Metropolitan Planning Organization

Implementation of Advanced Warning in School Speed Zones

Task Work Order # GPC-IV 15

Final Report

MIAMI-DADE County
Metropolitan Planning Organization (MPO)

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Miami-Dade County

Metropolitan Planning Organization

General Planning Consultant (GPC) Services

IMPLEMENTATION OF ADVANCED WARNING IN SCHOOL SPEED ZONES

CONTRACT NO.: E08-MPO-01
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EXECUTIVE SUMMARY

The objective of this study is to develop a process for implementing advanced warning in school speed zones. The implementation advanced warning sign prior to a school speed zone is intended to make the driver aware of a reduction in speed between a regular posted speed limit and a reduced-speed school zone. It is believed that the implementation of advanced warning in school speed zones will result in improved compliance with speed limit zone and improve the safety of children walking back and forth to school. A typical signing plan has been prepared for a typical school zone with advanced warning and suggested sign spacing distances, predicated upon travel speeds and MUTCD guidelines, were prepared.

Compliance rates of school zone speed limits are influenced by many things. Some of these include the level of congestion on the roadway, the proximity of upstream traffic control devices (stop signs or traffic signals), the visibility of existing signs advising drivers of the impending school speed zone, and on-site parent pick-up/drop-off queues that spill back onto the adjacent roadway. Understanding that each individual site requires an evaluation to determine if the implementation of advanced warning is an appropriate treatment to solve the identified problem, this study includes an outline of the steps and criteria that should be satisfied in order to consider implementing advanced warning in school speed zones.

Identify Speeding Problem and Posted Speed Limit - First, a vehicular speeding problem or safety concern due to high speeds along a corridor near a school speed zone must be identified. Once the concern has been identified and confirmed to be related to speed near a school speed zone, the normal posted speed limit on the corridor prior to the school speed zone is determined.

Collect Location Specific Volume and Speed Data - The next step in determining if advanced warning in the school zone would be an appropriate mitigation measure is to obtain speed, volume, and inventory data. Specific corridor speed data must be collected to conduct the analysis required to quantifiably determine if a speeding problem exists (defined as speeds exceeding the 85th percentile speed at that location). Peak hour traffic volumes and spot speed studies at the beginning and ending of the targeted school speed zones will be gathered. If the school speed zone is sufficiently long, then a spot speed study at the midpoint of the corridor may also be necessary. A school zone location with a demonstrated history of excessive speeding, or a history of pedestrian crashes that are speed-related that exceed statewide averages for similar roadway facilities, are candidates for advanced warning in the school speed zone.

Cataloging the roadway inventory including the number of lanes, posted speed limits, median type, on-street parking, bicycle lanes, and sidewalks would also be conducted. An existing sign inventory should be performed documenting the type and location of the warning and regulatory signs present, as well as the location of traffic control devices such as stop signs and traffic signals. The number of speeding citations that have been issued within the study area should also be gathered to determine if a safety and/or speeding problem exists.

As part of the valuation criteria for installing advanced warning signs, it is recommended that a school-age pedestrian count be conducted and the most heavily traveled walking routes be established. Further, the location of pedestrian crossings and the presence of crossing guards should be determined to assist children with safely crossing the street.

Evaluate the Geometric Layout of the School Speed Zone - Even if a speeding and crash problem are proven to exist within a school speed zone, the physical geometry of the roadway must be favorable towards advanced warning signs to implement it. This includes the proximity of traffic control devices, such as traffic signals and stop signs, to the entrance to the school speed zone. If they are located too close to a school speed zone, the natural interruption of traffic flow created by those devices will reduce travel speeds along the corridor. Thus, advanced warning signs would not be needed.

Analyze the Collected Data - Upon summarizing the collected speed data along the study area corridor, a spatial analysis of the speeds at specific locations should be performed. By plotting the recorded speeds against their corridor location, it can be easily confirmed if a speeding problem exists before or within a school speed zone. This spatial analysis can also determine if a specific direction of travel on the corridor is more prone to excessive travel speeds. Such information can assist the analyst in determining the magnitude of a speeding problem and where it is. It can also target the proposed mitigation treatments to where the problem exists.

Three Tiered Mitigation Approach - Once the magnitude of the speeding and/or crash problem and its approximate location has been confirmed, then mitigation treatments may be considered to rectify the problem. Traditionally, Education, Enforcement and Engineering are the mitigation tools used to solve problems within the transportation system. Only after Education and Enforcement have been explored should an Engineering solution, such as advanced warning in school speed zones be evaluated and implemented. This approach to identifying and applying the simplest and least costly solution is known as the Tiered Mitigation Approach.

Tier #1 – Education. Assuming that a speeding problem has been confirmed at a location near a school speeding zone, the first step to solving the problem would be to conduct an education program. This program would educate parents who drive their children to school along with other drivers who use the subject corridor as to the school zone speed limit of 15 miles per hour and where the school zone begins and ends. Drivers would be informed of the risks associated with speeding within a school speed zone and the potential danger school-age children encounter as they walk to school adjacent to speeding vehicles. After providing the educational information, an assessment of the effect education had upon travel speeds in the identified corridor segment would be performed. If speeding is still a problem, then the second tier of mitigation treatments would be engaged.

Tier #2 – Enforcement. If education as the first tier of mitigation fails to address the identified speeding problem, then the second tier solution, enforcement, is engaged. An active and visible police presence prior to and within the school speed zone would be mobilized to provide deterrence to speeding motorists. Traditionally, visible enforcement on its own has a short-term positive effect that tends to wane over time. Driver behavior is typically modified temporarily. As a means to improve enforcement as a long-term behavioral modification tool, it is recommended that education be jointly used with an enforcement program. It is believed such a joint program would have a better opportunity of successfully reducing travel speeds over the long term than enforcement alone.

Tier #3 – Engineering. If education and enforcement fail to curb the speeding problem, then the third tier of mitigation solutions is explored. This involves applying an initial engineering solution, such as installing overhead flashing beacons that visibly warn drivers of the upcoming school speed zone. Once installed, follow-up speed and crash analysis is required to determine if the selected engineering solution(s) eliminated the identified speeding problem. If these mitigation options fail to solve the

speeding problem, then the implementation of advanced warning in the school speed zone should be evaluated for implementation within the study area.

The criteria for implementing advanced warning in a school speed zone is meant to provide a simple-to-use checklist to determine if such a solution is viable. If the school speed zone along a subject corridor satisfies many of these criteria, then this is a strong indicator that advanced warning signs may be justified. Ultimately, the decision to install such devices should be made by the engineer of record and local permitting jurisdiction.

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1. Introduction

The objective of this study is to develop a process for implementing advanced warning in school speed zones. The implementation advanced warning sign prior to a school speed zone is intended to make the driver aware of a reduction in speed between a regular posted speed limit and a reduced-speed school zone. It is believed that the implementation of advanced warning in school speed zones will result in improved compliance with speed limit zone and improve the safety of children walking back and forth to school. A typical signing plan has been prepared for a typical school zone with advanced warning and suggested sign spacing distances, predicated upon travel speeds and MUTCD guidelines, were prepared.

The safety of children walking to and from school has always been a major concern for parents, educators and transportation professionals. Reduced-speed school zones are the most commonly adopted traffic control for school areas. However, there are many cases where a reduced-speed school zone is not sufficient to prevent drivers from speeding through the area. Increasing drivers' compliance to the school zone speed limit is often a key component in providing a safer environment for pedestrians entering and exiting the school.

