridor speeding may have increased at times but as the built-up area was reached, it may have decreased. Results somewhat differ with the “SLOW” pavement marking treatment. Though percent speeding decreased dramatically at the 45 mph counter, it still increased at the 35 mph counter. This same pattern can be seen in vehicles exceeding the speed limit by 10 mph or more.

Table 8. Bowling Green before and after speeding percentages

<table>
<thead>
<tr>
<th>Period</th>
<th>Percent &gt; Speed Limit</th>
<th>Percent &gt; Speed Limit +10mph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55mph</td>
<td>45 mph</td>
</tr>
<tr>
<td>Before</td>
<td>33.1</td>
<td>69.7</td>
</tr>
<tr>
<td>After-Sign</td>
<td>15.1</td>
<td>77.4</td>
</tr>
<tr>
<td>After-Slow</td>
<td>38.4</td>
<td>76.8</td>
</tr>
</tbody>
</table>

Finally, statistical tests were conducted on the variance for this location as well. The variance for the mean speeds and the 85th percentile speeds both increased and the tests showed a statistical significance for the use of the warning signs. At every counter, the mean speed for vehicles traveling above the 85th percentile decreased. This is more along the anticipated results and could mean more uniformity for the faster vehicles.

The variances associated with the pavement marking, on the other hand, all decreased except for the mean reduction in speed, which remained the same. So while both treatments showed similar effects for not successfully reducing speeds at all locations, the “SLOW” pavement marking was more effective at reducing the variance of speeds.

Though not all of the results at this location were anticipated, there are a few that suggest some improvements. The decrease of excessive speeding with the sign treatment as vehicles enter the built-up area could result in safety improvements. Furthermore, it is possible that the increased deceleration rate between the second and third counters could carry over into the town. Thus, though speeds may not be fully reduced by the 35 mph speed limit sign, they could be lower in the area following it.
However, this assumption could not be verified with the available data. In addition, a positive aspect of the pavement marking is the reduction in speed variance. The results of the Bowling Green treatments are not as evident as in Brownsville. The few benefits observed as a result of the treatments are subtle but not significant indicating that other treatments may be more beneficial.

**KY 69, Hawesville, KY**

The results of this location are somewhat mixed, since the counters are only 140 feet apart and thus no significant speed changes could occur. The location of the pavement marking and the geometry of the area do not allow for an expanded length of the corridor and thus could influence the results. Given these limitations, the potential effectiveness of pavement markings is evident (Table 9). Each difference shown is statistically significant which means mean speeds, 85th percentile speeds and the mean speeds of vehicles traveling over the 85th percentile speed have all significantly decreased at both locations. Similarly, the reduction in speed between the two counters increased as well as did the percent reduction in speed.

| Table 9. Hawesville before and after speed statistics |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Period                           | Mean Speeds (mph) | 85th Percentile Speed (mph) | Mean Speed > 85th Percentile (mph) | Mean Speed Reduction |
|                                 | Bridge | Curve | Bridge | Curve | Bridge | Curve | mph | %             |
| Before                          | 32.78  | 25.18 | 37.4   | 28.9  | 39.66  | 30.67 | 7.6 | 23.2          |
| After                           | 28.88  | 16.09 | 33.3   | 19.2  | 35.32  | 20.93 | 12.8| 44.3          |

At the bridge and curve counters mean speeds were reduced 3.9 mph and 9.1 mph respectively and the 85th percentile speeds were reduced 4.1 and 9.7 mph respectively. Similarly, the mean speed of vehicles traveling above the 85th percentile speed was reduced by 4.6 mph nearest the bridge and 9.7 mph nearest the curve. Finally, the reduction in speed between the two counters increased by 4.9 mph and almost doubled in percentage. Each of these statistics suggests that the pavement marking used effectively reduced speeds throughout this corridor.

The data also showed that the percent of vehicles exceeding the speed limit and suggested speed limit, or excessively exceeding the speed limit drastically decreased (Table 10). At the counter closest to the bridge, the percentage of vehicles traveling above the speed limit and over 10 mph over the speed limit showed a large decrease.
Similarly, at the counter closer to the curve, vehicles traveling over the speed limit were completely eliminated while the percentage traveling over the suggested speed of 15 mph was reduced from about all vehicles to only two thirds of them.

<table>
<thead>
<tr>
<th>Period</th>
<th>Percent &gt; Speed Limit</th>
<th>Percent &gt; Speed Limit +10mph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bridge</td>
<td>Curve</td>
</tr>
<tr>
<td>Before</td>
<td>74.8</td>
<td>97.8</td>
</tr>
<tr>
<td>After</td>
<td>44.8</td>
<td>66.5</td>
</tr>
</tbody>
</table>

Each of the statistics observed above only testifies to the effectiveness of this treatment. However, the results from the variance F-test indicate that the variance of mean speed for vehicles traveling about the 85th percentile speed increased near the curve as did the variance in mean reduction in speed between counters. All other variances decreased, as anticipated, however the increase of variance in the over the 85th percentile speeds is not expected. It is obvious that this treatment has been rather effective in this situation and possesses the ability to have these positive effects on similar corridors.

KY 3433, Wilmore, KY

The data in this site provided mixed results. For all conditions, there is a speed reduction between the 55 mph and 45 mph speed signs followed by an increase in speeds for the next pair of signs and a reduction again for the next set (Table 11). This could be attributed to the geometry of the roadway. After the 45 mph speed sign the roadway becomes straight and wide allowing vehicles to travel at greater speeds. The data indicates that the addition of the Spin Alert to the warning signs did not increase the speed reductions and it had lower effectiveness when considering the percent speed reductions between the two treatments. Mean speeds at the 55 to 45 and 35 to 25 mph zones reduced approximately 6 mph. On the contrary, there was an increase of over 3 mph in the 45 to 35 mph zone. These speed differences were statistically significant as the t-tests indicate. It is apparent that the added treatments have an effect on the speeds through this area as the data indicates.
Table 11. Wilmore before and after mean speeds and reductions

<table>
<thead>
<tr>
<th>Period</th>
<th>Mean Speeds (mph)</th>
<th>Reduction</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Free flow</td>
<td>1-2</td>
<td>2-3²</td>
<td>3-4</td>
<td>1-4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>45 mph</td>
<td>35 mph</td>
<td>25 mph</td>
<td>mph</td>
<td>%</td>
<td>mph</td>
</tr>
<tr>
<td>Before</td>
<td>43.9¹</td>
<td>38.0</td>
<td>38.7</td>
<td>35.2</td>
<td>5.9</td>
<td>13.4</td>
</tr>
<tr>
<td>After-Sign</td>
<td>43.9</td>
<td>37.1</td>
<td>40.4</td>
<td>32.9</td>
<td>6.8</td>
<td>15.5</td>
</tr>
<tr>
<td>After - Spin</td>
<td>42.1</td>
<td>36.3</td>
<td>39.9</td>
<td>33.9</td>
<td>5.9</td>
<td>13.9</td>
</tr>
</tbody>
</table>

¹: Data collected for 4 hours only; ²: Increase in speed

The total reduction over the entire corridor remained unchanged with the addition of the Spin Alert signs when compared to the before conditions. There was a larger decrease noted with the addition of the warning signs only of almost 11 mph, which is still lower than the desired 30 mph reduction (from 55 to 25 mph).

To further evaluate the effect due to the added treatments, the 85th percentile speed, or operating speed, was examined (Table 12). It was found that the 85th percentile speed was decreased at the 45 mph and 25 mph counters but increased at the other two. Though this is not anticipated there are other statistics that help measure the effect of this treatment on high-speed vehicles. One such metric is the mean speed for vehicles traveling above the 85th percentile speed. This average was reduced 3.24 mph, 0.84 mph, and 2.91 mph at each the free flow, 45 mph, and 35 mph counters. These decreases are important and demonstrate the effectiveness of this treatment.

Table 12. Wilmore before and after 85th percentile data

<table>
<thead>
<tr>
<th>Period</th>
<th>85th Percentile Speed (mph)</th>
<th>Mean of Vehicles &gt; 85th Percentile Speed (mph)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55mph</td>
<td>45mph</td>
</tr>
<tr>
<td>Before</td>
<td>48.8¹</td>
<td>43</td>
</tr>
<tr>
<td>After 1</td>
<td>49.1</td>
<td>41.0</td>
</tr>
<tr>
<td>After 2</td>
<td>48.9</td>
<td>41.1</td>
</tr>
</tbody>
</table>

¹: Low Data Sample – Only 4 hour

The examination of the speeding and excessive speeding statistics shows both positive and negative outcomes (Table 13). Both percentages of vehicles exceeding and exceeding by more than 10 mph of the 55 mph speed limit showed an increase with the placement of the transitional speed limit warning signs and remained unaffected with the
Spin Alert. At the 45 mph speed, both treatments resulted in a reduction of both metrics from 6.7 percent to 4.2 percent for the warning signs and 5.0 percent for the Spin Alert. Even though similar small reductions were noted at the 35 and 25 mph counters, there are a very large number of vehicles (85 percent and 93 percent respectively) exceeding the posted speed limit. Unfortunately, at these locations a large number of vehicles exceeded the speed limit by more than 10 mph. Even though the numbers are reduced with the addition of the treatments as compared to the existing conditions, these high speeding occurrences are a reality.

Table 13. Wilmore before and after speeding percentages

<table>
<thead>
<tr>
<th>Period</th>
<th>Percent &gt; Speed Limit</th>
<th>Percent &gt; Speed Limit + 10mph</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>55mph</td>
<td>45mph</td>
</tr>
<tr>
<td>Before</td>
<td>1.5*</td>
<td>6.7</td>
</tr>
<tr>
<td>After-Sign</td>
<td>4.2</td>
<td>4.2</td>
</tr>
<tr>
<td>After-Spin</td>
<td>0.6</td>
<td>5.0</td>
</tr>
</tbody>
</table>

*Low Data Sample – Only 4 hour

Finally, statistical tests were conducted on the variance of the speeds for this site. The variance for the mean speeds and the 85th percentile speeds both decreased and F-tests showed a statistical significance for the use of the warning signs and devices. Considering the low cost associated with implementing these treatments, the combination of these treatments is an effective method to decrease speeds and increase driverss awareness within transition zones.
CONCLUSIONS AND RECOMMENDATIONS

One of the main objectives of this project was to accumulate knowledge regarding transition zones and determine possible treatments. This objective was accomplished with a review of the current literature. Evaluation of treatments installed is another objective of the study and determination of their level of effectiveness would result in developing guidance for installations. A limited number of treatments have been evaluated aiming to understand their effectiveness and impact on reducing speeds. The literature review identified the implementation, benefits, and cost of each potential treatment. Through the implementation of the transitional speed limit warning signs and pavement markings, speed data was collected before and after the installation of the treatments and the data was analyzed for trends. It is anticipated that the study of these treatments is only the beginning of research regarding transition zone treatments. The ultimate objective of this study was to develop a guide based on the work completed. However, the inconsistencies among the results obtained for each site do not allow for the development of a systematic guide that could address each treatment and define its potential use, but rather point to the development of some general guidance on how to address such transition zones.

The results of Brownsville and Wilmore indicate the positive effects of the transitional speed limit warning signs. For the most part, speeds have been reduced around 2 mph at each location and the percentage of vehicles traveling over the speed limit has been reduced as well. The data indicate that this treatment has decreased speeds and improved safety, as desired. The treatment did not cause drastic changes in speed, but for such small cost and little to no maintenance, it is effective enough. The results from Hawesville lead to similar conclusions about the pavement markings. All speeds were reduced around 4 mph at the counter nearest the bridge and 9 mph at the counter nearest the curve. Along with decreases in variation for the most part and an increase in speed reduction between the two counters, it can be seen that there are also many benefits to this transition zone treatment. The results from Wilmore regarding the additional Spin Alert signs do not show any additional gains when placed with the warning signs and thus their effectiveness could be limited.

However, the results of Bowling Green must also be considered. Many of the results, as discussed, are negative and do not benefit the transition zone, either from the warning signs or pavement marking. However, some benefits could be observed from the treatments even at this site and therefore it is essential that additional installations
should be evaluated in the future. It is apparent that there is a need for more sites to be identified and more data to be collected to further study the impacts of this treatment. Since the results, in these cases, were so varied it would helpful to examine more corridors. With more data, more evident patterns for this treatment could be found and discussed for future transition zones.

Recommendations

The benefits obtained from the additional warning signs treatments that have been implemented could be considered small. However, they are present in all sites. The warning signs have the ability to reduce mean speed, percentage of vehicles speeding, 85th percentile speeds, and variance even if it is just slightly. For such a low cost of implementation, the possible benefits of this treatment can be worth the cost. It is therefore recommended that the layout presented in Figure 1 be implemented in all transition zones. This could be considered the low-cost standard treatment of transition zones.

There are some indications that the pavement markings could have an additional benefit in reducing speeds as it was shown in the Hawesville site. It is therefore possible to augment the warning signs with this treatment in cases where additional emphasis in the transition zone is required.

The scoring of the treatments by the SAC could also be used as a means for identifying and utilizing additional treatments. The SAC identified the following as potential treatments for each of the three areas of a transition zone:

**Driver Awareness**
- gateways
- speed feedback signs
- optical lane narrowing

**Transition Areas**
- central islands
- roundabouts
- road diets
- speed feedback signs
- speed humps
Maintenance of Speed Reduction

- road diets
- roadside vegetation
- speed activated speed limit signs

All these treatments could be considered in addition to the warning signs and pavement markings and could be implemented to increase the potential effectiveness of the transition zone. Additional information for each treatment is provided in Appendix A that can serve as the basis of implementing any of them. It is also recommended that a speed data collection is undertaken before and after the installation to determine and document the effectiveness of the treatment.
REFERENCES


Pennsylvania DOT and New Jersey DOT Smart Transportation Guidebook, 2008


APPENDIX A:

Treatment Information and Specifications
SRT: Median Island

Basic Concepts

A median island is used to create a horizontal displacement by shifting the travel lanes to the left of the centerline. Such islands are likely to draw drivers’ attention, since they require a change in direction when was not needed otherwise, and at the same time reduce their speed to negotiate the horizontal change. Median islands have a variety of shapes and lengths and can be designed either on one side of the road (the approach entering the built-up area) or on both sides of the road. The sharpness with which require the horizontal displacement has a direct relationship to the speed reduction. An example of such treatment is shown below.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Provide physical separation of traffic</td>
<td>• Reduce access to businesses (more for urban areas)</td>
</tr>
<tr>
<td>• Create refuge areas for pedestrians</td>
<td>• Require additional maintenance</td>
</tr>
<tr>
<td>• Allow for landscaping to enforce rural/built-up character change</td>
<td></td>
</tr>
</tbody>
</table>

Past Experience

Previous research and evaluation of sites where this element was used have shown mixed results regarding its effectiveness. A study in Austria evaluated different designs and types of median islands and concluded that in general placement at the boundaries between rural and built-up areas are very effective in reducing speeds (Berger and Linauer 1998). Their study showed that median islands with sharp displacement had the highest speed reductions (some showing reductions of over
40% of the 85th percentile speeds. A study in Ireland where raised median islands were used in conjunction with advance warning signs showed reductions of 9 mph of the 85th percentile speed in comparison to the speeds before the median island (Crowley and MacDermott 2001). They also noted lower speed reductions (in the range of 6 mph) in areas where the median island was not raised and the same warning signs were used. An Iowa study evaluated the use of median islands on a rural highway (Hallmark et al. 2007). The study concluded that the introduction of the median island did not have any effect but its effectiveness was increased when speed feedback displays were added. A Kentucky study examined the use of median islands as part of a transition zone to introduce a two-way left-turn lane in a rural community (Stamatiadis et al. 2004). The evaluation of the design indicted that the median island was effective in reducing the 85th percentile speeds by 12% at the median island. However the authors noted that speeds were still higher than the posted speed limit throughout the entire segment. A study by FHWA evaluated median island treatments for high speed rural intersections using low cost means (Bared 2008). The study showed an overall reduction of approximately 5 mph for the sites it was implemented. It should be noted that additional elements were incorporated in these designs including rumble strips and lane narrowing. The Transportation Association of Canada (1998) indicates that the use of median islands on local and collector streets can have a small (2 mph) speed reduction.

**Safety and Costs**

A recent study has documented crash reductions in the range of about 20% at the entry of the town based on several installations over the past 10 years (Curtis 2008). However, it should be pointed out that these median islands were accompanied by gateways with speed limit signs. The cost of this technique varies depending on the type of island used (raised or painted) and the length of the device.

**Engineering Evaluation**

- Typical Horizontal Deflection: 12 feet
- Conspicuity: 6 inch raised curb, conspicuity varies with landscape treatments.
- Roadside Clearance: 2.5 feet
- Anticipated Speed (FHWA-USLIMITS): 30 mph
- Anticipated Free Flow Speed (HCM): 35 mph
- Fastest Path: 22.5 mph

**References**
**SRT: Roundabout**

**Basic Concepts**

Roundabouts slow motorists down and make them yield without having to necessarily stop. They are circular intersections that reduce conflict points. Roundabouts are best used at intersections located before the built up area is actually reached. They are very efficient, but when implemented in a new community they can be hard for motorists to navigate at first. They are costly but good for towns that are familiar with the design.