This study was originated after the students of Miami Lakes Middle School, as part of their Project Citizen Class, developed a concept to implement transitional speed zones (TSZ) before and after the traditional school speed limit zones. The concept of TSZs was implemented on NW 114th Avenue at Eugenia B. Thomas Elementary School in 2006. Transitional speed limit zones are in place between the posted school speed limit of 15 miles per hour and the regular speed limit of 35 miles per hour. The transitional speed limit is currently posted at 25 miles per hour. This school was included as part of this study to evaluate current speed compliance within the school zone.

The implementation of advanced warning in school speed zones is expected to minimize the sudden change from the posted speed limit to the posted school speed limit, typically 15 miles per hour in Miami-Dade County. It is believed that this treatment will result in improved compliance within the speed limit zones and improve the safety of children walking back and forth to school.

2. Literature Review

A literature review was conducted that focused on local and national studies, plans and codes/regulations relevant to advanced warning in school speed zones standards, and criteria for implementation and guidelines.

Pursuant to Florida Statute 316.1895, "*No School Zone speed limit shall be less than 15 miles per hour except by local regulation. Such speed limit shall be in force only during those times 30 minutes before and 30 minutes after the times necessary and corresponding to the periods of time when pupils are arriving at and leaving regularly scheduled school sessions*." Further, signs must be uniform in size and color and display the times of the day when the school speed limit is enforced. Sign assemblies must be consistent with the Manual on Uniform Traffic Control Devices (MUTCD).

As noted in *Speeds in School Zones: A Comprehensive Guide to Traffic Control Near Schools* -- prepared by Texas Transportation Institute (performed in cooperation with the Texas Department of Transportation and the Federal Highway Administration) and published in February 2009 -- **previous Transportation Research Board (TRB) studies have noted that driver compliance with school speed limits is poor** (less than 20 percent). Attempts to increase driver compliance by improved signing and increased enforcement have only resulted in slight increases in compliance and modest reductions in speed. Therefore, the Texas Transportation Institute (TTI) noted, School Zones require not only the use of effective signing and strict enforcement, but also the establishment of reasonable school zone speed limits. The report also noted that a Nebraska study of speeds within 12 school speed zones considered to be representative of the variety of school speed limits used on urban streets concluded:

- Speeds in school zones are influenced more by the normal speed limits and speed characteristics of the streets on which the zones were located than by the school speed limits. They noted that this finding was also consistent with findings from a West Virginia study.

- School speed limits of 25 mph were more effective than 15- or 20-mph school speed limits on streets with a normal speed limit of 35 mph.

- Some studies have found that school speed limits signed with flashing beacons were more effective than passive forms of school speed limit signing.

The literature review also indicated that a reduction of approximately 20 miles per hour or more is adequate for the approach and departure sides of the School Speed Limit Zone. While school speeds within an urbanized setting, such as Miami, may not typically reach 55 miles per hour, the differential between the posted regular speed limit and the school zone speed limit is the critical element in determining the need for a the implementation of advanced warning for school speed zones.

These findings and the guidelines developed for implementing advanced warning in school speed zones have been reviewed thoroughly. The data and analysis contained herein was used to assist in the recommendations resulting from this study.

3. Preliminary School Zone Speed Data Analysis

The primary objective of advanced warning in school zones is to make the driver aware of a sudden reduction in speed between a regular posted speed limit and a reduced-speed school zone. Intuitively, the more drastic the reduction is, the greater the need for advanced warning signs. However, the use of traffic warning signs should be justified by an engineering study and engineering judgment, keeping the amount of signs to a minimum to avoid confusion and over signing.

Traditionally, regarding of traffic speeding, Education, Enforcement and Engineering (the "3 Es") are the tools used to protect the safe and efficient movement of people and goods within our transportation system. While this study focuses on the Engineering aspect of those solutions, it is important to use all of the tools at the local jurisdiction's disposal. This means that education and enforcement should be included in the evaluation process of when and where advanced warnings in school zones are feasible, and they should be explored prior to implementing an engineering solution since they tend to cost less. Only after Education and Enforcement have been explored should an Engineering solution, such as advanced warning in school zones, be evaluated and implemented.

SPEED DATA. The implementation of advanced warning in school zones would involve a speed study along the section of a roadway near a school that already has a school speed zone in place. The need for advanced warning may include several criteria, including safety and pedestrian volumes. However, the primary concern must involve excessive speeds within the school zone. In an effort to quantify compliance with current school speed zones in Miami-Dade County, speed data was collected at 5 school sites.

The 5 school sites were selected based on the roadway classification where the school speed zone is situated, the posted speed limit on that roadway, and the location of the school within Miami-Dade County. Potential sites on local roads, collectors, minor arterials, and arterials were targeted, and regular posted speed limits ranging from 30 miles per hour to 45 miles per hour were reviewed. Holding other characteristics constant, schools that had school speed zones installed on these roadways must also each have flashing warning beacons signaling to motorists the imminent school speed zone. The presence of a flashing warning beacon at each location normalizes the impact it may have upon compliance with the school zone speed limit of 15 miles per hour.

Additionally, each school speed zone must be located a sufficient distance from an upstream signalized intersection or stop-controlled intersection such that the traffic control device would not meter the speeds and flow of traffic as motorists approach the 15 mile per hour school speed zone. If the school speed zone was located too close to a traffic control device, recorded travel speeds would be unduly influenced and an accurate assessment of drivers' compliance with the school zone speed limit would not be possible.

After reviewing the elementary and middle schools in Miami-Dade County and the roadways they abut which have a school speed zone consistent with the noted criteria above, the following 5 schools were selected to collect speed data:

- Scott Lake Elementary School
- Charles R. Drew Elementary School
- Henry M. Flagler Elementary School
- Lake Stevens Elementary School
- Eugenia B. Thomas Elementary School

3.1. Data Gathering

Data was identified and collected as required to evaluate the feasibility of implementing advanced warning in school speed zones. Some of this data originates from the transitional speed zone implemented near Eugenia B. Thomas Elementary School. The following data was collected for each school:

1) Scott Lake Elementary School
   Roadway: NW 12th Avenue
   Functional Classification: Urban Collector
   Regular Posted Speed Limit: 30 miles per hour
   Data collected in the northbound direction on May 25th, 2011

2) Charles R. Drew Elementary School
   Roadway: NW 17th Avenue
   Functional Classification: Urban Minor Arterial
   Regular Posted Speed Limit: 35 miles per hour
   Data collected in the northbound direction on May 25th, 2011

3) Henry M. Flagler Elementary School
   Roadway: SR-968/Flagler Street
   Functional Classification: Urban Minor Arterial
   Regular Posted Speed Limit: 40 miles per hour
   Data collected in the eastbound direction on May 25th, 2011

4) Lake Stevens Elementary School
   Roadway: SR-860/Miami Gardens Drive
   Functional Classification: Urban Arterial
   Regular Posted Speed Limit: 45 miles per hour
   Data collected in the westbound direction on May 25th, 2011

5) Eugenia B. Thomas Elementary School
   Roadway: NW 114th Avenue
   Functional Classification: Urban Collector
   Regular Posted Speed Limit: 35 miles per hour
   Data collected on the southbound direction on May 25th, 2011

3.2. Data Analysis

Methodology to Analyze Speed Data - The optimum location was identified to place the data collection machines to record the speed data so that it is not affected by upstream traffic control devices or other items that influence speed. Then, the speed data was collected, sorted, and placed in data bins. These bins were organized and determined based on the range of speeds and the speed limits that the analyst is interested in evaluating. For the 5 schools where speed data was collected, the range of speed bins were established to record speeds from 0 to 9 miles per hour, and then each subsequent bin in increments of 5 miles per hour until 60 miles per hour. It included setting a bin with a range from 10 miles per hour to 15 miles per hour. The upper limit of this bin corresponds to the school zone speed limit, so the analyst can determine the number and percentage of vehicles travelling at or below the speed limit.

A bin was also established that reported all speeds greater than 60 miles per hour, so that no data is missed. While the data was recorded for a full 24-hour period, the results provided for the 5 schools are only shown for the AM and PM peak periods that correspond to the school zone times when the school speed zone is in effect.

Once the data was compiled in the speed bins, the percentage of the number of vehicles in each bin relative to the total number of vehicles in that analysis period was calculated. This data was also reported cumulatively for the AM and PM peak periods so that the analyst is able to determine the corresponding 85th percentile speed. The total frequency and resulting percentages are also provided for the combined AM and PM peak periods. This information assists the analyst in determining if a problem exists, when it occurs, and the magnitude of the speeding problem.

For each school the results of the analysis are:

Scott Lake Elementary School Speed Study Results – Situated just north of SR-826 in a highly residential area of Miami Gardens, NW 12th Avenue functions as an urban collector. It has a posted speed limit of 30 miles per hour. The northbound direction of traffic flow on NW 12th Avenue is relatively uninterrupted leading towards the posted school zone and flashing beacons on overhead signs are prominent and visible to the driver. Spot speed data was collected during the morning and afternoon peak hours of the school at the location where the school speed zone began and was in effect.

Results are summarized in **Table 1** and indicate that during the AM peak hour less than 60% of northbound drivers complied with the school speed zone and were traveling at or less than 15 miles per hour at the beginning of the School Speed Zone. However, more than 87% were recorded traveling at 20 miles per hour or less. This reveals that less than 13% of drivers were driving more than 5 miles per hour above the posted School Speed Zone limit of 15 miles per hour. During the PM peak hour, compliance rates showed a slight reduction to approximately 50% at or less than 15 miles per hour and nearly 84% at or less than 20 miles per hour.

Overall, the combined AM and PM peak hour data collected along NW 12th Avenue (the 30 miles per hour roadway) revealed that more than 86% of all drivers traveled at or less than 20 miles per hour during school speed zone times. Given that posted speed limits are set at the 85th Percentile speeds, i.e. where 85 percent of drivers are travelling at or below a certain speed, it appears that drivers are complying with the school zone speed limit reduction from 30 miles per hour to 15 miles per hour within accepted parameters.

Charles R. Drew Elementary School Speed Study Results – Located north of SR-112 and west of I-95, the Charles R. Drew Elementary School has a school speed zone posted on NW 17th Avenue, a 5-lane urban minor arterial. Situated in a highly residential area, the regular posted speed limit on NW 17th Avenue is 35 miles per hour, which is 20 miles per hour greater than the 15 miles per hour school speed zone limit. On northbound NW 17th Avenue south of the school, the school speed zone begins and flashing beacons on overhead signs are visible to drivers.

Summarized in **Table 2**, the results of the spot speed study revealed that approximately 75% of drivers complied with 15 miles per hour school speed zone limit during the AM peak hour at the location where it begins on northbound NW 17th Avenue. More than 93% of drivers were recorded traveling at or below 20 miles per hour. Similar results were noted during the PM peak hour. These compliance rates far exceed the compliance rates that normal speed limits are established against, indicating that motorists' speeds are within expected ranges.

Henry M. Flagler Elementary School Speed Study Results – Spot speed data was collected on eastbound SR-968/Flagler Street, which is a 5-lane urban minor arterial with a posted speed limit of 40 miles per hour. Located south of SR-836 and east of SR-959/Red Road, the school is surrounded primarily by residential neighborhoods

and strip commercial uses. Data was collected in the eastbound direction to ensure that a relatively uninterrupted flow of traffic approached the beginning of the school speed zone.

Results summarized in **Table 3** reveal that during the AM peak hour more than 80% of the drivers complied with the 15 miles per hour school speed zone limit. Further, more than 93% were traveling at or below 20 miles per hour. During the PM peak hour, the compliance rates similarly dropped to nearly 78% and 91%, respectively. Overall, compliance rates of the school speed zone limit of 15 miles per hour are consistent within accepted ranges of speed when setting speed limits, per the MUTCD.

Lake Stevens Elementary School Speed Study Results – Located in northwest Miami-Dade County near the City of Miami Gardens, spot speed data was collected on westbound SR-860/Miami Gardens Drive. In front of the school, SR-860/Miami Gardens Drive is a 6-lane urban arterial with a posted speed limit of 45 miles per hour. Overhead signs with flashing beacons warning drivers of the impending school speed zone are conspicuously visible.

Summarized in **Table 4**, spot speed study results indicate that approximately 84% of motorists drove at or less than 15 miles per hour as they entered the school speed zone during the AM and PM peak hours. Further, more than 96% of drivers travelled at or less than 20 miles per hour during both peak hours. This compliance rate was recorded even though these motorists had to slow down the most; from 45 miles per hour to 15 miles per hour.

Eugenia B. Thomas Elementary School Speed Study Results – The fifth school site sampled has the unique characteristic of being the only school in Miami-Dade County with a TSZ. School speed zones are implemented along NW 114th Avenue, which is a 4-lane divided urban collector with a normal posted speed limit of 35 miles per hour. The TSZ is located between the normal posted speed limit and the school zone speed limit. It has a posted transitional speed limit of 25 miles per hour, which is enforceable during morning arrival and afternoon dismissal school hours. Spot speed data was collected at the beginning of the school speed zone where speed limits are reduced to 15 miles per hour during select morning and afternoon periods that coincide with the school's arrival and dismissal pattern.

Results are summarized in **Table 5**. Along NW 114th Avenue, spot speed data revealed that during the AM peak hour, nearly 90% of the drivers traveled at or below 15 miles per hour and almost 97% of drivers were traveling at or below 20 miles per hour. These results are similar to those recorded during the PM peak hour. The speed data also revealed that a large percentage of motorists travelled between 0 and 9 miles per hour upon entering the speed zone on southbound NW 114th Avenue. More than 56% of the drivers during the AM peak hour and nearly 63% of drivers in the PM peak hour had speeds recorded less than 10 miles per hour.

It should be noted that field observations at this school revealed that the lack of on-site storage for parent pick-up and drop-off activities forced parents to stack on NW 114th Avenue. It is postulated that this queue on NW 114th Avenue may have produced sufficient friction to impede traffic flow and, hence, speeds as drivers approached the school speed zone. These observations reflect the complex nature of travel speeds in school zones, as they can be influenced by site design and geometric conditions of the roadway.

Table 1 - Scott Lake Elementary School Speed Study

NW 12th Avenue - Urban Collector - Posted Speed 30 mph

Data Collected 05/25/2011 - Northbound

AM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
AM	7:15	7:30	0	2	4	4	0	0	0	0	0	0	0	0
	7:30	7:45	0	9	8	5	0	1	0	0	0	0	0	0
	7:45	8:00	0	22	11	1	1	0	0	0	0	0	0	0
	8:00	8:15	0	23	6	2	0	0	0	0	0	0	0	0
	8:15	8:30	0	28	7	2	0	0	0	0	0	0	0	0
	8:30	8:45	1	10	16	1	4	0	0	0	0	0	0	0
Total	**168**		**1**	**94**	**52**	**15**	**5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**0.60%**	**55.95%**	**30.95%**	**8.93%**	**2.98%**	**0.60%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM)											
	Speed											
AM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	0.60%	56.55%	87.50%	96.43%	99.40%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

PM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
PM	13:45	14:00	0	25	11	1	0	0	0	0	0	0	0	0
	14:00	14:15	0	13	12	5	1	0	0	0	0	0	0	0
	14:15	14:30	0	6	6	5	2	0	0	0	0	0	0	0
Total	**87**		**0**	**44**	**29**	**11**	**3**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**0.00%**	**50.57%**	**33.33%**	**12.64%**	**3.45%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (PM)											
	Speed											
PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	0.00%	50.57%	83.91%	96.55%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