Advantages

- Slow vehicles down without stopping
- Efficiently move vehicles through the intersection

Disadvantages

- High cost especially if addition right of way must be bought
- Difficult for drivers to navigate at first

Past Experience

Roundabouts are commonly used for efficiency in intersections. Rodegerdts et al. (2007) studied roundabouts and the depth of their use. Though the publication does not directly look at the use of roundabouts in transition zones, roundabouts can be used as gateways to towns and are therefore an important aspect of transition zones. They are most useful for transition zones either containing an intersection or with an intersection near the built up area. The research discusses models for predicting future entering and exiting roundabout speeds. This is useful in design because radii can be selected depending on desired exit speeds.

Safety and Costs

Studies have found that roundabouts have decreased all crashes by 38% and all injury crashes by 76% (Retting et al. 2001). Furthermore, fatal and incapacitated injury crashes were reduced by an estimated 90%.

These structures can be costly especially depending on their size. The slower the speed, the smaller the radius, and the less land and construction needed.

Engineering Evaluation
Rodegerdts et al. (2007) has developed the following model for U.S. customary units in determining entering and exiting speeds for roundabouts.

**U.S. CUSTOMARY:**

\[
V_{exit} = \text{MIN} \left( a R_2^b : \frac{1}{1.47} \sqrt{(1.47a R_2^b)^2 + 13.8d_3} \right)
\]

\[
V_{enter} = \text{MIN} \left( a R_1^b : \frac{1}{1.47} \sqrt{(1.47a R_1^b)^2 + 8.4d_1} \right)
\]

Where: $V_{exit}$ = the predicted exit speed for the roundabout (mph)
$V_{enter}$ = the predicted entry speed for the roundabout (mph)
$R_1$ = path radius on entry to the roundabout (ft)
$R_2$ = path radius on the circulating roadway (ft)
$R_3$ = path radius on exit from the roundabout (ft)
$a, b$ = see Table 13
$d_3$ = distance between the midpoint of the path on the circulating roadway and the point of exit (ft)
$d_1$ = distance between the point of interest on the entry and the midpoint of the path on the roadway (ft)

**References**


**SRT: Road/Lane Narrowing**

**Basic Concepts**

Road or lane narrowing is the reduction of lane/road widths to make drivers more cautious and some have raised/painted platforms. If lane narrowing is implemented on roads with heavy large vehicle traffic they present potential for crashes. Small vehicles can pass one another in these narrowed places but it is much more difficult for trucks, busses, and vans. Therefore, this treatment is best for areas with little large vehicle traffic.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Traffic is forced to slow in order to navigate the narrowing road</td>
<td>• Potential for large vehicle crashes</td>
</tr>
<tr>
<td>• Drivers are required to pay more attention through the narrowing</td>
<td>• Cost of construction can be relatively high</td>
</tr>
</tbody>
</table>

**Past Experience**

Studies looking at road narrowing show that the narrowing’s can effectively reduce speeds but also can be a hazard for large vehicles. Country Surveyor’s Society (1994) conducted a study that looked at many different cases of traffic calming. This study concluded that where roads were narrowed, speeds were reduced by 12 mph on average. Speed limits for each of these roads were not given so the percent reduction is unknown in this study. However, another study reported an 11% to 20% reduction in speeds due to the narrowing in the road (Charlton and Bass 2006).
Safety and Costs

Country Surveyor’s Society (1994) reported crash rates dropping from .45 to .20 annual injury crashes per thousand vehicles per day in areas where road narrowing’s were implemented.

The cost for this technique can be relatively high. This especially depends on how the road is narrowed. Stripping the ground would be a lot less expensive but probably not as effective. On the other hand, creating a new curb or bump outs could be costly but would probably be more effective.

Engineering Evaluation

The design of the lane narrowing is very versatile. Materials used to create the narrowing and vary from paint to a raised curb to barriers. Furthermore, the width of the lane narrowing should consider the type of traffic that specific site experiences. Higher volumes of heavy vehicles would require a wider road just like a road with more personal-vehicles would be served better with narrower lanes for this treatment.

References


**SRT: Road Diet**

**Basic Concepts**

Road diets are the reallocation of roadway to reduce travel lanes and excessive speeding. The nice thing about road diets is that no new pavement must be laid. Furthermore, bicycle and pedestrian safety is often greatly increased. This is a great solution for areas with heavy bicycle or pedestrian traffic or the potential for it. Bicyclists are often given their own lane of travel, which in return creates a larger buffer for pedestrians from motor vehicles.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Encourages multimodal transportation</td>
<td>• Reduction of through travel lanes</td>
</tr>
<tr>
<td>• Improved bicycle safety</td>
<td>• May reduce the facility’s capacity</td>
</tr>
<tr>
<td>• Reduction in crashes</td>
<td></td>
</tr>
</tbody>
</table>

**Past Experience**

Road diets are relatively newer concepts but there are still many studies concerning this treatment. Knapp and Rosales (2007) conducted a study that looked at the results of many different road diet studies and sites. Before and after studies were looked at for 13 different conversions. What they found was that the average speed reduction was usually less than 5 mph, but that the average reduction in excessive speeding was 70%.

**Safety and Costs**

A study taking place in 2005 found that road diets reduced the crash risk by
20% to 40% (Huang et al. 2005).

The cost of this technique is relatively medium to high. Stripping and road signage must be removed and reapplied after the roadway has been reallocated.

**Engineering Evaluation**

The picture above shows an example of the reallocation of roadway in a road diet. In general the number of travel lanes is reduced with the addition of bicycle lanes and a two-way left-turn lane.

**References**


**SRT: Chicanes or Horizontal Deflections**

**Basic Concepts**

Chicanes or horizontal deflection are lateral deflections or shifts in alignment that require speed reduction to navigate. Studies show that greater speed reduction is associated with greater deflection. These are generally used with another treatment as well. These are best and often used in sets. There may be one set of chicanes upon reaching the transition zone, another when entering the built up area, and maybe even a set in the built up area itself. Chicanes can use the existing pavement especially if there is a large shoulder or area for parking. Installing a new, deflecting curb on these streets can create horizontal deflections.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Often don’t require additional ROW</td>
<td>• Could require high cost to construct</td>
</tr>
<tr>
<td>• Motorists must reduce speed in order to navigate shift in horizontal alignment</td>
<td>• Could increase single vehicle crashes</td>
</tr>
</tbody>
</table>

**Past Experience:**

Thus far, there are no cases in which chicanes are used alone in transition zones. However, there are many combinations of chicanes and other treatments that have been used. Lamberti et al. (2009) combined the chicanes with gateways. Reductions were found to be between 7 and 10 mph. Gateways were also studied without chicanes and results were about the same. That study seems to suggest that the gateway would have been sufficient without the added chicanes. Another study conducted by Country Surveyor's Society (1994) found reductions between 5 mph
and 13 mph where chicanes were combined with another treatment such as traffic islands, gateways, and textured surfaces. Other recommendations for the implementation of chicanes include using them on low speed roads only (<20mph) (Charlton and Baas 2006). They could be more of a hindrance than help on higher speed roadways. Finally, studies have shown that the decrease in speed caused by chicanes is directly proportional to the severity of the horizontal deflection (Forbes 2011).

**Safety and Costs**

County Surveyor’s Society (1944) reported that the use of chicanes with other transition zone treatments made a road safer. Injury crashes per year were reduced in all cases and crash rates were reduced between .04 and .37 annual injury crashes per thousand vehicles per day for these combined treatments.

The cost depends on severity of deflection and can often be relatively expensive depending on implementation.

**Engineering Evaluation**

Chicanes are not suitable for high speeds (>20 mph) and may increase incidence of single vehicle collision (Charlton and Baas 2007). Approaching motorists need plenty of warning of the chicane ahead to avoid such crash.

**References**


**SRT: Countdown Speed Signs and Markers**

**Basic Concepts**

Count down speed signs are signs with the reduced speed ahead displayed as well as 3 lines, the next will have 2, then 1 until the speed reduction zone is reached. For the use of these, public education and repeated exposure would be essential since there is little familiarity with these in the United States.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Brings drivers attention to speed reduction</td>
<td>• Public exposure is necessary for any significant results</td>
</tr>
<tr>
<td>• There is little cost for the signs</td>
<td></td>
</tr>
</tbody>
</table>

**Past Experience**

Thus far, these signs have mainly been used in Europe, specifically the United Kingdom. This element has had mixed results in studies. One particular study found no negative values of the signs but no positive ones either (Barker et al. 1997). This study found that the countdown speed markers had no significant effect on mean speed.

**Safety and Costs**

Safety measures do not seem to have improved or dissipated. Parallel to speed issues, safety seems to be relatively ineffective by these speed signs. The cost of this technique is low. Three signs must be created and installed but that is the only cost, it seems.

**Engineering Evaluation**

Typically signs are placed almost equally out from the beginning of the built up area. The sign with one stripe is placed 330 feet from the built up area, the two stripe
sign is 655 feet from built up area, and the three stripe sign, the first the driver will see, is placed 985 feet from the beginning of the built up area (Baker et al. 1997).

References
SRT: Speed Feedback Sign

Basic Concepts

Speed feedback signs are electronic signs measuring speed and displaying it for the driver. These seem to be most useful for an area having trouble with long-term effectiveness. Though drivers may get used to the sign, they will always be reminded of the speed as well as their own which changes. They are probably best for areas seeking increased attention to speed.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Speeds decrease at least for a while</td>
<td>• They are only effective when in</td>
</tr>
<tr>
<td>• Drivers are made aware of not only</td>
<td>place</td>
</tr>
<tr>
<td>the speed limit but their speed as</td>
<td></td>
</tr>
<tr>
<td>well.</td>
<td></td>
</tr>
</tbody>
</table>

Past Experience

These signs seem to be good at reducing drivers’ speeds. Farmer et al (1998) conducted a study in which speed feedback signs were placed at entrances to six cities in England. Speeds at the signs were examined at 1, 6, and 12 months. At each of these times a mean reduction of 4.3 miles per hour was sustained. Another study used the signs in transition zones and observed an average reduction of 6 mph both at the sign and downstream (Donnel and Cruzado 2008). Finally, Sandberg et al. (undated) conducted a survey looking at 4 sites and found a 6.9 mph speed reduction over the 12 months of their placement. Each of these studies seems to show the effectiveness of speed feedback signs.

Safety and Costs

It can be assumed that with such a decrease in speeds, the speed feedback signs have improved safety as well.

The cost of this treatment is average. Since it is electronic and needs a power
source, electricity will be a maintenance cost. Similarly, if the area in which the sign is being installed does not have electricity it will be even more expensive to get electricity to that spot. Another option is using solar panels, but those can be costly as well. Though there are these costs, they are not outrageous and well worth the benefit of the sign.

**Engineering Evaluation**

The speed feedback signs themselves are usually found alone but can be combined with other transition zone treatments as well.

**References**


**SRT: Speed Activated Speed Limit Sign**

**Basic Concepts**

Speed activated speed limit signs are similar to feedback signs but instead display “slow down” to speeding motorists instead of the motorists’ speed itself. These can often have high cost and are best implemented in an area with access to electricity for power supply. These too can often increase attention to speed in an area.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Significant speed reductions were found</td>
<td>• Signs can be costly in areas with no current power supply</td>
</tr>
</tbody>
</table>

**Past Experience**

This treatment has mainly been used in Europe and Canada but is becoming more common in the U.S. One study placed these signs in 19 places route and over 10 years noticed a decrease in the number of drivers exceeding the speed limit (Winnett et al. 2002). An 80% change in percent of drivers speeding was observed with these speed-activated speed limit signs, also called vehicle activated signs (VAS).

**Safety and Costs**

A study has documented casualty crash reductions of 34% (plus/minus 8%)
The cost of this technique varies depending on the availability of electricity at the location. Solar power is also an option but can be expensive and subject to theft (Forbes 2011)

**Engineering Evaluation**

Speed-activated speed limit signs are used alone rather than in groups. However, for more of an effect on reducing speed and crashes, this treatment can be combined with others.

**References**


**SRT: Transitional Speed Limits**

**Basic Concepts**

Transitional speed limits are often known as step down speed limits. A middle speed limit (ex. 40) is inserted between a large transition of speed limits (ex. 50 to 30). Not much effect has been reported for the middle sign but they are one of the least expensive measures since they often only require the placement of one more sign. So this is a good treatment for a town to try if they have a very low budget.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Low cost</td>
<td>• Often has little effect on reducing speeds in transition zones</td>
</tr>
<tr>
<td>• Helps slow cars over a longer stretch of road</td>
<td></td>
</tr>
</tbody>
</table>

**Past Experience**

Previous research and evaluation have found the transitional speed limit signs to have little if no effect on reducing speeds. Transitional speed limit signs are generally used if the decrease in speed is 25 mph or greater so that the change is graduated over time and less abrupt. Hildebrand et al. (2004) did a study on these signs at locations in New Brunswick, Canada and found that the signs had no significant impact on reducing mean speed, speed dispersion, or the percent of motorists found speeding.

**Safety and Costs**

Since speed is generally unaffected by these signs, safety is as well. Safety is often increased as speeds are decreased. With speeds remaining the same it is most likely that safety is not impacted as well. The cost of this technique is relatively low. The only cost is usually the addition of the middle speed limit sign.

**Engineering Evaluation**

Though these signs seem to have little effectiveness in reducing motorists’ speeds, they are still more appropriate than sudden speed reductions (Forbes 2011). This measure would probably work best when combined with one or more other
measure in a given transition zone.

References


SRT: Optical Speed Bars

Basic Concepts
Optical speed bars are perpendicular to the lane itself and get closer as the car nears the rural area. This gives the driver the effect that they are speeding up so that they will slow down to feel comfortable. They are relatively cheap to implement but it is projected that there is most likely more maintenance with this treatment. It would be easy to get used to these bars but could really help if the community often received motorists that were not familiar with the area.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cost is relatively low</td>
<td>• Don’t seems as effective long term</td>
</tr>
<tr>
<td>• Drivers discomfort should cause them to slow down as bars get closer</td>
<td>• Require additional maintenance</td>
</tr>
</tbody>
</table>

Past Experience
Previous research and evaluation of sites where this element was used have shown mixed results regarding its effectiveness. Arnold and Lantz (2008) tested these speed bars in rural villages and found a 3 to 9.5 mph reduction in 85th percentile speeds over 90 days at the two sites. Another study tested the optical speed bars at 5 locations and found that only 2 of them had statistically significant differences in speeds before and after the bars’ placement (Russell and Godavarthy 2010). These two did experience reduction in speed but only slightly. Finally, a study conducted by Fitch and Crum (2007), in four towns in Vermont, found only a 1 mph reduction in 85th percentile speed. Another interesting finding in their study was that the bars had a stronger effect on drivers who were exposed to the treatment on a daily basis. Though some results show little to no significant difference in speeds with the optical speed bars, others show positive results with this treatment.

**Safety and Costs**

A study conducted by Wheeler and Taylor (2000) determined that speed reduction is related to injury crash reduction. Since speeds are somewhat being reduced with optical speed bars, it is most likely that severe crashes are as well.

The cost of this technique is relatively low since the speed bars are simply marked on the road. However, since they are perpendicular to the lane itself, cars drive over them more often than other types of roadway markings. This could cause them to fade much quicker, needing to be repainted more often. Though little, this could increase the maintenance cost.

**Engineering Evaluation**

Speed bars can either be placed equidistant along a route to warn of the build up area and the need to slow down or they can gradually grow closer, making the driver feel as if they are speeding up in which case they will react by slowing down.

**References**


SRT: Removal of Pavement Markings

Basic Concepts

The removal of pavement markings is where lane dividing-lines are removed to create discomfort for motorists. Usually used in the UK and creates reduction in speed but can also increase crash potential. This measure would probably be best in an area where motorists fly through because they know the area so well. By switching things up and taking out marking they would have to slow down to navigate the area.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| • Driver slows down to navigate area due to discomfort of not knowing what to do | • Could cause confusion for motorists  
• Increase accident potential in some communities |

Past Experience

Quimby and Castle (2006) have conducted many studies relating to the removal of pavement markings. Two of their cases are most relatable to transition zones. In these two cases the centerline was removed for the given corridor of the road. In one village a 5 mph reduction was reported in speed and in the other a 7 mph speed reduction was reported.

Safety and Costs

The studies conducted by Quimby and Castle (2006) further show that the removal of pavement markings could increase safety. In one of the towns where directional dividing lines were removed a 35% decrease in crashes was reported. In another village, the 5 years prior to the treatment, there was 1 fatal crash, 7 injury
crashes, and 24 property damage crashes reported for the corridor. In the 3 years following the treatment only 1 injury crash and 5 property damage crashes were reported. In the correct circumstance it seems that this treatment would be beneficial to safety.

The cost of this technique is relatively low but directly proportional to the amount of striping that is removed since this is the main and often only cost.

**Engineering Evaluation**

Typically the centerline is the main pavement marking removed. Other markings that are often removed include markings dividing lanes, signs, directional arrows, and separation between modes of transport (Quimby and Castle 2006).

**References**

**SRT: Speed Humps/ Raised Crosswalks**

**Basic Concepts**

Speed humps, raised crosswalks, raised intersections, and vertical deflections cause discomfort to the driver and passengers when crossed too quickly. They may be difficult to use in transition zones, especially if speed is still relatively high. They could also cause serious crashes if struck too hard by the motorists. Therefore, these would be best implemented in transition zones where the speed is already reasonably low. Finally, by using speed humps in succession, motorists will be forced to slow throughout the whole area rather than in just one place.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Rarely cause multi-vehicle accidents</td>
<td>• Can cause single vehicle accidents if there is not sufficient warning</td>
</tr>
<tr>
<td>• Slow cars down tremendously while passing</td>
<td></td>
</tr>
</tbody>
</table>

**Past Experience**

Vertical deflections are widely used but not as common in transition zones. A study by Charlton and Baas (2006) reported that speed humps could reduce speeds in transition zones by 21% and that speed cushions could reduce speeds in transition zones by 9%. They also mention that these vertical deflections are more suitable for low speed corridors (<20 mph).