AM and PM Summary

Total AM and PM		Speed Intervals (mph)											
		0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
Total	**255**	1	138	81	26	8	1	0	0	0	0	0	0
Percentage	**100.00%**	**0.39%**	**54.12%**	**31.76%**	**10.20%**	**3.14%**	**0.39%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM and PM)											
	Speed											
AM and PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	0.39%	54.51%	86.27%	96.47%	99.61%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 2 - Charles R. Drew Elementary School Speed Study

NW 17th Avenue - Urban Minor Arterial - Posted Speed 35 mph

Data Collected 05/25/2011 - Northbound

AM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
AM	7:15	7:30	6	37	16	1	1	0	0	0	0	0	0	0
	7:30	7:45	3	62	16	3	0	0	0	0	0	0	0	0
	7:45	8:00	2	55	8	4	0	0	0	0	0	0	0	0
	8:00	8:15	6	69	8	3	0	0	0	0	0	0	0	0
	8:15	8:30	7	71	11	1	0	0	0	0	0	0	0	0
	8:30	8:45	3	37	28	9	8	2	1	0	0	0	0	0
Total	**478**		**27**	**331**	**87**	**21**	**9**	**2**	**1**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**5.65%**	**69.25%**	**18.20%**	**4.39%**	**1.88%**	**0.42%**	**0.21%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM)											
	Speed											
AM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	5.65%	74.90%	93.10%	97.49%	99.37%	99.79%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

PM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
PM	13:45	14:00	4	59	23	2	3	0	0	0	0	0	0	0
	14:00	14:15	15	66	21	6	1	1	0	0	0	0	0	0
	14:15	14:30	7	59	17	7	1	0	0	0	0	0	0	0
Total	**292**		**26**	**184**	**61**	**15**	**5**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**8.90%**	**63.01%**	**20.89%**	**5.14%**	**1.71%**	**0.34%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (PM)											
	Speed											
PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	8.90%	71.92%	92.81%	97.95%	99.66%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

AM and PM Summary

Total AM and PM		Speed Intervals (mph)											
		0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
Total	**770**	53	515	148	36	14	3	1	0	0	0	0	0
Percentage	**100.00%**	**6.88%**	**66.88%**	**19.22%**	**4.68%**	**1.82%**	**0.39%**	**0.13%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM and PM)											
	Speed											
AM and PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	6.88%	73.77%	92.99%	97.66%	99.48%	99.87%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 3 - Henry M. Flagler Elementary School Speed Study

SR-968/West Flagler Street - Urban Minor Arterial - Posted Speed 40 mph

Data Collected 05/25/2011 – Eastbound

AM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
AM	7:15	7:30	18	85	28	10	1	0	0	0	0	0	0	0
	7:30	7:45	34	97	19	6	0	0	0	0	0	0	0	0
	7:45	8:00	25	91	26	7	1	0	0	0	0	0	0	0
	8:00	8:15	30	104	22	2	0	0	0	0	0	0	0	0
	8:15	8:30	45	86	15	7	1	0	0	0	0	0	0	0
	8:30	8:45	39	94	15	7	15	2	0	0	0	0	0	0
Total	**932**		**191**	**557**	**125**	**39**	**18**	**2**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**20.49%**	**59.76%**	**13.41%**	**4.18%**	**1.93%**	**0.21%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM)											
	Speed											
AM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	20.49%	80.26%	93.67%	97.85%	99.79%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

PM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
PM	13:45	14:00	35	80	30	4	1	0	0	0	0	0	0	0
	14:00	14:15	23	116	21	2	0	2	0	0	0	0	0	0
	14:15	14:30	24	95	13	15	12	6	0	0	0	0	0	0
Total	**479**		**82**	**291**	**64**	**21**	**13**	**8**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**17.12%**	**60.75%**	**13.36%**	**4.38%**	**2.71%**	**1.67%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (PM)											
	Speed											
PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	17.12%	77.87%	91.23%	95.62%	98.33%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

AM and PM Summary

Total AM and PM		Speed Intervals (mph)											
		0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
Total	**1411**	273	848	189	60	31	10	0	0	0	0	0	0
Percentage	**100.00%**	**19.35%**	**60.10%**	**13.39%**	**4.25%**	**2.20%**	**0.71%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM and PM)											
	Speed											
AM and PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	19.35%	79.45%	92.84%	97.09%	99.29%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 4 - Lake Stevens Elementary School Speed Study

SR-860/Miami Gardens Drive/NW 183rd Street Urban Arterial - Posted Speed 45 mph

Data Collected 05/25/2011 – Westbound

AM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
AM	7:15	7:30	5	76	8	1	0	0	0	0	0	0	0	0
	7:30	7:45	6	58	9	3	0	0	0	0	0	0	0	0
	7:45	8:00	7	61	8	0	1	0	0	0	0	0	0	0
	8:00	8:15	12	59	17	0	0	0	0	0	0	0	0	0
	8:15	8:30	8	61	13	0	0	0	0	0	0	0	0	0
	8:30	8:45	8	54	8	4	7	2	0	0	0	0	0	0
Total	**496**		**46**	**369**	**63**	**8**	**8**	**2**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**9.27%**	**74.40%**	**12.70%**	**1.61%**	**1.61%**	**0.40%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM)											
	Speed											
AM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	9.27%	83.67%	96.37%	97.98%	99.60%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

PM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
PM	13:45	14:00	17	79	16	1	1	1	0	0	0	0	0	0
	14:00	14:15	34	64	9	0	0	0	0	0	0	0	0	0
	14:15	14:30	16	68	13	4	3	2	0	0	0	0	0	0
Total	**328**		**67**	**211**	**38**	**5**	**4**	**3**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**20.43%**	**64.33%**	**11.59%**	**1.52%**	**1.22%**	**0.91%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (PM)											
	Speed											
PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	20.43%	84.76%	96.34%	97.87%	99.09%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

AM and PM Summary

Total AM and PM		Speed Intervals (mph)											
		0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
Total	**824**	113	580	101	13	12	5	0	0	0	0	0	0
Percentage	**100.00%**	**13.71%**	**70.39%**	**12.26%**	**1.58%**	**1.46%**	**0.61%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM and PM)											
	Speed											
AM and PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	13.71%	84.10%	96.36%	97.94%	99.39%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

Table 5 - Eugenia B. Thomas Elementary School Speed Study

NW 114th Avenue - Urban Collector - Posted Speed 35 mph

Data Collected 05/25/2011 – Southbound

AM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
AM	7:15	7:30	7	47	26	9	3	0	0	0	0	0	0	0
	7:30	7:45	18	55	2	0	0	0	0	0	0	0	0	0
	7:45	8:00	49	52	1	0	0	0	0	0	0	0	0	0
	8:00	8:15	120	14	0	0	0	0	0	0	0	0	0	0
	8:15	8:30	129	0	0	0	0	0	0	0	0	0	0	0
	8:30	8:45	31	42	16	4	4	0	0	0	0	0	0	0
Total	**629**		**354**	**210**	**45**	**13**	**7**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**56.28%**	**33.39%**	**7.15%**	**2.07%**	**1.11%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM)											
	Speed											
AM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	56.28%	89.67%	96.82%	98.89%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

PM Summary

Period	Time		Speed Intervals (mph)											
	From	To	0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
PM	13:45	14:00	69	21	0	0	0	0	0	0	0	0	0	0
	14:00	14:15	105	9	1	0	1	0	0	0	0	0	0	0
	14:15	14:30	1	44	20	5	1	1	0	0	0	0	0	0
Total	**278**		**175**	**74**	**21**	**5**	**2**	**1**	**0**	**0**	**0**	**0**	**0**	**0**
Percentage	**100.00%**		**62.95%**	**26.62%**	**7.55%**	**1.80%**	**0.72%**	**0.36%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (PM)											
	Speed											
PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	62.95%	89.57%	97.12%	98.92%	99.64%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

AM and PM Summary

Total AM and PM		Speed Intervals (mph)											
		0-9	10-15	16-20	21- 25	26- 30	31- 35	36-40	41- 45	46- 50	51- 55	56- 60	>=61
Total	**907**	529	284	66	18	9	1	0	0	0	0	0	0
Percentage	**100.00%**	**58.32%**	**31.31%**	**7.28%**	**1.98%**	**0.99%**	**0.11%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**

Period	Cumulative Percentage (AM and PM)											
	Speed											
AM and PM	**< 10**	**< 15**	**< 20**	**< 25**	**< 30**	**< 35**	**< 40**	**< 45**	**< 50**	**< 55**	**< 60**	**All**
	58.32%	89.64%	96.91%	98.90%	99.89%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

SYNOPSIS OF THE SPEED DATA. From the limited data collected it appears that the higher the posted speed limit on the roadway, the greater the level of compliance with the school speed zone limit upon entering the school speed zone. While this statement seems to be counterintuitive and contradicts findings from research conducted by TTI and other respected institutions, it is believed that a confluence of factors contributes to motorists complying with posted speed limits near schools. The following is a summary of the confidence results during this study:

Entering Speed Zone	Percent of Rates
Less than 15 mph	50% to 90%
Less than 20 mph	83% to 96%
Less than 25 mph	96% to 98%

Compliance rates of school zone speed limits are influenced by many things. These include the level of congestion on the roadway, the proximity of upstream traffic control devices (stop signs or traffic signals), the visibility of signs warning drivers of the impending school speed zone, and on-site parent pick-up/drop-off queues that spill back onto the adjacent roadway. Compliance is also improved by an aggressive education campaign targeting drivers who frequently travel through the school speed zone, and by aggressive enforcement against excessive speeding.

Each of the studied sites has a highly visible overhead flashing beacon sign informing drivers of the upcoming 15 miles per hour school speed zone, which has been demonstrated to be an effective tool in mitigating travel speeds in school zones. The sites were specifically selected for this study to evaluate compliance rates on roadways with an ever-increasing normal posted speed limit, from 30 miles per hour to 45 miles per hour. These various factors all work together to affect travel speeds, albeit to an unknown degree in this study.

It should be noted that the data collected was only gathered during one school day, and only for a few Miami-Dade elementary schools. Further, the data collected was limited to only the beginning of the school speed zone, rather than being sampled from the beginning, middle, and end of the school speed zone where a complete understanding of the speeding problem can be determined. To ensure sufficient data is gathered, it is recommended as a guideline that spot speed data be obtained during 3 typical weekdays at several strategic locations within the school speed zone along a subject corridor. This allows for a spatial speed analysis to determine if a speeding problem exists and where it is located.

It is important to note that implementation of advanced warning signs must be evaluated on a case-by-case basis. A spot speed data and spatial analysis will provide actual data of travel speeds outside of the school zone. If collected before and after implementation of the advanced warning signs, this will provide quantifiable evidence of the success or failure of such treatment.

4. Guidelines for Implementing Advanced Warning in School Speed Zones

4.1. Advantages and Disadvantages of Advanced Warning in School Zones

Introducing an advanced warning sign prior to a school speed zone allows drivers to gradually slow their vehicle down, rather than an abrupt speed reduction. In situations with a high normal speed limit, such as 45 miles per hour, this requires the driver to reduce their speed by 30 miles per hour or more. The implementation of advanced warning signs would provide a buffer against such an abrupt reduction which would improve compliance rates with school speed zone limits. It would also minimize the need for strict enforcement as more drivers would be obeying the speed limit.

Extreme travel speed differences have long been known to be a contributing factor towards vehicle crashes. A graduated reduction in travel speed would have a positive impact upon these crashes. With less of a speed differential at the beginning of the school speed zone, it is believed that vehicular crashes and the severity of such impacts would be reduced because the difference in travel speeds between the vehicles would be lessened. This is particularly true as the speed limit differential increases, i.e. when the normal posted speed limit increases while the school speed zone remains 15 miles per hour per Miami-Dade County policy.

However, the implementation of additional signs may confuse drivers. Pursuant to Section 2A.04 of the MUTCD, 2009 Edition, the excessive use of regulatory and warning signs should be avoided. *"Regulatory and warning signs should be used conservatively because these signs, if used excessively, tend to lose their effectiveness."* This is particularly true when the signs only apply to specific times of the day, such as school arrival and dismissal periods.

Following are advantages and disadvantages of implementing advanced warning in school zones:

Advantages	Disadvantages
• Potential safety improvement for children walking to school. • Improves compliance with School Zone speed limit and other speed limits. • Potential reduction in need for enforcement. • Potential reduction in vehicular crashes due to smaller speed differentials.	• May confuse the drivers about the speed limits. • Times of day for advanced warning may confuse the drivers. • Can create over signing. • Increase cost of installing and maintenance.

4.2. Guidelines for Implementing Advanced Warning in School Speed Zones

Understanding that each individual site requires an evaluation to determine if the installation of advanced warning signs is an appropriate treatment to solve the identified problem, a flow chart of criteria and analysis was prepared that should be satisfied to implement such treatment. This flow chart is graphically displayed in **Figure 1**.

Identify a Speeding Problem and Posted Speed Limit - Initially, a vehicular speeding problem or safety concern due to high speeds along a corridor near a school speed zone must be identified. Once the concern has been identified and confirmed to be related to speed near a school speed zone, the normal posted speed limit on the corridor prior to the school speed zone is determined. In cases when the reduction in speed from the regular posted speed limit and the school zone speed limit is drastic the need for advanced warning signs would be greater.

Collect Location Specific Volume and Speed Data - Assuming a speeding concern exists, the next step in determining if advanced warning signs would be an appropriate mitigation measure is to obtain data. This data would include a roadway inventory cataloging functional classification and the number of lanes, posted speed limits, median type, on-street parking, bicycle lanes, and sidewalks. An existing sign inventory should be performed documenting the type and location of the warning and regulatory signs present, as well as the location of traffic control devices such as stop signs and traffic signals. The number of crashes and speeding citations that have been issued within the study area should also be gathered to determine if a safety and/or speeding problem exists. Field observations should also be conducted to visually assess the speeding problem and the impact to school-age pedestrians walking along the corridor.

Specific corridor data must also be collected to conduct the speeding analysis required to quantifiably determine if a speeding problem exists. Peak hour traffic volumes and spot speed studies at the beginning and ending of the targeted school speed zones will be gathered. If the school speed zone is sufficiently long, then a spot speed study at the midpoint of the corridor may also be necessary. Speed data should be gathered for a 3-day period of a typical school week, such a Tuesday, Wednesday, and Thursday. The data should be sorted in bins such that the 85th percentile speed can be ascertained at each location data was collected.

Analyze the Data - Upon summarizing the collected speed data along the study area corridor, an analysis of the speeds at specific locations should be performed. This analysis should closely resemble the speed data analysis contained herein at the 5 school sites. Additionally, by plotting the recorded speeds against their corridor spot locations, it can be easily confirmed if a speeding problem exists before or within a school speed zone.

Three Tiered Mitigation Approach - Once speed and crash data have been analyzed, a determination of whether a speeding and/or safety problem exists must be completed. This determination should also identify the magnitude of the problem and the problem's approximate location. If a speeding problem has been confirmed, then mitigation treatments may be considered to rectify the problem.