**Safety and Costs**

Though a reduction in speed can increase safety, vertical deflections can be hazardous to cars traveling too fast. It is important that notice is given to motorists before they reach the vertical deflection and that they are only implemented in areas with low speed limits. If vertical deflections are struck too fast by motorists they can
loose control of their vehicle or damage their vehicle (Forbes 2011).

The cost of this technique is about average but depends on the type of vertical deflection installed. The main cost is installation of the speed hump or raised area and is proportional to its size.

**Engineering Evaluation**

It is important that vertical deflections are used only in areas where speeds are below 20 mph. Many states agree that this treatment is inappropriate for transition zones unless placed downstream at the end of the zone (Forbes 2011).

**References**


**SRT: Rumblewave Surface**

**Basic Concepts**

Rumblewave surface is a wave surface with crest to sag difference of about 7 mm and distance between crests of about .35 meters. These are not large waves but enough to cause discomfort on the road. Because the surface would be hard to plow in ice and snow, this treatment is best for warmer climate regions. This is not a cheap treatment and can become more expensive in maintenance since there is much wear on the road.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Average speeds are usually reduced as drivers handle the uncomfortable terrain</td>
<td>- Cost can be high to construct and maintain</td>
</tr>
<tr>
<td></td>
<td>- Can be a winter weather hazard</td>
</tr>
</tbody>
</table>

**Past Experience**

The Department for Transport (2006) in the United Kingdom conducted a study that looked at 7 locations in which rumblewave surfaces were installed, including one in a transition zone. The lowest speed reduction of these 7 locations was 1% and the highest was 6%. The average speed reduction observed was about 4%.

**Safety and Costs**

The Department for Transport (2005) also obtained crash data for 6 of their 7 sites. At these 6 locations, casualty crashes were reduced between 24% and 100% with an average of 55%. However, since 3 of the 6 were having high crash rate problems prior to the treatment, 55% is quite optimistic for the reduction of casualty crash rates at future locations.

The cost of this technique is often relatively high. Though the installation of the rumblewave surface is not that high for a treatment, maintenance cost can be. They will need special treatment in winter weather conditions and long term effects are still unknown.

**Engineering Evaluation**
Wave Length: .35 meters
Amplitude: 7 millimeters
Profile: Sinusoidal

References

**SRT: Gateways**

**Basic Concepts**

Gateways are placed at the side of the road to indicate things are changing. They are better in areas where the change in speed is less than 20 mph. They may not be that effective but are good for communities wanting to driver to acknowledge they are entering a new area/town hoping their change in speed matches.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Shows change in surrounding area and hopefully driver will notice this and change their driving as well</td>
<td></td>
</tr>
<tr>
<td>• Do not have to be high cost</td>
<td>• Could become a roadside hazard for single vehicle crashes.</td>
</tr>
</tbody>
</table>

**Past Experience**

This treatment looks at elements placed to visually cue the driver that their surrounding is changing. A study by Herrstedt et al (1993) found an 11% reduction in mean speed and a 15% reduction in percent of drivers going over 5mph over the speed limit after gateways were installed. County Surveyor’s Society (1994) also looked at the use of gateways and found little reduction in speed when the gateways
were used alone. However, when used with other treatments the gateways showed significant reductions in speeds. In these types of cases it is often hard to tell if the studied element, gateway, had any effect on the total speed reduction. This same problem was found in another study that found reductions in speed but since many measures, including gateways, were applied, the effect of single measures was unknown (Abate et al 2009). A study by Charlton and Baas (2006) had similar findings. Although they found gateways reduced speeds between 2 and 3 mph at their locations, the speed reduction was always decreased when the gateway was combined with other measures. There have also been studies conducted that look at gateways alone. Kennedy et al (2005) implemented gateway monuments with the name of the town on each. This study found that mean speeds were reduced 4 to 8 mph. Another study conducted in a similar manner found a 6.9 to 10.6 mph reduction in speed (Lamberti et al 2009). Finally, a study conducted by Alley (2000) discovered two other interesting things about gateways. First, the vehicles often did not decrease their speed until after the location of the gateway, and secondly, while a 6.2 mph reduction in speed was detected 6 months after the gateway’s placement only a 3.3 mph reduction was recorded after 12 months indicating a novelty effect of the treatment.

**Safety and Costs**

There are many studies that look at the safety of gateways and not all conclusions necessarily line up. The first study conducted by Wheeler and Taylor (2000) found a crash reduction factor of .55 for fatal crashes and .19 for injury crashes. Their data makes the use of gateways in transition zones seem very safe. On the other hand, Andresson et al (2008) more recently reported much less safe statistics after looking at 251 town gateways. They found a 34% increase in property damage only crashes, a 100% increase in single motor vehicle crashes, a 28% increase in urban area crashes and a 29% decrease in crossing crashes. Though these numbers seem largely negative it should be noted that they were statistically insignificant, meaning the number of crashes was already so small that such a large jump could be cause by 1 or 2 more crashes. Andersson et al (2008) also found that combined visual and physical gateways reduced injury crashes by 28% but increased property damage crashes 36%. Finally, they concluded that gateways are better for transition zones where the speed transition is less than 20 mph. Another study by Veneziano et al (2009) looked at 7 gateways monuments with the city’s name. They
found a reduction in crashes ranging between 2.2% and 32.0% and though there may be other studies that where gateways seem unsafe, they have concluded that they are not detrimental to safety.

The cost of this technique varies depending on the type of gateway built. It should be noted that a study conducted by Lamberti et al (2009) found that high cost gateways were no more efficient than low costing gateways.

**Engineering Evaluation**

Gateways should be placed where they cannot easily be struck by vehicles. In order to be effective, gateways should blend in with their surrounding as to not be conspicuous.

**References**


Wheeler, A.H. and M.C. Taylor, *Changes in Accident Fre- quency Following the Introduction of
**SRT: Optical Lane Narrowing**

**Basic Concepts**

Optical lane narrowing can be created in any number of ways but the goal is to make the driver feel as though the road or lane is narrowing when, in reality, it is not. One way of doing this is with pavement markings such as dragon’s teeth. As shown in the picture on the right, markings that make the lane seem narrower can slow vehicles down. Another way of creating an optical lane narrowing is to increase the vertical height to horizontal width ratio. This can be done by placing objects closer to the road or building taller structures near the road. The height to width ratio effects the visual perception the driver has of the roadway width. This treatment is very similar to roadside vegetation and often overlaps in design and purpose.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pavement markings effect only the side of the road they are implemented on</td>
<td>• Large scale projects can be costly</td>
</tr>
<tr>
<td>• Makes drivers feel the road is narrowing without have to actually narrow the road</td>
<td>• Pavement markings must be maintained since they will probably be driver over often</td>
</tr>
</tbody>
</table>

**Past Experience**

The main treatments for optically narrowing lane widths are dragon’s teeth and landscape or structures close to the road. One study by Abate et al. (2009) showed
successful reduction in operating speeds when using the dragon’s teeth along with other factors such as a gateway. Another study reported a 10% decrease in 85th percentile speeds at the end of the transition zone as a result of dragon’s teeth and roadside trees (Cartier 2009). Though these studies have shown positive effects of dragon’s teeth, Jamson et al. (2008) conducted a study and found that this treatment was much less effective than count down signs or rumble strips. Finally, it should be noted that the Irish have done much with optical lane narrowing in transition zones. Their guidelines rely heavily on this concept and the relationship between the height and width of the roadway elements (Herrstedt et al. 1993). “Optical width” is a powerful visual cue that helps motorists choose an appropriate speed. To slow motorists Herrstedt et al. suggests increasing vertical dimensions along the road, decreasing horizontal dimensions of the road, or doing both.

Safety and Costs

With this treatment’s ability to decrease speeds, it can only be assumed that crash rates are decreased as well. This is a proven relationship that leads to increased safety. Furthermore, though roadside trees and landscaping were thought to be dangerous, these types of crashes account for less than 0.1% of all crashes (Wolf 2010).

The cost of this technique varies depending on the treatment used to achieve it. Dragon’s teeth and pavement markings are going to be relatively inexpensive while the installation of landscape or structures would be much more costly.

Engineering Evaluation

As shown in the picture below, the optical width is a ratio between height and width. With increased height to width ratio, the optical width shrinks. As mentioned, this can be done by increasing roadside heights or decreasing horizontal width.
References

SRT: Roadside Vegetation
Basic Concepts
Roadside vegetation or landscaping such as trees and shrubs can be used as a traffic calming technique in transition zones. The presence of landscaping near the road does two things for drivers entering the area. First it makes the road feel narrower so they will slow down to navigate it. Secondly, it can be used to show a change is occurring. The change in composition of the area surrounding the road shows drivers that the environment is changing so their driving should change too. This effect can be layered as well. As the built-up area is approached the amount,
thickness, or height of the roadside vegetation can increase to decrease speeds.

<table>
<thead>
<tr>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Slow vehicles by decreasing optical</td>
<td>• High cost</td>
</tr>
<tr>
<td>width of roadway</td>
<td>• Create potential for single vehicle</td>
</tr>
<tr>
<td>• Creates environmental change and can</td>
<td>crashes</td>
</tr>
<tr>
<td>be layered as speeds are decreased.</td>
<td></td>
</tr>
</tbody>
</table>

**Past Experience**

For a long time, guidelines prevented the placement of trees and landscaping close to roadways because a clear zone was to be kept. However, as the benefits of this treatment continue to be studied, it has become more accepted and used in areas such as transition zones. Even in non-transition zone areas, such measures have shown a 3% drop in cruising speed (Wolf 2010). A study by Chartier (2009) found that when combined with other treatments such as dragon’s teeth, regularly spaced trees has an effect of reducing 85\textsuperscript{th} percentile speed 10\% and mean speed 7\%. This treatment is very versatile and allows designers to be creative while improving speed reductions and safety.

**Safety and Costs**

In the past, trees have often been seen as a safety hazard, a potential for single vehicle crashes. While this is true, it has been found that only about 0.1\% of crashes have involved trees, with only about a tenth of those being found in more urban areas (Wolf 2010). One study found a 46\% reduction in crash rates once “landscape improvements” were implemented (Mok et al. 2006). A similar study found the installation of trees and landscaping decreased mid-block crashes between 5\%
and 20% (Naderi 2003). So while trees and landscaping are objects that can be struck by motorists, they seem to improve safety much more than hurt it.

This treatment is usually quite costly. Not only must the plants and other landscaping be purchased and installed, it must be maintained: watered, trimmed, etc.

**Engineering Evaluation**

Often landscaping is layered with denser and taller trees and plants located closer to the built up area. Furthermore, the proximity of the treatment to the roadway is also influential over the decrease in drivers’ speeds.

**References**


APPENDIX B:

Treatment Preferences and Proposal
MEMORANDUM

From: Nick Stamatiadis and Adam Kirk
To: SPR 12-431 Study Advisory Committee (SAC)
RE: Summary of rankings and proposed treatments
Date: March 16, 2012

This memo summarizes the treatment scores of the 2/29/12 meeting and proposes potential treatments for evaluation. A short description of the setup and data analysis is also discussed.

Once agreement is reached on the potential treatments, candidate sites will be identified in order to initiate the data collection of the existing conditions and proceed with the development of plans for the installation of the treatments.

Treatment Rankings by Category

The SAC members scored each treatment based on its appropriateness and effectiveness to reduce speeds. Each treatment was considered whether it was appropriate for placement within each of the three zones (awareness, transition and maintenance) as shown in Figure 1. Similarly, each treatment was evaluated for its effectiveness within each zone. The range of scores was between 1 (not appropriate/effective) and 5 (most appropriate/effective). The scores for each zone are summarized in Tables 1 through 3.

![Figure 1: Proposed treatment location diagram](image)
Table 1 Summary of rank-ordered treatment scores for awareness zone

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Applicability</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gateway</td>
<td>4</td>
<td>2.57</td>
</tr>
<tr>
<td>Speed Feedback Sign</td>
<td>3.86</td>
<td>3.43</td>
</tr>
<tr>
<td>Optical Lane Narrowing</td>
<td>3.71</td>
<td>3.14</td>
</tr>
<tr>
<td>Chicanes</td>
<td>3.43</td>
<td>2.86</td>
</tr>
<tr>
<td>Transitional Speed Limit Signs</td>
<td>3.14</td>
<td>2.14</td>
</tr>
<tr>
<td>Roadside Vegetation</td>
<td>3</td>
<td>2.57</td>
</tr>
<tr>
<td>Speed Activated Speed Limit Sign</td>
<td>2.86</td>
<td>2.43</td>
</tr>
<tr>
<td>Optical Speed Bars</td>
<td>2.86</td>
<td>2.33</td>
</tr>
<tr>
<td>Speed Humps/ Raised Crosswalk</td>
<td>2.57</td>
<td>2.43</td>
</tr>
<tr>
<td>Rumblewave</td>
<td>2.29</td>
<td>2</td>
</tr>
<tr>
<td>Countdown Speed Signs</td>
<td>2.14</td>
<td>2</td>
</tr>
<tr>
<td>Roundabout</td>
<td>2</td>
<td>1.71</td>
</tr>
<tr>
<td>Road Diet</td>
<td>2</td>
<td>1.86</td>
</tr>
<tr>
<td>Removal of Pavement Markings</td>
<td>2</td>
<td>1.71</td>
</tr>
<tr>
<td>Road/Lane Narrowing</td>
<td>1.71</td>
<td>1.57</td>
</tr>
<tr>
<td>Central Island/Raised Median</td>
<td>1.43</td>
<td>1.29</td>
</tr>
</tbody>
</table>
Table 2 Summary of rank-ordered treatment scores for transition zone

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Applicability</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Central Island/Raised Median</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>Roundabout</td>
<td>3.86</td>
<td>4.43</td>
</tr>
<tr>
<td>Road Diet</td>
<td>3.86</td>
<td>3.86</td>
</tr>
<tr>
<td>Speed Feedback Sign</td>
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<tr>
<td>Roadside Vegetation</td>
<td>3.57</td>
<td>3.14</td>
</tr>
<tr>
<td>Chicanes</td>
<td>3.43</td>
<td>3</td>
</tr>
<tr>
<td>Gateway</td>
<td>3.43</td>
<td>2.43</td>
</tr>
<tr>
<td>Countdown Speed Signs</td>
<td>3.29</td>
<td>3.43</td>
</tr>
<tr>
<td>Transitional Speed Limit Signs</td>
<td>3.29</td>
<td>2.71</td>
</tr>
<tr>
<td>Rumblewave</td>
<td>2.71</td>
<td>2.86</td>
</tr>
<tr>
<td>Optical Speed Bars</td>
<td>2.57</td>
<td>2.57</td>
</tr>
<tr>
<td>Removal of Pavement Markings</td>
<td>2.29</td>
<td>2</td>
</tr>
</tbody>
</table>
Table 3 Summary of rank-ordered treatment scores for maintenance zone

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Applicability</th>
<th>Effectiveness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Road Diet</td>
<td>4.29</td>
<td>3.71</td>
</tr>
<tr>
<td>Roadside Vegetation</td>
<td>3.43</td>
<td>2.86</td>
</tr>
<tr>
<td>Speed Activated Speed Limit Sign</td>
<td>3.14</td>
<td>2.86</td>
</tr>
<tr>
<td>Roundabout</td>
<td>2.71</td>
<td>2.71</td>
</tr>
<tr>
<td>Transitional Speed Limit Signs</td>
<td>2.71</td>
<td>2.57</td>
</tr>
<tr>
<td>Optical Lane Narrowing</td>
<td>2.71</td>
<td>2.29</td>
</tr>
<tr>
<td>Road/Lane Narrowing</td>
<td>2.57</td>
<td>2.29</td>
</tr>
<tr>
<td>Speed Feedback Sign</td>
<td>2.57</td>
<td>2.43</td>
</tr>
<tr>
<td>Removal of Pavement Markings</td>
<td>2.57</td>
<td>1.86</td>
</tr>
<tr>
<td>Rumblewave</td>
<td>2.57</td>
<td>2.86</td>
</tr>
<tr>
<td>Gateway</td>
<td>2.57</td>
<td>2.00</td>
</tr>
<tr>
<td>Countdown Speed Signs</td>
<td>2.43</td>
<td>2.57</td>
</tr>
<tr>
<td>Speed Humps/ Raised Crosswalk</td>
<td>2.29</td>
<td>2.43</td>
</tr>
<tr>
<td>Central Island/Raised Median</td>
<td>1.29</td>
<td>1.14</td>
</tr>
</tbody>
</table>

The data in these tables indicates that there is a number of treatments with high scores indicating that these treatments are appropriate for use in their specific locations. Table 1 indicates that the most appropriate treatments for the awareness zone are gateways, speed feedback signs and optical lane narrowing. For the transition zone, the highest scores were for central island/raised median, roundabout, road diet, speed feedback sign, and speed humps/raised crosswalk (Table 2). Finally, for the maintenance zone, the highest scores were for road diet, roadside vegetation, and speed activated speed limit sign (Table 3).