Traditionally, Education, Enforcement and Engineering (the "3 Es") are the mitigation tools used to solve problems within our transportation system. Rather than readily identifying complex and costly engineering solutions for speeding problems, it is recommended that education and enforcement be included in the evaluation process first. Only after Education and Enforcement have been explored should an Engineering

solution, such as advanced warning signs, be evaluated and implemented. This approach to identifying and applying the simplest and least costly solution is known herein as the Tiered Mitigation Approach.

Tier #1 – Education. Assuming that a speeding problem has been confirmed at a location near a school speed zone, the first step to solving the problem would be to conduct an education program. This program would educate parents who drive their children to school along with other drivers who use the subject corridor as to the school zone speed limit of 15 miles per hour and where the school zone begins and ends. Drivers would be informed of the risks associated with speeding within a school speed zone and the potential danger school-age children encounter as they walk to school adjacent to speeding vehicles.

After providing the educational information, an assessment of the affect Education had upon travel speeds in the identified corridor segment would be performed. If speeding were considered to still be a problem, then the second tier of mitigation treatments would be engaged.

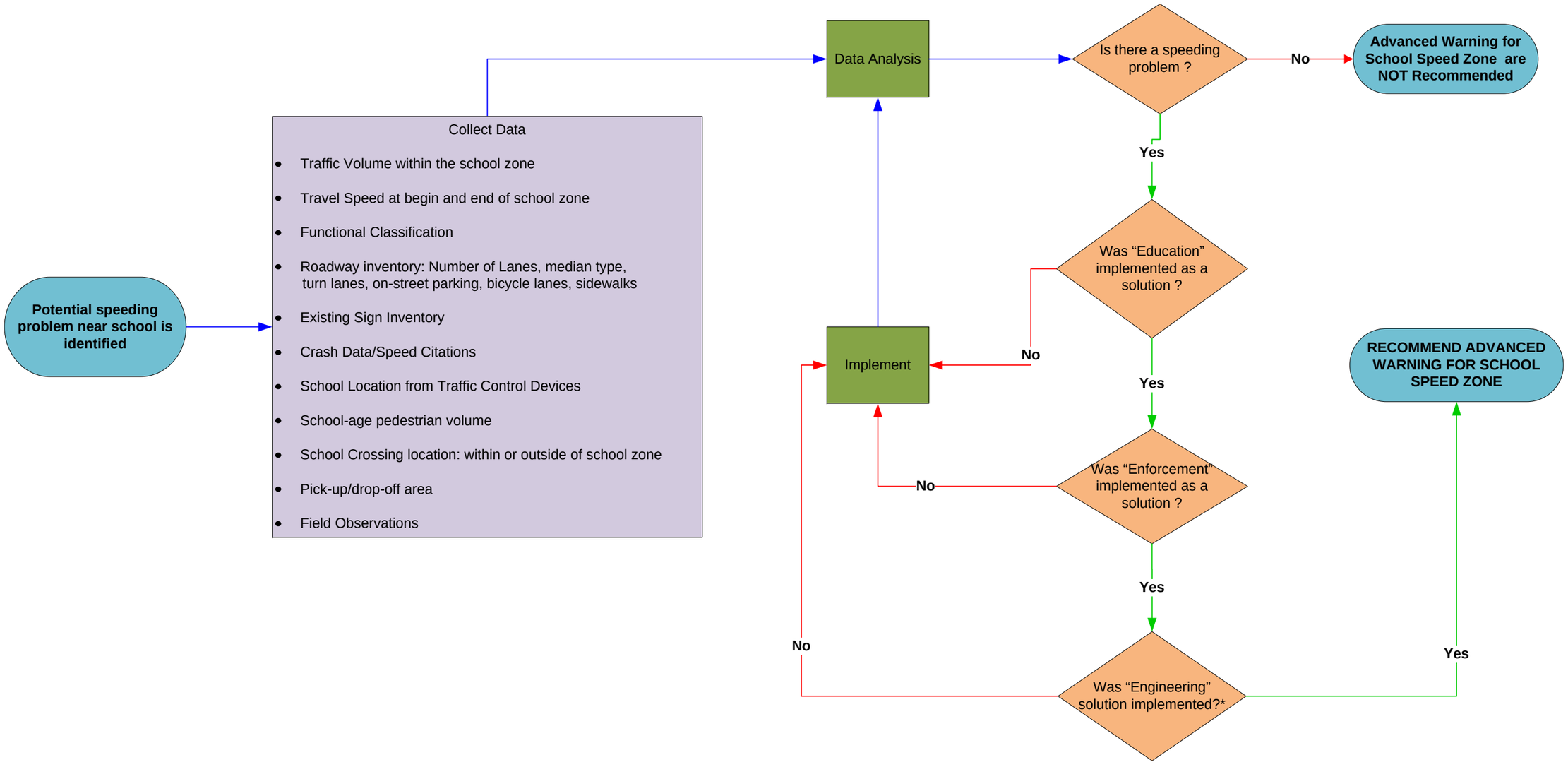
Tier #2 – Enforcement. If education fails to address the identified speeding problem, then the second tier solution, enforcement, is engaged. An active and visible police presence prior to and within the school speed zone is mobilized to provide deterrence to speeding motorists. Traditionally, visible enforcement on its own has a short term positive effect that tends to wane over time. Driver behavior is modified temporarily, resulting in slower speeds, but over a longer period drivers usually revert back to previous speeding habits. To improve enforcement as a long term behavioral modification tool, it is recommended that education be jointly used with an enforcement program. It is believed such a joint program would have a better opportunity of successfully reducing travel speeds over the long term than enforcement alone.

Tier #3 – Engineering. If education and enforcement fail to curb the speeding problem, then the third tier of mitigation solutions is explored. This involves applying an engineering solution, such as installing overhead flashing beacons that visibly warn drivers of the upcoming school speed zone and subsequent reduced speed limit. Once these preliminary engineering solutions, such as flashing beacons are installed, follow-up analysis is required to determine if the selected engineering solution eliminated the identified speeding problem. If these mitigation options fail to solve the speeding problem, then the installation of advanced warning signs should be evaluated for implementation within the study area.

As noted previously, the flow chart of criteria and analysis should be followed to implement an engineering solution such as advanced warning signs in school speed zones. This flow chart is graphically displayed in **Figure 1**.

Figure 1

Flow Chart For Implementing Advanced Warning for School Speed Zones



*Example solutions may include overhead flashing beacons and ground posted school signs with flashing beacons.

4.3. Typical Signing Plan for Advanced Warning Signs In School Speed Zones

Depicted in **Figure 2** is a typical school zone signing plan that includes advanced warning signs. This typical signing plan has been developed consistent with principles espoused within the MUTCD and local Miami-Dade County practice. The advanced warning signs are also equipped with flashing beacons; that will be in effect only during school hours times of a day. Recent research has demonstrated that motorists are more likely to notice and obey flashing beacons. Pursuant to Section 7B.16 of the MUTCD, 2009 Edition, *"A Reduced School Speed Limit Ahead (S4-5, S4-5a) sign should be used to inform road users of a reduced speed zone where the speed limit is being reduced by more than 10 mph, or where engineering judgment indicates that advance notice would be appropriate".* The distance separating the various sign assemblies is dependent on the travel speeds of the roadway and the stopping distances associated with those speeds. A tabular summary of those distances, listed by speed, is provided in **Table 6** and are offered as a component of the implementation guidelines depicted in **Figure 2**. However, final sign location and spacing shall be determined at each school site and adjusted based on existing conditions.