The costs of treatments should also be considered in the selection process as well as the potential for retrofitting particular sites. For example, roundabouts could be considered either at sites with adequate right of way or at new construction where their design could be incorporated. However, they cannot be easily placed or removed for testing as part of this project.

Vertical elements such as speed humps and the rumblewave may also present maintenance issues such as snow removal and may contribute to potential safety hazards on high speed approaches if not recognized by approaching drivers prior to arrival at the treatment.
The selected treatments with high scores can be categorized in three broad groups: physical, signs, and markings. The treatments included in the first category are median, lane/road narrowing, and roundabout. The treatments in the signs category include speed feedback, and transitional speed limit. Treatments included in the markings category are optical speed bars, optical lane narrowing, and rumble strips.

The following section presents a proposed plan for treatments to be evaluated to test for their effectiveness and usage.

**Suggested Treatments**
It was determined that certain treatments could be combined, including awareness, transition and maintenance treatments in a single application to test for their effectiveness. This approach was considered more appropriate than testing only individual treatments, since basic understanding of the effectiveness of several individual treatments is available in the literature. Moreover, it was deemed appropriate to identify a basic set of treatments that could be used as the foundation for widespread application at transition zones and identify additional treatments that could be used to address problem areas with safety or operational problems resulting from high speed transitions.

For each of the proposed evaluation treatments presented below, a schematic diagram of the site has been developed and shown along with a brief description of the treatment.

1. Transitional speed limit signs (T1): A set of four signs will be placed for this treatment (Figure 2). A W3-5 (45 mph speed limit with arrow) will be placed in the awareness zone, followed with a 45 mph speed limit and another W3-5 (with 35 mph speed limit sign on it) in the transition zone. The 35 mph speed limit will be placed in the maintenance zone.

![Figure 2 Treatment 1 diagram](image)

2. Transitional speed limit signs-Active (T2): This is similar to the previous design with the exception that a speed limit feedback sign will be placed with the 45 mph speed limit (Figure 3).
Figure 3 Treatment 2 diagram

3. Transitional speed limit signs (T3): A set of three signs will be placed in this setup. A W3-5 will be placed in the awareness zone with a 35 mph speed limit sign, followed by the same sign in the transition zone and the actual speed limit sign in the maintenance zone (Figure 4).

Figure 4 Treatment 3 diagram

4. Transitional speed limit signs-Active (T4): This is similar to setup with the three signs (treatment 3) with the addition of the speed limit feedback sign with the 35 mph speed limit in the maintenance zone (Figure 5).
5. Median (T5): The setup will introduce a median in the inbound direction through lane-shifting (Figure 6). An R4-7 (Keep Right) sign will be placed in the awareness zone with a W3-5 speed reduction warning sign. The median will be placed within the transition zone. A 35 mph speed limit sign will be placed at the maintenance zone.

6. Lane narrowing (T6): The setup will reduce the lane width in the inbound direction through shifting the shoulder (Figure 7). A W5-1 (road narrows) sign will be placed in the awareness zone with a W3-5 speed reduction warning sign. The lane narrowing will be placed in the transition zone. A 35 mph speed limit sign will be placed in the maintenance zone.
7. Optical speed bars (T7): A set of transverse bars will be placed on the pavement to alert the driver of approaching speed changes (T6). A W3-5 with 35 mph speed limit sign will be placed in the awareness zone followed by a series of transverse lines only in the inbound direction to be placed in the transition zone. A 35 mph speed limit will be placed in the maintenance zone.

8. Rumble strips (T9): This is a similar treatment as the one with the optical speed bars (Treatment 8) but this time the bars will be with some height to provide for a tactile feeling to the driver.

9. Pavement message (T9): This treatment will display the word SLOW in white letters in red background to indicate the anticipated speed reduction (Figure 9). A W3-5 with 35 mph speed limit sign will be placed in the awareness zone followed by the pavement message only in the inbound direction to be placed in the transition zone. A 35 mph speed limit will be placed in the maintenance zone.
10. Median with Signs (T10): This combines treatments T5 (median) and T1 (transitional speed limit signs). The setup will be as described in T5 and the signs will be added to the corresponding locations (Figure 10). Specifically, a W3-5 with 45 mph speed limit will be placed in the awareness zone, followed with the 45 mph speed limit and W3-5 with 35 mph speed limit signs in the transition zone. The median will be in the inbound direction also in the transition zone and the 35 mph speed limit will be placed in the maintenance zone.

11. Lane narrowing with Signs (T11): This combines treatments T6 (lane narrowing) and T1 (transitional speed limit signs). The setup will be as described in T6 and the signs will be added to the corresponding locations (Figure 11). Specifically, a W3-5 with 45 mph speed limit will be placed in the awareness zone, followed with the 45 mph speed limit and W3-5 with 35 mph speed limit signs in the transition zone. The lane narrowing will be in the inbound direction in the transition zone and the 35 mph speed limit will be placed in the maintenance zone.
12. Optical speed bars with Signs (T12): This combines treatments T7 (speed bars) and T1 (transitional speed limit signs). The setup will be as described in T7 and the signs will be added to the corresponding locations (Figure 12). Specifically, a W3-5 with 45 mph speed limit will be placed in the awareness zone, followed with the 45 mph speed limit and W3-5 with 35 mph speed limit in the transition zone. The transverse bars will be in the inbound direction in the transition zone and the 35 mph speed limit will be placed in the maintenance zone.

13. Rumble strips with Signs (T13): This combines treatments T8 (rumble strips) and T1 (transitional speed limit signs). The setup will be as described in treatment 112 with the exception that the bars will be higher to allow for the tactile feeling to the drivers.

14. Pavement message with Signs (T14): This combines treatments T9 (pavement message) and T1 (transitional speed limit signs). The setup will be as described in T9 and the signs will be added to the corresponding locations (Figure 13). Specifically, a W3-5 with 45 mph speed limit will be placed in the awareness zone, followed with the 45 mph speed limit and W3-5 with 35 mph speed limit signs in the transition zone. The SLOW message will be in the inbound direction in the transition zone and 3 and the 35 mph speed limit will be placed in the maintenance zone.
It is recommended that in cases where combination treatments will be installed, the sign treatments are evaluated initially and then the physical or markings are installed. This will allow for examining both the effect of the signs alone and the effect of the combination.

**Data Collection and Analysis**

For each site, speed data will be collected at five spots. The first will be in advance of any treatments to capture the speeds in the rural setting. The second will be after location 1 to capture the initial reduction of speeds and determine the effectiveness of first treatment. The third and fourth spots will be after locations 2 and 3 to determine the speed reductions within the transition zone. The last spot will be after location 4 to measure the speed upon entering the built-up area and determine the effectiveness of the overall treatment.

The speeds will be measured for existing and newly treated conditions. Automated speed collection devices (HI-STAR) will be utilized to collect the speed data. The collection of speeds throughout the transition zone will allow for following individual vehicles throughout the system and then determining their speed reduction as they progressed through the study area. It is anticipated that all locations will be along a tangent and this criterion will determine the potential for a site to be included in the evaluation. Data reduction software will be used to correctly identify and track individual vehicles through the transition zone.

All treatments will be given a ten-day waiting period before measuring speeds. This waiting period is considered critical to allow local traffic to become familiar with the treatment and in turn, not give false speed-readings due to potential novelty effects. For instance, if a local driver navigates the same road every day, and then sees something different, then this driver is likely to slow down more than usual. If the drivers are given a few days to become familiar with the new situation, the recorded speeds will be more accurate and will allow for a better evaluation of the effectiveness of the treatment.

Data will be collected over a three-day period and additional data will be collected at a later time (most likely 30 to 60 days later) to determine the long term effectiveness of the treatment. This process will be followed for all single treatments unless a combination is placed at a later date. In this case, only the long term effectiveness of the combination will be evaluated.
To test for differences among various treatments and determine which treatment has the potential for a greater speed reduction, a series of statistical tests will be used. The general null hypothesis is that no treatment has any effect on the speed reduction. To test this, two different tests will be employed. The first will test for differences in average speeds, and the second examines the variances of the speed distributions. The test for the average speeds allows for simple comparisons between averages and identifies whether a treatment affected the average speeds. This is achieved with a z-test. Similarly, the 85th percentile speeds will be tested to determine any treatment effects. In addition, speeds exceeding the 85th percentile speeds will be examined to determine the potential of the treatment to affect drivers with excessive speeds. The second test will examine whether the treatments have impacted the distribution of the speeds by forcing more drivers to drive at similar speeds, i.e. reducing the variance among speeds.
APPENDIX C:

Speed Summary Reports from MCReport, Pre-Matching
**Bowling Green**
**35 MPH**
**Pre-Treatment**

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-70 -- English (ENU)**

**Datasets:**
- **Site:** [BG1] BG transition zone
- **Direction:** 1 - North bound, A hit first. **Lane:** 0
- **Survey Duration:** 0:00 Wednesday, August 08, 2012 => 12:51 Tuesday, August 21, 2012
- **Zone:**
- **File:** BG121Aug2012.EC0 (Plus)
- **Identifier:** EM22T2JJ MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)

**Profile:**
- **Filter time:** 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
- **Included classes:** 2, 3
- **Speed range:** 5 - 100 mph.
- **Direction:** North, East, South, West (bound)
- **Separation:** Greater than 2.00 seconds. - (Headway)
- **Name:** Default Profile
- **Scheme:** Vehicle classification (Scheme F2)
- **Units:** Non metric (ft, mi, ft/s, mph, lb, ton)
- **In profile:** Vehicles = 11367 / 35784 (31.77%)
Speed Statistics

SpeedStat-70

Site: BG1.0.0N
Description: BG transition zone
Filter time: 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
Scheme: Vehicle classification (Scheme F2)
Filter:Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 11367
Posted speed limit = 37 mph, Exceeding = 6103 (53.69%), Mean Exceeding = 40.76 mph
Maximum = 69.6 mph, Minimum = 7.9 mph, Mean = 37.4 mph
85% Speed = 41.8 mph, 95% Speed = 45.0 mph, Median = 37.4 mph
10 mph Pace = 32 - 42, Number in Pace = 8459 (74.42%)
Variance = 23.60, Standard Deviation = 4.86 mph

Speed Bins

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<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<td>20 - 25</td>
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<td>30 - 35</td>
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</table>
Bowling Green
45 MPH
Pre-Treatment

MetroCount Traffic Executive

Speed Statistics

SpeedStat-71 -- English (ENU)

Datasets:
Site: [BG2] BG Transiton Zone
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 0:00 Wednesday, August 08, 2012 => 12:55 Tuesday, August 21, 2012
Zone:
File: BG221Aug2012.EC0 (Plus)
Identifier: EM14Q0S8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: beforeBG
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 12160 / 34990 (34.75%)

Speed Statistics

SpeedStat-71
Site: BG2.0.0N
Description: BG Transiton Zone
Filter time: 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
Scheme: Vehicle classification (Scheme F2)
Filter:Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 12160
Posted speed limit = 37 mph, Exceeding = 11581 (95.24%), Mean Exceeding = 47.84 mph
Maximum = 80.1 mph, Minimum = 9.5 mph, Mean = 46.9 mph
85% Speed = 52.3 mph, 95% Speed = 55.5 mph, Median = 47.2 mph
10 mph Pace = 43 - 53, Number in Pace = 8440 (69.41%)
Variance = 40.54, Standard Deviation = 6.37 mph

Speed Bins

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<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
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97
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<th>12160 100.0%</th>
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<td>11993 98.6%</td>
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<td>25 - 30</td>
<td>144 1.2%</td>
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Bowling Green
Free Flow
Pre-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-72 -- English (ENU)**

**Datasets:**
- **Site:** [BG3] BG Transiton Zone
- **Direction:** 2 - East bound, A hit first. **Lane:** 1
- **Survey Duration:** 0:00 Wednesday, August 08, 2012 => 13:00 Tuesday, August 21, 2012
- **Zone:**
- **File:** BG321Aug2012.EC1 (Plus)
- **Identifier:** EM150YS5 MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)

**Profile:**
- **Filter time:** 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
- **Included classes:** 2, 3
- **Speed range:** 5 - 100 mph.
- **Direction:** North, East, South, West (bound)
- **Separation:** Greater than 2.00 seconds. - (Headway)
- **Name:** beforeBG
- **Scheme:** Vehicle classification (Scheme F2)
- **Units:** Non metric (ft, mi, ft/s, mph, lb, ton)
- **In profile:** Vehicles = 12154 / 34855 (34.87%)
Speed Statistics

Site: BG3.1.0E
Description: BG Transition Zone
Filter time: 0:00 Sunday, August 12, 2012 => 0:00 Thursday, August 16, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 12154
Posted speed limit = 37 mph, Exceeding = 12006 (98.78%), Mean Exceeding = 53.05 mph
Maximum = 86.5 mph, Minimum = 8.4 mph, Mean = 52.8 mph
85% Speed = 57.5 mph, 95% Speed = 60.2 mph, Median = 53.0 mph
10 mph Pace = 48 - 58, Number in Pace = 9053 (74.49%)
Variance = 29.10, Standard Deviation = 5.39 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
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<td>0.0%</td>
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<td>0.0%</td>
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</tr>
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</table>

Bowling Green
Free Flow
Post-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-69 -- English (ENU)**

**Datasets:**
- **Site:** [ONE] ONE
- **Direction:** 1 - North bound, A hit first. **Lane:** 0
- **Survey Duration:** 0:00 Friday, September 07, 2012 => 14:58 Tuesday, October 09, 2012
- **Zone:**
- **File:** 55BGafter.EC0 (Plus)
- **Identifier:** EM22T2JJ MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 0:00 Sunday, September 30, 2012 => 0:00 Thursday, October 04, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: afterBG
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 12961 / 126535 (10.24%)

Speed Statistics

SpeedStat-69
Site: ONE.0.0N
Description: ONE
Filter time: 0:00 Sunday, September 30, 2012 => 0:00 Thursday, October 04, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 12961
Posted speed limit = 37 mph, Exceeding = 12749 (98.36%), Mean Exceeding = 50.83 mph
Maximum = 78.7 mph, Minimum = 8.7 mph, Mean = 50.5 mph
85% Speed = 55.5 mph, 95% Speed = 58.2 mph, Median = 50.8 mph
10 mph Pace = 46 - 56, Number in Pace = 9234 (71.24%)
Variance = 29.89, Standard Deviation = 5.47 mph

Speed Bins

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<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<td>Total</td>
<td>Count</td>
<td>Percentage</td>
<td>Total</td>
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<td>------------</td>
<td>-------</td>
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<td>0.1%</td>
<td>12947</td>
<td>99.9%</td>
</tr>
<tr>
<td>10.00 - 15</td>
<td>11</td>
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<td>12936</td>
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<td>20.00 - 25</td>
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<td>17.6%</td>
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<td>319</td>
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<td>0.0%</td>
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<td>0.0%</td>
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<td>0.0%</td>
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<td>12961</td>
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<td>0.0%</td>
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<tr>
<td>95.00 - 100</td>
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<td>12961</td>
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</tr>
</tbody>
</table>
# MetroCount Traffic Executive

## Speed Statistics

### SpeedStat-68 -- English (ENU)

**Datasets:**

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<th>Site:</th>
<th>[EM17] EM17</th>
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<tbody>
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<td>1 - North bound, A hit first. <strong>Lane:</strong> 0</td>
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<td>Survey Duration:</td>
<td>13:00 Tuesday, September 25, 2012 =&gt; 14:43 Tuesday, October 09, 2012</td>
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<td>File:</td>
<td>45BGafter.EC0 (Plus)</td>
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<tr>
<td>Identifier:</td>
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<tr>
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<tr>
<td>Data type:</td>
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</tbody>
</table>

**Profile:**

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<tbody>
<tr>
<td>Included classes:</td>
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<td>Speed range:</td>
<td>5 - 100 mph.</td>
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<tr>
<td>Direction:</td>
<td>North, East, South, West (bound)</td>
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<tr>
<td>Separation:</td>
<td>Greater than 2.00 seconds. - (Headway)</td>
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<tr>
<td>Name:</td>
<td>afterBG</td>
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<tr>
<td>Scheme:</td>
<td>Vehicle classification (Scheme F2)</td>
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<tr>
<td>Units:</td>
<td>Non metric (ft, mi, ft/s, mph, lb, ton)</td>
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<tr>
<td>In profile:</td>
<td>Vehicles = 11069 / 39940 (27.71%)</td>
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Speed Statistics

SpeedStat-68
Site: EM17.0.0N
Description: EM17
Filter time: 0:00 Sunday, September 30, 2012 => 0:00 Thursday, October 04, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 11069
Posted speed limit = 37 mph, Exceeding = 10615 (95.90%), Mean Exceeding = 50.01 mph
Maximum = 85.6 mph, Minimum = 12.4 mph, Mean = 49.1 mph
85% Speed = 55.5 mph, 95% Speed = 59.7 mph, Median = 49.2 mph
10 mph Pace = 45 - 55, Number in Pace = 6856 (61.94%)
Variance = 52.99, Standard Deviation = 7.28 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<td>* vMult</td>
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<td>0  0.0%</td>
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<tr>
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<td>5 -  10</td>
<td>0  0.0%</td>
<td>0  0.0%</td>
<td>11069 100.0%</td>
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<td>50 - 55</td>
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<tr>
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</tbody>
</table>

Bowling Green
35 MPH
Post-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-67 -- English (ENU)**