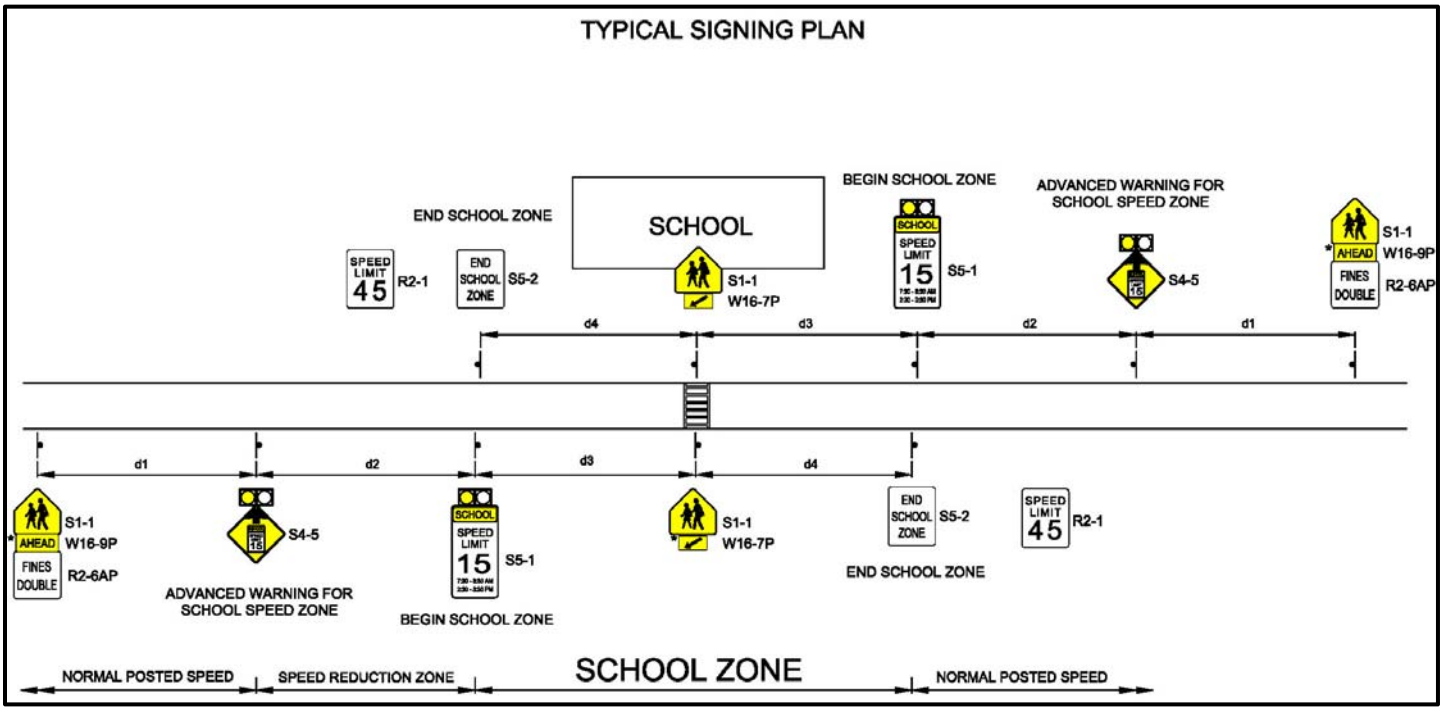


Figure 2 - Typical School Zone Speed Zone with Advanced Warning Signs

** Note: Signs W16-7P and W16-9P will only be used when a crosswalk is present within the School Zone*

Table 6

Spacing Between Signs for School Zones with Advanced Warning Signs

Posted or 85th Percentile Speed (mph)	School Speed Limit (mph)	Distance between Advance Warning Signs[X] D1	D2 (feet)[Y]	D3 (feet)[X]	D4 (feet)[X]
45	15	100	283	200	200
40	15	100	224	200	200
35	15	100	169	200	200
30	15	100	120	200	200

**Advanced Warning for School Speed Zone is recommended where the speed limit is being reduced by more than 10 mph*

[X] Obtained from 2010 FDOT Design Standards - Index No. 17344

[Y] Include decision sight distance and braking distance for speed differential

Definitions:

D1 - Distance between School Advance Crossing assembly and Reduced School Speed Limit Ahead (S4-5) sign (feet)

D2 - Minimum distance required to reduce from Posted or 85th Percentile Speed to 15 mph (feet)

D3 - Minimum distance between School Speed Limit (S5-1) sign and school driveway or marked crosswalk (and School Crossing assembly) (feet)

D4 - Distance between school driveway or marked crosswalk (and School Crossing assembly) to end of School Zone (feet)

Note: Please see Figure 2 for a graphical depiction of the recommended sign locations.

The recommended sign spacing summarized in **Table 6** is a guideline. It is understood that each location is unique and presents numerous challenges and physical impediments that the engineer must address when installing the signs for a school speed zone with advanced warning signs. This is particularly true in urban settings where the clustering of other signs reduces the visibility and effectiveness of regulatory signs.

4.4. Estimated Cost to Implement Advanced Warning in School Speed Zones

It is understood that the implementation of advanced warning signs in school speed zones includes a unique set of signs and conditions for each location. To obtain a generalized cost estimate for a typical set of advanced warning signs, the signing plan recommended and displayed in **Figure 2** is used as a base condition. Costs (2011 dollars) for the various sign assemblies and other materials are from information obtained from the Miami-Dade County Traffic Engineering Division, and are summarized in **Table 7**.

Assuming that a traditional school speed zone is currently in place and that advanced warning signs are proposed to augment the existing signage, it is estimated that a total of two sign assemblies (S4-5, MUTCD 2009) in both directions of traffic flow are needed. To improve visibility and compliance with the advanced warning signs, it is recommended that each assembly be outfitted with flashing beacons.

The data collection required for an advanced warning in school speed zone justification study depends on the number of data points to be collected and the number of data collection machines needed. Assuming that the study area includes only one roadway segment and that speed data is needed prior to the school speed zone; and at the beginning, middle, and end of the school speed zone; 4 data locations in each direction of flow are needed. This equates to a total of 8 data collection machines that are required for 3 consecutive days of a typical week when school is in session.

The costs for an advanced warning in school speed zone justification study are highly dependent upon each site's characteristics. The more complex the study area, the more professional time is needed to accurately assess the problem and identify the most appropriate mitigation treatment. Assuming a moderate degree of complexity requiring professional engineering experience, it is estimated that a signed and sealed study would have fees of $4,000.

The cost for an individual speed limit sign (S4-5, MUTCD 2009) assembly with attached flashing beacons, including the ground mounted sign and the solar panel is approximately $7,000 according to information obtained from the Miami-Dade County Traffic Engineering Division. For four sign assemblies with flashing beacons, the total material cost to implementation for both directions of travel on a single, typical roadway is a minimum of $14,000. Please note costs estimates include the cost for engineering, mobilization, and any contingencies associated with the design preparation and construction effort where each are estimated to be 10% of the total sign assembly cost.

Table 7 - Implementation Costs

TSZ Components	Cost
Data Collection*	$5,000
Justification Study	$4,000
Sign Assemblies with Flashing Beacons (4)**	$14,000
Subtotal:	***$23,000***
Engineering (10%)	$2,300
Mobilization (10%)	$2,300
Contingency (10%)	$2,300
Total:	***$29,900.00***

**Assumed to include a total of 8 data collection locations for three 24-hour periods*

***Signs assemblies assumed for both directions of traffic flow on one roadway*

5. Recommendations

The implementation of advanced warning in school speed zones is a relatively new transportation mitigation treatment in Miami-Dade County. Excessive speeding and a lack of compliance with school zone speed limits can be mitigated in a number of ways. One solution in the transportation "toolbox" for those problems should be the implementation of advanced warning in school speed zones.