**Datasets:**

- **Site:** [EM16] EM16
- **Direction:** 1 - North bound, A hit first. **Lane:** 0
- **Survey Duration:** 0:00 Wednesday, September 26, 2012 => 14:37 Tuesday, October 09, 2012
- **Zone:**
- **File:** 35BGafter.EC0 (Plus)
- **Identifier:** EM165Z38 MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)
Profile:
Filter time: 0:00 Sunday, September 30, 2012 => 0:00 Thursday, October 04, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: afterBG
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 11162 / 67704 (16.49%)

Speed Statistics

SpeedStat-67
Site: EM16.0.0N
Description: EM16
Filter time: 0:00 Sunday, September 30, 2012 => 0:00 Thursday, October 04, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 11162
Posted speed limit = 37 mph, Exceeding = 6642 (59.51%), Mean Exceeding = 40.83 mph
Maximum = 77.7 mph, Minimum = 8.9 mph, Mean = 37.6 mph
85% Speed = 42.3 mph, 95% Speed = 45.2 mph, Median = 37.8 mph
10 mph Pace = 33 - 43, Number in Pace = 8296 (74.32%)
Variance = 27.30, Standard Deviation = 5.23 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
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<tbody>
<tr>
<td>0 - 5</td>
<td>0.0%</td>
<td>0.0%</td>
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<td>100.0%</td>
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</tr>
<tr>
<td>5 - 10</td>
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</tr>
<tr>
<td>0.00</td>
<td>10 - 15</td>
<td>27 0.2%</td>
<td>31 0.3%</td>
<td>11131 99.7%</td>
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</tr>
<tr>
<td>0.00</td>
<td>15 - 20</td>
<td>39 0.3%</td>
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<td>11092 99.4%</td>
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<tr>
<td>0.00</td>
<td>20 - 25</td>
<td>202 1.8%</td>
<td>272 2.4%</td>
<td>10890 97.6%</td>
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<tr>
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<tr>
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<tr>
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<td>40 - 45</td>
<td>2874 25.7%</td>
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<td>45 - 50</td>
<td>543 4.9%</td>
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<td>60 - 65</td>
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<td>1 0.0%</td>
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<td>65 - 70</td>
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<tr>
<td>0.00</td>
<td>75 - 80</td>
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<td>11162 100.0%</td>
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</tbody>
</table>

Brownsville
Free Flow
Pre-Treatment
MetroCount Traffic Executive

Speed Statistics

SpeedStat-89 -- English (ENU)

Datasets:

Site: [Brownsville 3] Brownsville Transition Zone
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 0:00 Wednesday, August 08, 2012 => 12:34 Thursday, August 16, 2012
Zone:
File: Brownsville 316Aug2012.EC0 (Plus)
Identifier: EM165Z38 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 0:00 Friday, August 10, 2012 => 0:00 Tuesday, August 14, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: beforeB
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 7099 / 24998 (28.40%)
**Speed Statistics**

**SpeedStat-89**

**Site:** Brownsville 3.0.0N

**Description:** Brownsville Transition Zone

**Filter time:** 0:00 Friday, August 10, 2012 => 0:00 Tuesday, August 14, 2012

**Scheme:** Vehicle classification (Scheme F2)

**Filter:** Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

**Vehicles = 7099**

**Posted speed limit** = 37 mph, **Exceeding** = 7081 (99.75%), **Mean Exceeding** = 53.90 mph

**Maximum** = 96.8 mph, **Minimum** = 18.5 mph, **Mean** = 53.8 mph

**85% Speed** = 58.2 mph, **95% Speed** = 61.3 mph, **Median** = 53.9 mph

**10 mph Pace** = 49 - 59, **Number in Pace** = 5366 (75.59%)

**Variance** = 23.26, **Standard Deviation** = 4.82 mph

**Speed Bins**

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<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<tr>
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</tbody>
</table>

Brownsville
45 MPH
Pre-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-88 -- English (ENU)**

**Datasets:**
- **Site:** [Brownsville 2] Brownsville Transtion Zone
- **Direction:** 1 - North bound, A hit first. Lane: 0
- **Survey Duration:** 0:00 Wednesday, August 08, 2012 => 12:48 Thursday, August 16, 2012
- **Zone:**
- **File:** Brownsville 216Aug2012.EC0 (Plus)
- **Identifier:** EM1387GA MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 0:00 Friday, August 10, 2012 => 0:00 Tuesday, August 14, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: beforeB
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 8001 / 23277 (34.37%)

Speed Statistics

SpeedStat-88
Site: Brownsville 2.0.0N
Description: Brownsville Transition Zone
Filter time: 0:00 Friday, August 10, 2012 => 0:00 Tuesday, August 14, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8001
Posted speed limit = 37 mph, Exceeding = 7909 (98.85%), Mean Exceeding = 50.27 mph
Maximum = 79.5 mph, Minimum = 14.3 mph, Mean = 50.1 mph
85% Speed = 55.9 mph, 95% Speed = 59.7 mph, Median = 49.9 mph
10 mph Pace = 44 - 54, Number in Pace = 4892 (61.14%)
Variance = 35.35, Standard Deviation = 5.95 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<td>0.0%</td>
<td>8001 100.0%</td>
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<td>10 Min</td>
<td>20 Min</td>
<td>25 Min</td>
<td>30 Min</td>
<td>35 Min</td>
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Brownsville
35 MPH
Pre-Treatment

**MetroCount Traffic Executive**
Speed Statistics

Site: [Brownsville 1] Brownsville Transition Zone
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 0:00 Wednesday, August 08, 2012 => 12:56 Thursday, August 16, 2012
Zone:
File: Brownsville 116Aug2012.EC0 (Plus)
Identifier: EM17W5KT MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)
Profile:
Filter time: 0:00 Friday, August 10, 2012 => 0:00 Tuesday, August 14, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: beforeB
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 8585 / 23747 (36.15%)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8585

Posted speed limit = 37 mph, Exceeding = 6592 (76.79%), Mean Exceeding = 44.09 mph

Maximum = 86.1 mph, Minimum = 9.1 mph, Mean = 41.6 mph

85% Speed = 47.9 mph, 95% Speed = 52.1 mph, Median = 41.4 mph

10 mph Pace = 36 - 46, Number in Pace = 4949 (57.65%)

Variance = 40.41, Standard Deviation = 6.36 mph

### Speed Bins

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<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
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Brownsville
Free Flow
Post-Treatment

MetroCount Traffic Executive

Speed Statistics

SpeedStat-86 -- English (ENU)

Datasets:

Site: [TWO] TWO
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 0:00 Friday, September 07, 2012 => 14:48 Tuesday, October 09, 2012
Zone:
File: 55Brownsvilleafter.EC0 (Plus)
Identifier: EM14Q0S8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: afterB
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 7619 / 44947 (16.95%)

**Speed Statistics**

**SpeedStat-86**

Site: TWO.0.0N
Description: TWO
Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 7619
Posted speed limit = 37 mph, Exceeding = 7595 (99.68%), Mean Exceeding = 51.17 mph
Maximum = 83.6 mph, Minimum = 25.8 mph, Mean = 51.1 mph
85% Speed = 55.0 mph, 95% Speed = 57.5 mph, Median = 51.0 mph
10 mph Pace = 46 - 56, Number in Pace = 6173 (81.02%)
Variance = 17.66, Standard Deviation = 4.20 mph

**Speed Bins**

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<th>Above</th>
<th>Energy</th>
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Brownsville
45 MPH
Post-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-85 -- English (ENU)**

**Datasets:**

**Site:** [THREE] THREE

**Direction:** 2 - East bound, A hit first. **Lane:** 1
Survey Duration: 0:00 Wednesday, September 26, 2012 => 14:54 Tuesday, October 09, 2012

Zone: 45Brownsvilleafter.EC1 (Plus)

File: EM150YS5 MC56-L5 [MC55] (c)Microcom 19Oct04

Identifier: Factory default (v3.21 - 15315)

Algorithm: Axle sensors - Paired (Class/Speed/Count)

Profile:

Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012

Included classes: 2, 3

Speed range: 5 - 100 mph.

Direction: North, East, South, West (bound)

Separation: Greater than 2.00 seconds. - (Headway)

Name: afterB

Scheme: Vehicle classification (Scheme F2)

Units: Non metric (ft, mi, ft/s, mph, lb, ton)

In profile: Vehicles = 7823 / 33762 (23.17%)
Speed Statistics

SpeedStat-85

Site: THREE.1.0E

Description: THREE

Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012

Scheme: Vehicle classification (Scheme F2)

Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 7823

Posted speed limit = 37 mph, Exceeding = 7682 (98.20%), Mean Exceeding = 48.60 mph

Maximum = 92.8 mph, Minimum = 17.6 mph, Mean = 48.3 mph

85% Speed = 53.9 mph, 95% Speed = 57.7 mph, Median = 48.1 mph

10 mph Pace = 43 - 53, Number in Pace = 4887 (62.47%)

Variance = 33.78, Standard Deviation = 5.81 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
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120
Brownsville
35 MPH
Post-Treatment

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-84 -- English (ENU)**

**Datasets:**

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<td>Zone:</td>
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<td>File:</td>
<td>35brownsvilleafter.EC0 (Plus)</td>
</tr>
<tr>
<td>Identifier:</td>
<td>EM1387GA MC56-L5 [MC55] (c)Microcom 19Oct04</td>
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<tr>
<td>Algorithm:</td>
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<td>Data type:</td>
<td>Axle sensors - Paired (Class/Speed/Count)</td>
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</tbody>
</table>
Profile:
Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: afterB
Scheme: Vehicle classification (Scheme F2)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 8339 / 33634 (24.79%)

Speed Statistics

SpeedStat-84
Site: EM13.0.0N
Description: EM13
Filter time: 0:00 Thursday, September 27, 2012 => 0:00 Monday, October 01, 2012
Scheme: Vehicle classification (Scheme F2)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8339
Posted speed limit = 37 mph, Exceeding = 5431 (65.13%), Mean Exceeding = 42.68 mph
Maximum = 69.0 mph, Minimum = 7.7 mph, Mean = 39.4 mph
85% Speed = 45.4 mph, 95% Speed = 48.8 mph, Median = 39.1 mph
10 mph Pace = 34 - 44, Number in Pace = 5051 (60.57%)
Variance = 34.62, Standard Deviation = 5.88 mph

Speed Bins

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>vMult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* vMult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5</td>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>8339</td>
<td>100.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>0.00</td>
<td>5</td>
<td>1.0%</td>
<td>1.0%</td>
<td>8338</td>
<td>100.0%</td>
<td>0.00</td>
</tr>
</tbody>
</table>

122
<table>
<thead>
<tr>
<th>Speed (mph)</th>
<th>Percentage 1</th>
<th>Percentage 2</th>
<th>Average Speed</th>
<th>Average Time</th>
<th>Average Distance</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>55mph Pre-Treatment</td>
<td>MetroCount Traffic Executive</td>
<td>Speed Statistics</td>
<td>123</td>
<td></td>
</tr>
</tbody>
</table>
Datasets:

Site: [KY29_5] KY29_5
Direction: 1 - North bound, A hit first. Lane: 0
Zone: File: KY29_520Jun2013.EC0 (Plus)
Identifier: EM14Q0S8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 310 / 538 (57.62%)
Speed Statistics

SpeedStat-22

Site: KY29_5.0.0N
Description: KY29_5
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 310
Posted speed limit = 55 mph, Exceeding = 278 (89.68%), Mean Exceeding = 44.74 mph
Maximum = 58.1 mph, Minimum = 13.0 mph, Mean = 43.1 mph
85% Speed = 49.0 mph, 95% Speed = 52.8 mph, Median = 43.2 mph
10 mph Pace = 38 - 48, Number in Pace = 212 (68.39%)
Variance = 47.51, Standard Deviation = 6.89 mph

Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>* vMult</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 -  5</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>310 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>310 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>10 - 15</td>
<td>2 0.6%</td>
<td>2 0.6%</td>
<td>308 99.4%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>2 0.6%</td>
<td>4 1.3%</td>
<td>306 98.7%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>20 - 25</td>
<td>8 2.6%</td>
<td>12 3.9%</td>
<td>298 96.1%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>25 - 30</td>
<td>4 1.3%</td>
<td>16 5.2%</td>
<td>294 94.8%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>30 - 35</td>
<td>4 1.3%</td>
<td>20 6.5%</td>
<td>290 93.5%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>35 - 40</td>
<td>46 14.8%</td>
<td>66 21.3%</td>
<td>244 78.7%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>40 - 45</td>
<td>128 41.3%</td>
<td>194 62.6%</td>
<td>116 37.4%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>45 - 50</td>
<td>81 26.1%</td>
<td>275 88.7%</td>
<td>35 11.3%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>Speed Range</td>
<td>Axle Count</td>
<td>Speed Count</td>
<td>Max Speed Count</td>
<td>Mph</td>
<td>Veh Count</td>
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<tr>
<td>-------------</td>
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<td>-------------</td>
<td>----------------</td>
<td>-----</td>
<td>-----------</td>
<td></td>
</tr>
<tr>
<td>50 - 55</td>
<td>29</td>
<td>304</td>
<td>6</td>
<td>1.9%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>55 - 60</td>
<td>6</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>60 - 65</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>65 - 70</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>70 - 75</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>75 - 80</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>80 - 85</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>85 - 90</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>90 - 95</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>310</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

Wilmore
Pre-Treatment, 25mph

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-25 -- English (ENU)**

**Datasets:**
- **Site:** [KY29_4] KY29_4
- **Direction:** 1 - North bound, A hit first. Lane: 0
- **Survey Duration:** 10:38 Monday, May 20, 2013 => 10:27 Tuesday, June 04, 2013
- **Zone:**
- **File:** KY29_419Jun2013.EC0 (Plus)
- **Identifier:** EM17W5KT MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)
Profile:
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 8121 / 10411 (78.00%)

**Speed Statistics**

SpeedStat-25
Site: KY29_4.0.0N
Description: KY29_4
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8121
Posted speed limit = 25 mph, Exceeding = 3102 (38.20%), Mean Exceeding = 41.03 mph
Maximum = 72.2 mph, Minimum = 9.9 mph, Mean = 35.4 mph
85% Speed = 40.9 mph, 95% Speed = 44.5 mph, Median = 35.1 mph
10 mph Pace = 30 - 40, Number in Pace = 5136 (63.24%)
Variance = 33.24, Standard Deviation = 5.77 mph

**Speed Bins (Partial days)**

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>0</td>
<td>0.0%</td>
<td>8121 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td>1</td>
<td>0.0%</td>
<td>8120 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>0.00</td>
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</tr>
<tr>
<td>Speed Range</td>
<td>Total</td>
<td>Speed Percent</td>
<td>Moving Energy Percent</td>
<td>Speed Rating</td>
<td>Moving Energy Rating</td>
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<td>-------------</td>
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<td>---------------</td>
<td>-----------------------</td>
<td>--------------</td>
<td>---------------------</td>
<td></td>
</tr>
<tr>
<td>10 - 15</td>
<td>8</td>
<td>0.1%</td>
<td>8112 99.9%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>35</td>
<td>0.4%</td>
<td>8077 99.5%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>20 - 25</td>
<td>231</td>
<td>2.8%</td>
<td>7846 96.6%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>25 - 30</td>
<td>1102</td>
<td>13.6%</td>
<td>6744 83.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>30 - 35</td>
<td>2491</td>
<td>30.7%</td>
<td>4253 52.4%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>35 - 40</td>
<td>2605</td>
<td>32.1%</td>
<td>1648 20.3%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>40 - 45</td>
<td>1291</td>
<td>15.9%</td>
<td>357 4.4%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>45 - 50</td>
<td>294</td>
<td>3.6%</td>
<td>63 0.8%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>50 - 55</td>
<td>49</td>
<td>0.6%</td>
<td>14 0.2%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>55 - 60</td>
<td>13</td>
<td>0.2%</td>
<td>1 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>60 - 65</td>
<td>0</td>
<td>0.0%</td>
<td>1 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>65 - 70</td>
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<td>0.0%</td>
<td>1 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>70 - 75</td>
<td>1</td>
<td>0.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>75 - 80</td>
<td>0</td>
<td>0.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>80 - 85</td>
<td>0</td>
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<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>85 - 90</td>
<td>0</td>
<td>0.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>90 - 95</td>
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<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>

**Total Speed Rating = 0.00**

**Total Moving Energy (Estimated) = 0.00**

Wilmore

Pre-Treatment, 35mph
MetroCount Traffic Executive
Speed Statistics

SpeedStat-23 -- English (ENU)

Datasets:
Site:       [KY 29_1] VIRGINIA
Direction:  1 - North bound, A hit first. Lane: 1
Zone:
File:       KY 29_119Jun2013.EC1 (Plus)
Identifier: EM150YS5 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm:  Factory default (v3.21 - 15315)
Data type:  Axle sensors - Paired (Class/Speed/Count)

Profile:
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 8959 / 11499 (77.91%)

Speed Statistics

SpeedStat-23
Site:       KY 29_1.1.0N
Description: VIRGINIA
Scheme: Vehicle classification (ARX)
**Filter:**  
Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8959  
**Posted speed limit** = 35 mph, Exceeding = 5636 (62.91%), Mean Exceeding = 42.56 mph  
**Maximum** = 76.2 mph, **Minimum** = 9.3 mph, **Mean** = 38.9 mph  
85% Speed = 45.0 mph, 95% Speed = 48.5 mph, **Median** = 38.9 mph  
10 mph Pace = 34 - 44, **Number in Pace** = 5353 (59.75%)  
**Variance** = 38.03, **Standard Deviation** = 6.17 mph

### Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>* vMult</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 -  5</td>
<td>0  0.0%</td>
<td>0  0.0%</td>
<td>8959 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td>1  0.0%</td>
<td>1  0.0%</td>
<td>8958 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>10 - 15</td>
<td>10 0.1%</td>
<td>11 0.1%</td>
<td>8948 99.9%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>15 - 20</td>
<td>23 0.3%</td>
<td>34 0.4%</td>
<td>8925 99.6%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>20 - 25</td>
<td>86 1.0%</td>
<td>120 1.3%</td>
<td>8839 98.7%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>25 - 30</td>
<td>467 5.2%</td>
<td>587 6.6%</td>
<td>8372 93.4%</td>
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<td>0.00</td>
<td></td>
</tr>
<tr>
<td>30 - 35</td>
<td>1772 19.8%</td>
<td>2359 26.3%</td>
<td>6600 73.7%</td>
<td>0.00</td>
<td>0.00</td>
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</tr>
<tr>
<td>35 - 40</td>
<td>2694 30.1%</td>
<td>5053 56.4%</td>
<td>3906 43.6%</td>
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<td>0.00</td>
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</tr>
<tr>
<td>40 - 45</td>
<td>2548 28.4%</td>
<td>7601 84.8%</td>
<td>1358 15.2%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>45 - 50</td>
<td>1072 12.0%</td>
<td>8673 96.8%</td>
<td>286 3.2%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>50 - 55</td>
<td>243 2.7%</td>
<td>8916 99.5%</td>
<td>43 0.5%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>55 - 60</td>
<td>27 0.3%</td>
<td>8943 99.8%</td>
<td>16 0.2%</td>
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<td>0.00</td>
<td></td>
</tr>
<tr>
<td>60 - 65</td>
<td>11 0.1%</td>
<td>8954 99.9%</td>
<td>5 0.1%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>65 - 70</td>
<td>4 0.0%</td>
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<td>1 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>70 - 75</td>
<td>0 0.0%</td>
<td>8958 100.0%</td>
<td>1 0.0%</td>
<td>0.00</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>
Wilmore
Pre-Treatment, 45mph

MetroCount Traffic Executive
Speed Statistics

SpeedStat-24 -- English (ENU)

Datasets:
Site: [KY 29_2] KY29
Direction: 1 - North bound, A hit first. Lane: 0
Zone:
File: KY 29_219Jun2013.EC0 (Plus)
Identifier: EM1387GA MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
**Separation:** Greater than 2.00 seconds. - (Headway)

**Name:** Default Profile

**Scheme:** Vehicle classification (ARX)

**Units:** Non metric (ft, mi, ft/s, mph, lb, ton)

**In profile:** Vehicles = 9852 / 14251 (69.13%)

## Speed Statistics

**SpeedStat-24**

**Site:** KY 29 _2.0.0N

**Description:** KY29

**Filter time:** 10:28 Monday, May 20, 2013 => 10:27 Tuesday, June 04, 2013

**Scheme:** Vehicle classification (ARX)

**Filter:** CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 9852

*Posted speed limit* = 45 mph, *Exceeding* = 6212 (63.05%), *Mean Exceeding* = 41.53 mph

*Maximum* = 60.4 mph, *Minimum* = 5.1 mph, *Mean* = 38.5 mph

85% Speed = 43.4 mph, 95% Speed = 46.8 mph, Median = 38.5 mph

10 mph Pace = 33 - 43, *Number in Pace* = 6987 (70.92%)

**Variance** = 27.98, **Standard Deviation** = 5.29 mph

### Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<td>9852</td>
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<tr>
<td>5 - 10</td>
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<tr>
<td>10 - 15</td>
<td>8</td>
<td>0.1%</td>
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<td>9825</td>
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<td>15 - 20</td>
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<td>47</td>
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132
### Speed Statistics

**Total Speed Rating** = 0.00  
**Total Moving Energy (Estimated)** = 0.00

### Wilmore

**Pre-Treatment, 55mph**

#### MetroCount Traffic Executive

**Speed Statistics**

**Datasets:**  
**Site:** [KY29_5] KY29_5
Direction: 1 - North bound, A hit first. Lane: 0
Zone:
File: KY29_520Jun2013.EC0 (Plus)
Identifier: EM14Q0S8 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Included classes: 2, 3
Speed range: 25 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 298 / 538 (55.39%)

Speed Statistics

SpeedStat-28
Site: KY29_5.0.0N
Description: KY29_5
Scheme: Vehicle classification (ARX)
Filter: Cls(2 3 ) Dir(NESW) Sp(25,100) Headway(>2)

Vehicles = 298
Posted speed limit = 55 mph, Exceeding = 278 (93.29%), Mean Exceeding = 44.74 mph
Maximum = 58.1 mph, Minimum = 25.3 mph, Mean = 44.0 mph
85% Speed = 49.0 mph, 95% Speed = 52.8 mph, Median = 43.6 mph
10 mph Pace = 38 - 48, Number in Pace = 212 (71.14%)
Variance = 25.66, Standard Deviation = 5.07 mph
## Speed Bins (Partial days)

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<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
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<tr>
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<td>298 100.0%</td>
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<td>4 1.3%</td>
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<td>4 1.3%</td>
<td>8 2.7%</td>
<td>290 97.3%</td>
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<td>30 - 35</td>
<td>46 15.4%</td>
<td>54 18.1%</td>
<td>244 81.9%</td>
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<td>182 61.1%</td>
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<td>81 27.2%</td>
<td>263 88.3%</td>
<td>35 11.7%</td>
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<td>298 100.0%</td>
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<td></td>
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</tbody>
</table>
Wilmore Pre-Treatment
Day (7:00-19:00)

25

Vehicles = 7674
Posted speed limit = 37 mph, Exceeding = 2848 (37.11%), Mean Exceeding = 40.91 mph
Maximum = 57.9 mph, Minimum = 5.8 mph, Mean = 35.2 mph
85% Speed = 40.9 mph, 95% Speed = 44.3 mph, Median = 35.1 mph
10 mph Pace = 31 - 41, Number in Pace = 4891 (63.73%)
Variance = 32.99, Standard Deviation = 5.74 mph

35

Vehicles = 6416
Posted speed limit = 37 mph, Exceeding = 4111 (64.07%), Mean Exceeding = 42.54 mph
Maximum = 66.6 mph, Minimum = 9.3 mph, Mean = 39.0 mph
85% Speed = 45.0 mph, 95% Speed = 48.3 mph, Median = 39.1 mph
10 mph Pace = 34 - 44, Number in Pace = 3872 (60.35%)
Variance = 36.81, Standard Deviation = 6.07 mph

45

Vehicles = 6804
Posted speed limit = 37 mph, Exceeding = 4402 (64.70%), Mean Exceeding = 41.45 mph
Maximum = 59.6 mph, Minimum = 5.1 mph, Mean = 38.6 mph
85% Speed = 43.4 mph, 95% Speed = 46.5 mph, Median = 38.7 mph
10 mph Pace = 34 - 44, Number in Pace = 4960 (72.90%)
Variance = 27.67, Standard Deviation = 5.26 mph

55

Vehicles = 309
Posted speed limit = 37 mph, Exceeding = 278 (89.97%), Mean Exceeding = 44.74 mph
Maximum = 58.1 mph, Minimum = 13.0 mph, Mean = 43.2 mph
85% Speed = 49.0 mph, 95% Speed = 52.8 mph, Median = 43.2 mph
10 mph Pace = 38 - 48, Number in Pace = 212 (68.61%)
Variance = 44.83, Standard Deviation = 6.70 mph

Night (19:00-7:00)

25
Vehicles = 2277  
**Posted speed limit** = 37 mph, Exceeding = 828 (36.36%), Mean Exceeding = 41.19 mph  
Maximum = 72.2 mph, Minimum = 16.7 mph, Mean = 35.2 mph  
85% Speed = 40.9 mph, 95% Speed = 44.5 mph, Median = 34.9 mph  
10 mph Pace = 30 - 40, Number in Pace = 1446 (63.50%)  
Variance = 33.77, Standard Deviation = 5.81 mph

35

Vehicles = 6416  
**Posted speed limit** = 37 mph, Exceeding = 4111 (64.07%), Mean Exceeding = 42.54 mph  
Maximum = 66.6 mph, Minimum = 9.3 mph, Mean = 39.0 mph  
85% Speed = 45.0 mph, 95% Speed = 48.3 mph, Median = 39.1 mph  
10 mph Pace = 34 - 44, Number in Pace = 3872 (60.35%)  
Variance = 36.81, Standard Deviation = 6.07 mph

45

Vehicles = 6804  
**Posted speed limit** = 37 mph, Exceeding = 4402 (64.70%), Mean Exceeding = 41.45 mph  
Maximum = 59.6 mph, Minimum = 5.1 mph, Mean = 38.6 mph  
85% Speed = 43.4 mph, 95% Speed = 46.5 mph, Median = 38.7 mph  
10 mph Pace = 34 - 44, Number in Pace = 4960 (72.90%)  
Variance = 27.67, Standard Deviation = 5.26 mph

55

Vehicles = 309  
**Posted speed limit** = 37 mph, Exceeding = 278 (89.97%), Mean Exceeding = 44.74 mph  
Maximum = 58.1 mph, Minimum = 13.0 mph, Mean = 43.2 mph  
85% Speed = 49.0 mph, 95% Speed = 52.8 mph, Median = 43.2 mph  
10 mph Pace = 38 - 48, Number in Pace = 212 (68.61%)  
Variance = 44.83, Standard Deviation = 6.70 mph

Weekdays

25

Vehicles = 5580  
**Posted speed limit** = 37 mph, Exceeding = 2143 (38.41%), Mean Exceeding = 41.02 mph  
Maximum = 72.2 mph, Minimum = 9.9 mph, Mean = 35.4 mph  
85% Speed = 40.9 mph, 95% Speed = 44.5 mph, Median = 35.3 mph  
10 mph Pace = 30 - 40, Number in Pace = 3544 (63.51%)  
Variance = 33.29, Standard Deviation = 5.77 mph

35
Vehicles = 6158
Posted speed limit = 37 mph, Exceeding = 3918 (63.62%), Mean Exceeding = 42.58 mph
Maximum = 67.4 mph, Minimum = 9.3 mph, Mean = 38.9 mph
85% Speed = 45.0 mph, 95% Speed = 48.5 mph, Median = 38.9 mph
10 mph Pace = 34 - 44, Number in Pace = 3698 (60.05%)
Variance = 38.28, Standard Deviation = 6.19 mph

45

Vehicles = 6778
Posted speed limit = 37 mph, Exceeding = 4285 (63.22%), Mean Exceeding = 41.51 mph
Maximum = 60.4 mph, Minimum = 5.7 mph, Mean = 38.5 mph
85% Speed = 43.6 mph, 95% Speed = 46.5 mph, Median = 38.5 mph
10 mph Pace = 34 - 44, Number in Pace = 4819 (71.10%)
Variance = 27.99, Standard Deviation = 5.29 mph

55

Vehicles = 309
Posted speed limit = 37 mph, Exceeding = 278 (89.97%), Mean Exceeding = 44.74 mph
Maximum = 58.1 mph, Minimum = 13.0 mph, Mean = 43.2 mph
85% Speed = 49.0 mph, 95% Speed = 52.8 mph, Median = 43.2 mph
10 mph Pace = 38 - 48, Number in Pace = 212 (68.61%)
Variance = 44.83, Standard Deviation = 6.70 mph

Weekend

25

Vehicles = 2989
Posted speed limit = 37 mph, Exceeding = 1135 (37.97%), Mean Exceeding = 41.04 mph
Maximum = 57.9 mph, Minimum = 14.6 mph, Mean = 35.3 mph
85% Speed = 41.2 mph, 95% Speed = 44.5 mph, Median = 35.1 mph
10 mph Pace = 31 - 41, Number in Pace = 1893 (63.33%)
Variance = 32.90, Standard Deviation = 5.74 mph

35

Vehicles = 3200
Posted speed limit = 37 mph, Exceeding = 2001 (62.53%), Mean Exceeding = 42.59 mph
Maximum = 76.2 mph, Minimum = 12.2 mph, Mean = 38.9 mph
85% Speed = 45.0 mph, 95% Speed = 48.5 mph, Median = 38.9 mph
10 mph Pace = 34 - 44, Number in Pace = 1910 (59.69%)
Variance = 37.75, Standard Deviation = 6.14 mph

45
Vehicles = 3461
Posted speed limit = 37 mph, Exceeding = 2187 (63.19%), Mean Exceeding = 41.56 mph
Maximum = 59.3 mph, Minimum = 5.1 mph, Mean = 38.6 mph
85% Speed = 43.4 mph, 95% Speed = 46.8 mph, Median = 38.5 mph
10 mph Pace = 33 - 43, Number in Pace = 2475 (71.51%)
Variance = 27.50, Standard Deviation = 5.24 mph

55

No Vehicles

Wilmore
Post-Treatment 1, 25mph

MetroCount Traffic Executive

Speed Statistics

SpeedStat-50 -- English (ENU)

Datasets:
Site: [KY29_6] KY29_6
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:20 Friday, July 12, 2013 => 14:29 Wednesday, July 24, 2013
Zone:
File: 2.K29_624Jul2013.EC0 (Plus)
Identifier: EM22T2JJ MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 13:00 Friday, July 19, 2013 => 14:29 Wednesday, July 24, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 7035 / 15726 (44.73%)

Speed Statistics

SpeedStat-50
Site: KY29_6.0.0N
Description: KY29_6
Filter time: 13:00 Friday, July 19, 2013 => 14:29 Wednesday, July 24, 2013
Scheme: Vehicle classification (ARX)
Filter:Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 7035
Posted speed limit = 25 mph, Exceeding = 1318 (18.73%), Mean Exceeding = 39.86 mph
Maximum = 55.0 mph, Minimum = 5.4 mph, Mean = 32.4 mph
85% Speed = 37.6 mph, 95% Speed = 40.7 mph, Median = 32.2 mph
10 mph Pace = 27 - 37, Number in Pace = 4762 (67.69%)
Variance = 26.89, Standard Deviation = 5.19 mph

Speed Bins (Partial days)

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<th>Above</th>
<th>Energy</th>
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<td>5 - 10</td>
<td>5  0.1%</td>
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<td>90 - 95</td>
<td>0</td>
<td>0.0%</td>
<td>7035</td>
<td>100.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>7035</td>
<td>100.0%</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00

Wilmore
Post-Treatment 1, 35mph

MetroCount Traffic Executive
Speed Statistics

SpeedStat-51 -- English (ENU)

Datasets:
Site: [KY29_4] KY29_4
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:16 Friday, July 12, 2013 => 14:27 Wednesday, July 24, 2013
Zone:
File: KY29_424Jul2013.EC0 (Plus)
Identifier: EM17W5KT MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 13:00 Friday, July 19, 2013 => 14:27 Wednesday, July 24, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 7227 / 17049 (42.39%)

**Speed Statistics**

SpeedStat-51
Site: KY29_4.0.0N
Description: KY29_4
Filter time: 13:00 Friday, July 19, 2013 => 14:27 Wednesday, July 24, 2013
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 7227
Posted speed limit = 35 mph, Exceeding = 3880 (53.69%), Mean Exceeding = 41.93 mph
Maximum = 63.5 mph, Minimum = 8.6 mph, Mean = 37.6 mph
85% Speed = 43.4 mph, 95% Speed = 46.8 mph, Median = 37.6 mph
10 mph Pace = 32 - 42, Number in Pace = 4434 (61.35%)
Variance = 35.16, Standard Deviation = 5.93 mph

**Speed Bins (Partial days)**

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
</table>
| * vMult

142
<table>
<thead>
<tr>
<th>Speed Range</th>
<th>Count</th>
<th>Percent</th>
<th>Speed Rating</th>
<th>Moving Energy</th>
<th>Total Speed Rating</th>
<th>Total Moving Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - 5</td>
<td>0</td>
<td>0.0%</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5 - 10</td>
<td>3</td>
<td>0.0%</td>
<td>0.0%</td>
<td>7224 100.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>10 - 15</td>
<td>11</td>
<td>0.2%</td>
<td>14 0.2%</td>
<td>7213 99.8%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>15 - 20</td>
<td>21</td>
<td>0.3%</td>
<td>35 0.5%</td>
<td>7192 99.5%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>20 - 25</td>
<td>103</td>
<td>1.4%</td>
<td>138 1.9%</td>
<td>7089 98.1%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>25 - 30</td>
<td>507</td>
<td>7.0%</td>
<td>645 8.9%</td>
<td>6582 91.1%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>30 - 35</td>
<td>1785</td>
<td>24.7%</td>
<td>2430 33.6%</td>
<td>4797 66.4%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>35 - 40</td>
<td>2306</td>
<td>31.9%</td>
<td>4736 65.5%</td>
<td>2491 34.5%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>40 - 45</td>
<td>1759</td>
<td>24.3%</td>
<td>6495 89.9%</td>
<td>732 10.1%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>45 - 50</td>
<td>624</td>
<td>8.6%</td>
<td>7119 98.5%</td>
<td>108 1.5%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>50 - 55</td>
<td>92</td>
<td>1.3%</td>
<td>7211 99.8%</td>
<td>16 0.2%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>55 - 60</td>
<td>14</td>
<td>0.2%</td>
<td>7225 100.0%</td>
<td>2 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>60 - 65</td>
<td>2</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>65 - 70</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>70 - 75</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>75 - 80</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>80 - 85</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>85 - 90</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>90 - 95</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>7227 100.0%</td>
<td>0 0.0%</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00
Wilmore
Post-Treatment 1, 45mph

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-52 -- English (ENU)**

**Datasets:**
- **Site:** [KY 29_2] KY29
- **Direction:** 1 - North bound, A hit first. **Lane:** 0
- **Survey Duration:** 11:08 Friday, July 12, 2013 => 14:19 Wednesday, July 24, 2013
- **Zone:**
- **File:** KY 29_224Jul2013.EC0 (Plus)
- **Identifier:** EM1387GA MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)

**Profile:**
- **Filter time:** 13:00 Friday, July 19, 2013 => 14:19 Wednesday, July 24, 2013
- **Included classes:** 2, 3
- **Speed range:** 5 - 100 mph.
- **Direction:** North, East, South, West (bound)
- **Separation:** Greater than 2.00 seconds. - (Headway)
- **Name:** Default Profile
- **Scheme:** Vehicle classification (ARX)
- **Units:** Non metric (ft, mi, ft/s, mph, lb, ton)
- **In profile:** Vehicles = 8028 / 20662 (38.85%)

**Speed Statistics**

**SpeedStat-52**
- **Site:** KY 29_2.0.0N
- **Description:** KY29
Filter time: 13:00 Friday, July 19, 2013 => 14:19 Wednesday, July 24, 2013

Scheme: Vehicle classification (ARX)

Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 8028

Posted speed limit = 45 mph, Exceeding = 3115 (38.80%), Mean Exceeding = 40.32 mph

Maximum = 63.3 mph, Minimum = 5.4 mph, Mean = 35.8 mph

85% Speed = 40.3 mph, 95% Speed = 43.4 mph, Median = 35.6 mph

10 mph Pace = 31 - 41, Number in Pace = 6009 (74.85%)

Variance = 24.17, Standard Deviation = 4.92 mph

### Speed Bins (Partial days)

<table>
<thead>
<tr>
<th></th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>* vMult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5</td>
<td>0</td>
<td>0.0%</td>
<td>0</td>
<td>8028</td>
<td>100.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 - 10</td>
<td>15</td>
<td>0.2%</td>
<td>15</td>
<td>8013</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>10 - 15</td>
<td>14</td>
<td>0.2%</td>
<td>29</td>
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<td>0.00</td>
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<tr>
<td>15 - 20</td>
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<td>25 - 30</td>
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<td>7288</td>
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<tr>
<td>30 - 35</td>
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<td>4602</td>
<td>57.3%</td>
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<tr>
<td>35 - 40</td>
<td>3202</td>
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<td>1400</td>
<td>17.4%</td>
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</tr>
<tr>
<td>40 - 45</td>
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<td>7812</td>
<td>216</td>
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</tr>
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<tr>
<td>45 - 50</td>
<td>185</td>
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<td>7997</td>
<td>31</td>
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</tr>
<tr>
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<td></td>
<td></td>
</tr>
<tr>
<td>50 - 55</td>
<td>28</td>
<td>0.3%</td>
<td>8025</td>
<td>3</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
<tr>
<td>55 - 60</td>
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<td>8027</td>
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</tr>
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</tr>
<tr>
<td>60 - 65</td>
<td>1</td>
<td>0.0%</td>
<td>8028</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>65 - 70</td>
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<td>0.0%</td>
<td>8028</td>
<td>0</td>
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<td>0.00</td>
</tr>
<tr>
<td>0.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
70 - 75 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |
75 - 80 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |
80 - 85 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |
85 - 90 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |
90 - 95 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |
95 - 100 | 0 0.0% | 8028 100.0% | 0 0.0% | 0.00 | 0.00 |

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00

Wilmore
Post-Treatment 1, 55mph

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-53 -- English (ENU)**

**Datasets:**

Site: [KY29_3] KY29
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:11 Friday, July 12, 2013 => 14:24 Wednesday, July 24, 2013
Zone: File: KY29_324Jul2013.EC0 (Plus)
Identifier: EM165Z38 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

**Profile:**

Filter time: 13:00 Friday, July 19, 2013 => 14:24 Wednesday, July 24, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 3199 / 14347 (22.30%)

Speed Statistics

SpeedStat-53
Site: KY29_3.0.0N
Description: KY29
Filter time: 13:00 Friday, July 19, 2013 => 14:24 Wednesday, July 24, 2013
Scheme: Vehicle classification (ARX)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 3199
Posted speed limit = 55 mph, Exceeding = 2718 (84.96%), Mean Exceeding = 45.33 mph
Maximum = 73.5 mph, Minimum = 6.2 mph, Mean = 43.1 mph
85% Speed = 49.7 mph, 95% Speed = 53.9 mph, Median = 43.6 mph
10 mph Pace = 39 - 49, Number in Pace = 1924 (60.14%)
Variance = 56.10, Standard Deviation = 7.49 mph

Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
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<td>0 - 5</td>
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<td>99.9%</td>
<td>0.00</td>
</tr>
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<td>0.1%</td>
<td>3189</td>
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<td>10 - 15</td>
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<td>10.3%</td>
<td>3189</td>
<td>99.7%</td>
<td>0.00</td>
</tr>
<tr>
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<td>0.2%</td>
<td>10.3%</td>
<td>3189</td>
<td>99.7%</td>
<td>0.00</td>
</tr>
<tr>
<td>15 - 20</td>
<td>1.2</td>
<td>39.2%</td>
<td>49.1%</td>
<td>3150</td>
<td>98.5%</td>
<td>0.00</td>
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<td>1.2%</td>
<td>15.5%</td>
<td>3150</td>
<td>98.5%</td>
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</tr>
<tr>
<td>20 - 25</td>
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<td>97.3%</td>
<td>3102</td>
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<tr>
<td>25 - 30</td>
<td>1.8</td>
<td>57.8%</td>
<td>154.4%</td>
<td>3045</td>
<td>95.2%</td>
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<td>4.8%</td>
<td>3045</td>
<td>95.2%</td>
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</tr>
<tr>
<td>Speed Range</td>
<td>Vehicles</td>
<td>% of Total</td>
<td>Vehicles</td>
<td>% of Total</td>
<td>Vehicles</td>
<td>% of Total</td>
</tr>
<tr>
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<td>------------</td>
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</tr>
<tr>
<td>30 - 35</td>
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<td>5.1%</td>
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<td>9.9%</td>
<td>2883</td>
<td>90.1%</td>
</tr>
<tr>
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<td>553</td>
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<td>869</td>
<td>27.2%</td>
<td>2330</td>
<td>72.8%</td>
</tr>
<tr>
<td>40 - 45</td>
<td>1021</td>
<td>31.9%</td>
<td>1890</td>
<td>59.1%</td>
<td>1309</td>
<td>40.9%</td>
</tr>
<tr>
<td>45 - 50</td>
<td>859</td>
<td>26.9%</td>
<td>2749</td>
<td>85.9%</td>
<td>450</td>
<td>14.1%</td>
</tr>
<tr>
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<td>328</td>
<td>10.3%</td>
<td>3077</td>
<td>96.2%</td>
<td>122</td>
<td>3.8%</td>
</tr>
<tr>
<td>55 - 60</td>
<td>92</td>
<td>2.9%</td>
<td>3169</td>
<td>99.1%</td>
<td>30</td>
<td>0.9%</td>
</tr>
<tr>
<td>60 - 65</td>
<td>20</td>
<td>0.6%</td>
<td>3189</td>
<td>99.7%</td>
<td>10</td>
<td>0.3%</td>
</tr>
<tr>
<td>65 - 70</td>
<td>8</td>
<td>0.3%</td>
<td>3197</td>
<td>99.9%</td>
<td>2</td>
<td>0.1%</td>
</tr>
<tr>
<td>70 - 75</td>
<td>2</td>
<td>0.1%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>75 - 80</td>
<td>0</td>
<td>0.0%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>80 - 85</td>
<td>0</td>
<td>0.0%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>85 - 90</td>
<td>0</td>
<td>0.0%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>90 - 95</td>
<td>0</td>
<td>0.0%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>3199</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

**Total Speed Rating** = 0.00
**Total Moving Energy (Estimated)** = 0.00

**Wilmore Post-Treatment 1**

**Day (7:00-19:00)**

25 Vehicles = 5086

*Posted speed limit* = 37 mph, *Exceeding = 958 (18.84%), Mean Exceeding = 39.77 mph

*Maximum = 55.0 mph, Minimum = 5.4 mph, Mean = 32.4 mph

85% Speed = 37.6 mph, 95% Speed = 40.5 mph, Median = 32.4 mph

*10 mph Pace* = 27 - 37, *Number in Pace* = 3468 (68.19%)

*Variance = 26.67, Standard Deviation = 5.16 mph*

35 Vehicles = 5113

*Posted speed limit = 37 mph, Exceeding = 2794 (54.65%), Mean Exceeding = 41.95 mph*
Maximum = 63.5 mph, Minimum = 8.6 mph, Mean = 37.6 mph
85% Speed = 43.6 mph, 95% Speed = 46.8 mph, Median = 37.6 mph
10 mph Pace = 32 - 42, Number in Pace = 3111 (60.84%) Variance = 35.49, Standard Deviation = 5.96 mph

45 Vehicles = 5525
Posted speed limit = 37 mph, Exceeding = 2152 (38.95%), Mean Exceeding = 40.17 mph
Maximum = 57.9 mph, Minimum = 5.4 mph, Mean = 35.7 mph
85% Speed = 40.3 mph, 95% Speed = 43.2 mph, Median = 35.8 mph
10 mph Pace = 31 - 41, Number in Pace = 4153 (75.17%) Variance = 24.05, Standard Deviation = 4.90 mph

55 Vehicles = 2271
Posted speed limit = 37 mph, Exceeding = 1919 (84.50%), Mean Exceeding = 45.34 mph
Maximum = 73.5 mph, Minimum = 6.2 mph, Mean = 42.9 mph
85% Speed = 49.7 mph, 95% Speed = 53.9 mph, Median = 43.4 mph
10 mph Pace = 39 - 49, Number in Pace = 1357 (59.75%) Variance = 62.33, Standard Deviation = 7.90 mph

Night (19:00-7:00)
25
Vehicles = 1949
Posted speed limit = 37 mph, Exceeding = 360 (18.47%), Mean Exceeding = 40.11 mph
Maximum = 50.3 mph, Minimum = 13.8 mph, Mean = 32.4 mph
85% Speed = 37.8 mph, 95% Speed = 41.2 mph, Median = 32.2 mph
10 mph Pace = 27 - 37, Number in Pace = 1300 (66.70%) Variance = 27.47, Standard Deviation = 5.24 mph

35
Vehicles = 2114
Posted speed limit = 37 mph, Exceeding = 1086 (51.37%), Mean Exceeding = 41.88 mph
Maximum = 62.3 mph, Minimum = 12.0 mph, Mean = 37.4 mph
85% Speed = 43.2 mph, 95% Speed = 47.0 mph, Median = 37.1 mph
10 mph Pace = 33 - 43, Number in Pace = 1328 (62.82%) Variance = 34.33, Standard Deviation = 5.86 mph

45
Vehicles = 2503
Posted speed limit = 37 mph, Exceeding = 963 (38.47%), Mean Exceeding = 40.67 mph
Maximum = 63.3 mph, Minimum = 7.4 mph, Mean = 36.0 mph
85% Speed = 40.5 mph, 95% Speed = 44.1 mph, Median = 35.6 mph
10 mph Pace = 31 - 41, Number in Pace = 1859 (74.27%) Variance = 24.39, Standard Deviation = 4.94 mph

55
Vehicles = 928
Posted speed limit = 37 mph, Exceeding = 799 (86.10%), Mean Exceeding = 45.32 mph
Maximum = 66.2 mph, Minimum = 18.3 mph, Mean = 43.7 mph
85% Speed = 49.7 mph, 95% Speed = 53.9 mph, Median = 43.6 mph
10 mph Pace = 39 - 49, Number in Pace = 567 (61.10%)
Variance = 40.46, Standard Deviation = 6.36 mph

Weekdays (MTWRF)
25
Vehicles = 4506
Posted speed limit = 37 mph, Exceeding = 837 (18.58%), Mean Exceeding = 39.89 mph
Maximum = 52.2 mph, Minimum = 5.4 mph, Mean = 32.5 mph
85% Speed = 37.6 mph, 95% Speed = 40.9 mph, Median = 32.4 mph
10 mph Pace = 27 - 37, Number in Pace = 3091 (68.60%)
Variance = 26.42, Standard Deviation = 5.14 mph

35
Vehicles = 4594
Posted speed limit = 37 mph, Exceeding = 2546 (55.42%), Mean Exceeding = 42.06 mph
Maximum = 63.5 mph, Minimum = 8.6 mph, Mean = 37.8 mph
85% Speed = 43.8 mph, 95% Speed = 47.2 mph, Median = 37.8 mph
10 mph Pace = 33 - 43, Number in Pace = 2794 (60.82%)
Variance = 36.25, Standard Deviation = 6.02 mph

45
Vehicles = 5059
Posted speed limit = 37 mph, Exceeding = 1876 (37.08%), Mean Exceeding = 40.17 mph
Maximum = 57.9 mph, Minimum = 5.4 mph, Mean = 35.5 mph
85% Speed = 40.0 mph, 95% Speed = 42.9 mph, Median = 35.6 mph
10 mph Pace = 31 - 41, Number in Pace = 3810 (75.31%)
Variance = 23.67, Standard Deviation = 4.87 mph

55
Vehicles = 3154
Posted speed limit = 37 mph, Exceeding = 2713 (86.02%), Mean Exceeding = 45.33 mph
Maximum = 73.5 mph, Minimum = 6.2 mph, Mean = 43.4 mph
85% Speed = 49.7 mph, 95% Speed = 53.9 mph, Median = 43.6 mph
10 mph Pace = 39 - 49, Number in Pace = 1923 (60.97%)
Variance = 51.23, Standard Deviation = 7.16 mph

Weekends (SS)
25
Vehicles = 2529
Posted speed limit = 37 mph, Exceeding = 481 (19.02%), Mean Exceeding = 39.82 mph
Maximum = 55.0 mph, Minimum = 7.7 mph, Mean = 32.4 mph
85% Speed = 37.8 mph, 95% Speed = 40.5 mph, Median = 32.2 mph
10 mph Pace = 27 - 37, Number in Pace = 1671 (66.07%)
Variance = 27.72, Standard Deviation = 5.26 mph

35
Vehicles = 2633
Posted speed limit = 37 mph, Exceeding = 1334 (50.66%), Mean Exceeding = 41.67 mph
Maximum = 59.6 mph, Minimum = 12.0 mph, Mean = 37.2 mph
85% Speed = 42.9 mph, 95% Speed = 46.3 mph, Median = 36.9 mph
10 mph Pace = 32 - 42, Number in Pace = 1657 (62.93%)
Variance = 33.00, Standard Deviation = 5.74 mph
45
Vehicles = 2969
Posted speed limit = 37 mph, Exceeding = 1239 (41.73%), Mean Exceeding = 40.56 mph
Maximum = 63.3 mph, Minimum = 7.0 mph, Mean = 36.2 mph
85% Speed = 40.7 mph, 95% Speed = 43.8 mph, Median = 36.0 mph
10 mph Pace = 31 - 41, Number in Pace = 2210 (74.44%)
Variance = 24.75, Standard Deviation = 4.97 mph
55
Vehicles = 45
Posted speed limit = 37 mph, Exceeding = 5 (11.11%), Mean Exceeding = 46.29 mph
Maximum = 59.1 mph, Minimum = 8.9 mph, Mean = 25.8 mph
85% Speed = 34.4 mph, 95% Speed = 45.6 mph, Median = 23.3 mph
10 mph Pace = 15 - 25, Number in Pace = 26 (57.78%)
Variance = 94.54, Standard Deviation = 9.72 mph

Wilmore
Post-Treatment 2, 25mph

MetroCount Traffic Executive
Speed Statistics

SpeedStat-54 -- English (ENU)

Datasets:
Site: [KY29_6] KY29_6
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:20 Friday, July 12, 2013 => 14:29 Wednesday, July 24, 2013
Zone:
File: 2.K29_624Jul2013.EC0 (Plus)
Identifier: EM22T2JJ MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 11:21 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 6014 / 15726 (38.24%)

Speed Statistics

SpeedStat-54
Site: KY29_6.0.0N
Description: KY29_6
Filter time: 11:21 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 6014
Posted speed limit = 25 mph, Exceeding = 1070 (17.79%), Mean Exceeding = 40.00 mph
Maximum = 62.5 mph, Minimum = 8.3 mph, Mean = 32.3 mph
85% Speed = 37.6 mph, 95% Speed = 40.9 mph, Median = 32.0 mph
10 mph Pace = 27 - 37, Number in Pace = 4076 (67.78%)
Variance = 27.42, Standard Deviation = 5.24 mph

Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
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<td>vMult</td>
<td></td>
<td></td>
<td></td>
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<td>10 - 15</td>
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<td>14 0.2%</td>
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<td>Speed Range</td>
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<td>Percentage</td>
<td>Total Vehs</td>
<td>Percentage</td>
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<td>Moving Energy</td>
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<td>------------</td>
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<td>7.2%</td>
<td>5581</td>
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<td>1967</td>
<td>32.7%</td>
<td>4047</td>
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<tr>
<td>60 - 65</td>
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</tr>
<tr>
<td>65 - 70</td>
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<td>0.0%</td>
</tr>
<tr>
<td>70 - 75</td>
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<td>6014</td>
<td>100.0%</td>
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<td>0.0%</td>
</tr>
<tr>
<td>75 - 80</td>
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<td>6014</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>80 - 85</td>
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<td>6014</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>85 - 90</td>
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<td>6014</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>90 - 95</td>
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<td>6014</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>6014</td>
<td>100.0%</td>
<td>0</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00

Wilmore
Post-Treatment 2, 35mph

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-55 -- English (ENU)**
Datasets:

Site: [KY29_4] KY29_4
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:16 Friday, July 12, 2013 => 14:27 Wednesday, July 24, 2013
Zone:

File: KY29_424Jul2013.EC0 (Plus)
Identifier: EM17W5KT MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 11:17 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 6152 / 17049 (36.08%)

### Speed Statistics

**SpeedStat-55**

Site: KY29_4.0.0N
Description: KY29_4
Filter time: 11:17 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Scheme: Vehicle classification (ARX)
Filter: Cls(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 6152
Posted speed limit = 35 mph, Exceeding = 3237 (52.62%), Mean Exceeding = 41.96 mph
Maximum = 77.7 mph, Minimum = 7.2 mph, Mean = 37.2 mph
85% Speed = 43.4 mph, 95% Speed = 47.2 mph, Median = 37.4 mph
10 mph Pace = 32 - 42, Number in Pace = 3721 (60.48%)
Variance = 41.86, Standard Deviation = 6.47 mph

### Speed Bins (Partial days)

| Speed | Bin | Below | Above | Energy | vMult | n *
|-------|-----|-------|-------|--------|-------|-----
| 0 - 5 | 0   | 0.0%  | 0    | 100.0% | 0.00  | 0.00
| 5 - 10| 5   | 0.1%  | 5    | 99.9%  | 0.00  | 0.00
| 10 - 15| 26 | 0.4%  | 31   | 95.5%  | 0.00  | 0.00
| 15 - 20| 44 | 0.7%  | 75   | 98.8%  | 0.00  | 0.00
| 20 - 25| 133| 2.2%  | 208  | 97.8%  | 0.00  | 0.00
| 25 - 30| 479| 7.8%  | 687  | 92.2%  | 0.00  | 0.00
| 30 - 35| 1448| 23.5%| 2135 | 76.5%  | 0.00  | 0.00
| 35 - 40| 1950| 31.7%| 4085 | 68.3%  | 0.00  | 0.00
| 40 - 45| 1452| 23.6%| 5537 | 90.0%  | 0.00  | 0.00
| 45 - 50| 510 | 8.3%  | 6047 | 98.3%  | 105   | 1.7%  | 0.00  | 0.00
| 50 - 55| 88  | 1.4%  | 6135 | 99.7%  | 17    | 0.3%  | 0.00  | 0.00
| 55 - 60| 12  | 0.2%  | 6147 | 99.9%  | 5     | 0.1%  | 0.00  | 0.00
| 60 - 65| 3   | 0.0%  | 6150 | 100.0% | 2     | 0.0%  | 0.00  | 0.00
| 65 - 70| 0   | 0.0%  | 6150 | 100.0% | 2     | 0.0%  | 0.00  | 0.00
| 70 - 75| 1   | 0.0%  | 6151 | 100.0% | 1     | 0.0%  | 0.00  | 0.00
| 75 - 80| 1   | 0.0%  | 6152 | 100.0% | 0     | 0.0%  | 0.00  | 0.00
| 80 - 85| 0   | 0.0%  | 6152 | 100.0% | 0     | 0.0%  | 0.00  | 0.00

155
85 - 90 | 0 0.0% | 6152 100.0% | 0 0.0% | 0.00 | 0.00 |
0.00
90 - 95 | 0 0.0% | 6152 100.0% | 0 0.0% | 0.00 | 0.00 |
0.00
95 - 100 | 0 0.0% | 6152 100.0% | 0 0.0% | 0.00 | 0.00 |
0.00

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00

Wilmore
Post-Treatment 2, 45mph

**MetroCount Traffic Executive**

**Speed Statistics**

**SpeedStat-56 -- English (ENU)**

**Datasets:**
- **Site:** [KY 29_2] KY29
- **Direction:** 1 - North bound, A hit first. **Lane:** 0
- **Survey Duration:** 11:08 Friday, July 12, 2013 => 14:19 Wednesday, July 24, 2013
- **Zone:**
- **File:** KY 29_224Jul2013.EC0 (Plus)
- **Identifier:** EM1387GA MC56-L5 [MC55] (c)Microcom 19Oct04
- **Algorithm:** Factory default (v3.21 - 15315)
- **Data type:** Axle sensors - Paired (Class/Speed/Count)

**Profile:**
- **Filter time:** 11:09 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
- **Included classes:** 2, 3
- **Speed range:** 5 - 100 mph.
- **Direction:** North, East, South, West (bound)
- **Separation:** Greater than 2.00 seconds. - (Headway)
- **Name:** Default Profile
- **Scheme:** Vehicle classification (ARX)
- **Units:** Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 7073 / 20662 (34.23%)
Speed Statistics

SpeedStat-56
Site: KY 29_2.0.0N
Description: KY29
Filter time: 11:09 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 7073
Posted speed limit = 45 mph, Exceeding = 2237 (31.63%), Mean Exceeding = 40.32 mph
Maximum = 57.4 mph, Minimum = 6.5 mph, Mean = 34.2 mph
85% Speed = 39.8 mph, 95% Speed = 42.7 mph, Median = 34.4 mph
10 mph Pace = 30 - 40, Number in Pace = 4496 (63.57%)
Variance = 31.64, Standard Deviation = 5.62 mph

Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
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<td>0 - 5</td>
<td>0.0%</td>
<td>0.0%</td>
<td>100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5 - 10</td>
<td>0.1%</td>
<td>0.1%</td>
<td>99.9%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>10 - 15</td>
<td>0.1%</td>
<td>0.2%</td>
<td>99.8%</td>
<td>0.00</td>
<td>0.00</td>
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</tr>
<tr>
<td>15 - 20</td>
<td>0.8%</td>
<td>1.0%</td>
<td>99.0%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>20 - 25</td>
<td>3.8%</td>
<td>4.8%</td>
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<td>22.9%</td>
<td>77.1%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>30 - 35</td>
<td>31.1%</td>
<td>54.0%</td>
<td>46.0%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>35 - 40</td>
<td>31.9%</td>
<td>85.8%</td>
<td>14.2%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>40 - 45</td>
<td>12.1%</td>
<td>97.9%</td>
<td>2.1%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>45 - 50</td>
<td>1.7%</td>
<td>99.6%</td>
<td>0.4%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>
Wilmore
Post-Treatment 2, 55mph

MetroCount Traffic Executive
Speed Statistics

SpeedStat-57 -- English (ENU)

Datasets:
Site: [KY29_3] KY29
Direction: 1 - North bound, A hit first. Lane: 0
Survey Duration: 11:11 Friday, July 12, 2013 => 14:24 Wednesday, July 24, 2013
Zone:
File: KY29_324Jul2013.EC0 (Plus)
Identifier: EM165Z38 MC56-L5 [MC55] (c)Microcom 19Oct04
Algorithm: Factory default (v3.21 - 15315)
Data type: Axle sensors - Paired (Class/Speed/Count)

Profile:
Filter time: 11:12 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Included classes: 2, 3
Speed range: 5 - 100 mph.
Direction: North, East, South, West (bound)
Separation: Greater than 2.00 seconds. - (Headway)
Name: Default Profile
Scheme: Vehicle classification (ARX)
Units: Non metric (ft, mi, ft/s, mph, lb, ton)
In profile: Vehicles = 6362 / 14347 (44.34%)

Speed Statistics

SpeedStat-57
Site: KY29_3.0.0N
Description: KY29
Filter time: 11:12 Friday, July 12, 2013 => 13:00 Friday, July 19, 2013
Scheme: Vehicle classification (ARX)
Filter: CIs(2 3 ) Dir(NESW) Sp(5,100) Headway(>2)

Vehicles = 6362
Posted speed limit = 55 mph, Exceeding = 4626 (72.71%), Mean Exceeding = 46.16 mph
Maximum = 82.1 mph, Minimum = 11.8 mph, Mean = 42.1 mph
85% Speed = 50.3 mph, 95% Speed = 55.0 mph, Median = 42.7 mph
10 mph Pace = 40 - 50, Number in Pace = 2921 (45.91%)
Variance = 70.95, Standard Deviation = 8.42 mph

Speed Bins (Partial days)

<table>
<thead>
<tr>
<th>Speed</th>
<th>Bin</th>
<th>Below</th>
<th>Above</th>
<th>Energy</th>
<th>vMult</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>* vMult</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0 - 5</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>6362 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>5 - 10</td>
<td>0 0.0%</td>
<td>0 0.0%</td>
<td>6362 100.0%</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Speed Range</td>
<td>Total Vehicles</td>
<td>Percent Over Limit</td>
<td>Percentage of Total</td>
<td>Mean Speed</td>
<td>Exceeding Limit</td>
<td>Total Moving Energy (Estimated)</td>
</tr>
<tr>
<td>-------------</td>
<td>----------------</td>
<td>-------------------</td>
<td>---------------------</td>
<td>------------</td>
<td>----------------</td>
<td>-------------------------------</td>
</tr>
<tr>
<td>10 - 15</td>
<td>4</td>
<td>0.1%</td>
<td>4</td>
<td>6358</td>
<td>99.9%</td>
<td>0.00</td>
</tr>
<tr>
<td>15 - 20</td>
<td>24</td>
<td>0.4%</td>
<td>28</td>
<td>6334</td>
<td>99.6%</td>
<td>0.00</td>
</tr>
<tr>
<td>20 - 25</td>
<td>93</td>
<td>1.5%</td>
<td>121</td>
<td>6241</td>
<td>98.1%</td>
<td>0.00</td>
</tr>
<tr>
<td>25 - 30</td>
<td>409</td>
<td>6.4%</td>
<td>530</td>
<td>5832</td>
<td>91.7%</td>
<td>0.00</td>
</tr>
<tr>
<td>30 - 35</td>
<td>843</td>
<td>13.3%</td>
<td>1373</td>
<td>4989</td>
<td>78.4%</td>
<td>0.00</td>
</tr>
<tr>
<td>35 - 40</td>
<td>1017</td>
<td>16.0%</td>
<td>2390</td>
<td>3972</td>
<td>62.4%</td>
<td>0.00</td>
</tr>
<tr>
<td>40 - 45</td>
<td>1470</td>
<td>23.1%</td>
<td>3860</td>
<td>2502</td>
<td>39.3%</td>
<td>0.00</td>
</tr>
<tr>
<td>45 - 50</td>
<td>1429</td>
<td>22.5%</td>
<td>5289</td>
<td>1073</td>
<td>16.9%</td>
<td>0.00</td>
</tr>
<tr>
<td>50 - 55</td>
<td>753</td>
<td>11.8%</td>
<td>6042</td>
<td>320</td>
<td>5.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>55 - 60</td>
<td>229</td>
<td>3.6%</td>
<td>6271</td>
<td>91</td>
<td>1.4%</td>
<td>0.00</td>
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<tr>
<td>60 - 65</td>
<td>72</td>
<td>1.1%</td>
<td>6343</td>
<td>19</td>
<td>0.3%</td>
<td>0.00</td>
</tr>
<tr>
<td>65 - 70</td>
<td>14</td>
<td>0.2%</td>
<td>6357</td>
<td>5</td>
<td>0.1%</td>
<td>0.00</td>
</tr>
<tr>
<td>70 - 75</td>
<td>4</td>
<td>0.1%</td>
<td>6361</td>
<td>1</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>75 - 80</td>
<td>0</td>
<td>0.0%</td>
<td>6361</td>
<td>1</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>80 - 85</td>
<td>1</td>
<td>0.0%</td>
<td>6362</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>85 - 90</td>
<td>0</td>
<td>0.0%</td>
<td>6362</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>90 - 95</td>
<td>0</td>
<td>0.0%</td>
<td>6362</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
<tr>
<td>95 - 100</td>
<td>0</td>
<td>0.0%</td>
<td>6362</td>
<td>0</td>
<td>0.0%</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Total Speed Rating = 0.00
Total Moving Energy (Estimated) = 0.00

Daytime (7:00-19:00)
25

Vehicles = 4306
Posted speed limit = 37 mph, Exceeding = 778 (18.07%), Mean Exceeding = 39.85 mph
Maximum = 62.5 mph, Minimum = 8.3 mph, Mean = 32.3 mph
85% Speed = 37.6 mph, 95% Speed = 40.7 mph, Median = 32.2 mph
10 mph Pace = 28 - 38, Number in Pace = 2901 (67.37%)
Variance = 27.56, Standard Deviation = 5.25 mph

35
Vehicles = 4349
Posted speed limit = 37 mph, Exceeding = 2295 (52.77%), Mean Exceeding = 42.05 mph
Maximum = 77.7 mph, Minimum = 7.2 mph, Mean = 37.2 mph
85% Speed = 43.6 mph, 95% Speed = 47.2 mph, Median = 37.4 mph
10 mph Pace = 33 - 43, Number in Pace = 2570 (59.09%)
Variance = 45.30, Standard Deviation = 6.73 mph

45
Vehicles = 4995
Posted speed limit = 37 mph, Exceeding = 1616 (32.35%), Mean Exceeding = 40.20 mph
Maximum = 56.1 mph, Minimum = 6.5 mph, Mean = 34.2 mph
85% Speed = 39.6 mph, 95% Speed = 42.7 mph, Median = 34.4 mph
10 mph Pace = 30 - 40, Number in Pace = 3210 (64.26%)
Variance = 68.70, Standard Deviation = 8.29 mph

Nighttime (19:00-7:00)
25
Vehicles = 1708
Posted speed limit = 37 mph, Exceeding = 292 (17.10%), Mean Exceeding = 40.40 mph
Maximum = 60.4 mph, Minimum = 16.6 mph, Mean = 32.4 mph
85% Speed = 37.4 mph, 95% Speed = 41.4 mph, Median = 32.0 mph
10 mph Pace = 27 - 37, Number in Pace = 1186 (69.44%)
Variance = 27.07, Standard Deviation = 5.20 mph

35
Vehicles = 1803
Posted speed limit = 37 mph, Exceeding = 942 (52.25%), Mean Exceeding = 41.73 mph
Maximum = 70.9 mph, Minimum = 16.6 mph, Mean = 37.4 mph
85% Speed = 42.9 mph, 95% Speed = 46.8 mph, Median = 37.4 mph
10 mph Pace = 32 - 42, Number in Pace = 1168 (64.78%)
Variance = 33.53, Standard Deviation = 5.79 mph

45
Vehicles = 2078
Posted speed limit = 37 mph, Exceeding = 621 (29.88%), Mean Exceeding = 40.65 mph
Maximum = 57.4 mph, Minimum = 16.6 mph, Mean = 34.1 mph
85% Speed = 39.8 mph, 95% Speed = 42.9 mph, Median = 34.0 mph
10 mph Pace = 28 - 38, Number in Pace = 1300 (62.56%)
Variance = 31.84, Standard Deviation = 5.64 mph

Vehicles = 1880
Posted speed limit = 37 mph, Exceeding = 1281 (68.14%), Mean Exceeding = 46.08 mph
Maximum = 82.1 mph, Minimum = 15.2 mph, Mean = 41.3 mph
85% Speed = 50.1 mph, 95% Speed = 54.4 mph, Median = 42.1 mph
10 mph Pace = 39 - 49, Number in Pace = 830 (44.15%)
Variance = 75.25, Standard Deviation = 8.67 mph

Weekdays (MTWRF)
25
Vehicles = 6014
Posted speed limit = 37 mph, Exceeding = 1070 (17.79%), Mean Exceeding = 40.00 mph
Maximum = 62.5 mph, Minimum = 8.3 mph, Mean = 32.3 mph
85% Speed = 37.6 mph, 95% Speed = 40.9 mph, Median = 32.0 mph
10 mph Pace = 27 - 37, Number in Pace = 4076 (67.78%)
Variance = 27.42, Standard Deviation = 5.24 mph

35
Vehicles = 7073
Posted speed limit = 37 mph, Exceeding = 2237 (31.63%), Mean Exceeding = 40.32 mph
Maximum = 57.4 mph, Minimum = 6.5 mph, Mean = 34.2 mph
85% Speed = 39.8 mph, 95% Speed = 42.7 mph, Median = 34.4 mph
10 mph Pace = 30 - 40, Number in Pace = 4496 (63.57%)
Variance = 31.64, Standard Deviation = 5.62 mph

55
Vehicles = 6362
Posted speed limit = 37 mph, Exceeding = 4626 (72.71%), Mean Exceeding = 46.16 mph
Maximum = 82.1 mph, Minimum = 11.8 mph, Mean = 42.1 mph
85% Speed = 50.3 mph, 95% Speed = 55.0 mph, Median = 42.7 mph
10 mph Pace = 40 - 50, Number in Pace = 2921 (45.91%)
Variance = 70.95, Standard Deviation = 8.42 mph

Weekends (SS)
25
No Vehicles
35
No Vehicles
45
No Vehicles
55
No Vehicles