Installing advanced warning signs in a school zone should be part of a progressive process to address speeding in school speed zones. A specific set of characteristics must be identified that advanced warning signs are best suited to address and other mitigation measures should be attempted and determine to be ineffective before additional signs are installed. As graphically outlined in **Figure 1** and simply summarized in a **Table 8** in a "checklist" form, a set of criteria guidelines are offered to assist local Miami-Dade County jurisdictions and agencies when determining if advanced warning signs are the most appropriate treatment at a specific location.

1) Noted Excessive Speeding and/or Crash Histories. A school zone location with measured 85th percentile speeds in excess of 20 miles per hour (the 15 miles per hour school zone speed limit plus a 5 miles per hour cushion), or a history of speed-related pedestrian crashes that exceed statewide averages for similar roadways, are candidates for the implementation of advanced warning signs. It is recommended the speed data be collected over a Tuesday, Wednesday, and Thursday period while school is in session. Further, it is recommended that a three-year compilation of recent crash data be gathered. The spot speed data specifically collected at locations prior to and within the school speed zone will allow the analyst to quantitatively evaluate the speeding and safety claims, and identify where the speeding or safety problem exists.

2) Geometric Layout of the School Speed Zone. Even if a speeding and crash problem is proven to exist within a school speed zone, the physical geometry of the roadway must be favorable towards the implementation of advanced warning signs in a school speed zone. This includes the proximity of traffic control devices, such as traffic signals and stop signs, to the entrance to the school speed zone. If they are located too close to a school speed zone, the natural interruption of traffic flow created by those devices will reduce travel speeds along the corridor. However, if no such devices are present along the corridor and little friction is generated to impede travel speeds and traffic flow prior to and within the school speed zone, then advanced warning signs may be viable a candidate.

3) Effectiveness of Other Mitigation Treatments. As noted previously, education, enforcement, and other modest engineering solutions should be explored first before implementing a treatment such as advanced warning signs in a school speed zone. If a speeding problem is identified, it is the objective of the engineer to modify the driver behavior to better comply with the posted speed limits.

   It is recommended that an education campaign be attempted first to influence drivers to slow down in the school speed zone. If that is determined to be ineffective, then the next step should involve a more visible police presence to enforce the speed limit. Given that enforcement is rarely viewed as a long term solution, if a more permanent solution is determined to be needed, then the installation of advanced warning signs should be considered.

Table 8
Criteria for Implementing Advanced Warning Signs in School Speed Zones

No.	Criteria	Details	Yes	No
1	Travel Speeds*	Do travel speed data collected at begin, middle, and end of school zones indicate a speeding problem?	☐	☐
		Is there any traffic congestion?	☐	☐
		Does the pick-up/drop-off area cause any change in travel speeds or create congestion?	☐	☐
2	Speeding Complaints	Are there any complaints by the locals and parents regarding excessive speeding of vehicles?	☐	☐
3	Speeding Citations	Are there any speeding citations in the school speed zone?	☐	☐
4	Crash History (Speed Related)	Is there crash data involving pedestrians?	☐	☐
		Is there crash data involving speeding vehicles?	☐	☐
5	Traffic Control Devices Layout and Signage	Is the school zone located near a signalized intersection or a stop controlled intersection?	☐	☐
6	Pedestrian Crossing Locations and School Crossing Guard Presence	Are the pedestrian crossings located within the school zone?	☐	☐
		Are school crossing guards present within the school speed zone?	☐	☐
7	Existing Sign Inventory	Do overhead flashing beacons exist in the school zone?	☐	☐

**Needs to be satisfied for implementation of advanced warning signs in school speed zones*

The criteria for the implementation of advanced warning in school speed zones, summarized in **Table 8**, are meant to provide a simple-to-use checklist to determine if such a solution is viable. If the school speed zone along a subject corridor satisfies many of these criteria, then this is a strong indicator that such a treatment may be justified. If, however, none of the criteria are met, the opposite may be true. It should be noted that these are simply guidelines and that a subject corridor that meets only a few of the criteria may be well-justified in implementing this type of engineering treatment. Similarly, a subject corridor that satisfied nearly all of the criteria may not be well-suited for such a mitigation treatment. These decisions should be made with the discretion of the engineer of record and local permitting jurisdiction.

Timeframe to Implement Advanced Warning in School Speed Zones. The timeframe for implementing the advanced warning in a school zone includes initiating the justification study for such devices, the permit and approval of installing the sign assemblies, and the construction and installation of the signs themselves. The time to complete each of these steps is dependent upon the complexity of the site location and the level of detailed information necessary to obtain approval. Based on a typical proposed installation site in an urban area of Miami-Dade County, it is estimated that the justification study would require between 3 and 6 months. This timeframe is representative of the steps needed to complete the various tasks outlined in the process flow chart depicted in **Figure 1** of this document, which includes evaluations of less intrusive and less costly solutions before approving the implementation of an additional set advanced warning signs.

Once conceptual approval has been granted by the local authority based on the justification study, a specific signing plan must be developed and permitted. It is estimated that this process would require between 1 and 2 months to be completed. Finally, the fabrication and installation of the sign assemblies is estimated to take between 1 and 2 months to complete. Overall, the schedule to obtain approval, permit, and construct a typical set of advanced warning in school speed zones in Miami-Dade County is estimated to be between 5 and 10 months. These estimated timeframes represent an average schedule based on a typical urban site with moderate complexity. Each site location will have a unique set of characteristics that the engineer must address; these factors may alter the schedule substantially.

Task	Timeframe to Complete
Justification Study and Conceptual Approval	3 – 6 months
Signing Plan and Permit Approval	1 – 2 months
Fabrication and Installation of Signs	1 – 2 months
Total Implementation Time:	***5 – 10 months***

6. Theoretical Applications of Advanced Warning in School Speed Zones

Because advanced warning in school speed zones are meant to improve safety for children walking to and from school, crash rates and frequencies should be one criterion that will be explored. The speed differential between the regular posted speed limit and the reduced school zone speed limit will be another, as will be the typical student pedestrian volume of the school. Using the selection criteria for pilot project schools outlined in the *School Zone Traffic Congestion Study* prepared for the Miami-Dade MPO in 2002, the four candidate sites (Scott Lake Elementary School, Charles R. Drew Elementary School, Henry M. Flagler Elementary School, and Lake Stevens Elementary School) were considered to explore the viability of implementing advanced warning in school speed zones. They were selected based on a desire to include a cross section of elementary and middle schools within different geographical areas.

To theoretically evaluate applying this engineering treatment at one of the four schools, field observations are recommended to be performed to document noted concerns and verify posted speed limits and general student pedestrian volume intensity. Next, condition diagrams are suggested to depict the school speed zone signing present at the site. An aerial photograph that illustrates key land uses and features that affect the vehicular and non-vehicular transportation system is also recommended.

PILOT SITE EVALUATIONS. An initial screening of the four school sites was performed to determine if one of these locations is a viable candidate for the implementation of advanced warning in school speed zones.

Scott Lake Elementary School **-** The school speed zone implemented on the 2-lane NW 12th Avenue segment is situated such that speed data was collected for the northbound direction of traffic. Data was collected in this direction to ensure that the speed data is not corrupted by upstream traffic control devices.

A speed data analysis was conducted for Scott Lake Elementary School based on the data collected and presented herein. Results indicate that during the AM peak hour more than 87% were recorded traveling at 20 miles per hour or less. This reveals that less than 13% of drivers were driving more than 5 miles per hour above the posted School Speed Zone limit of 15 miles per hour. During the PM peak hour, compliance rates showed a slight reduction to nearly 84% at or less than 20 miles per hour. Based on the results from this preliminary speed data analysis since this rate is nearly the 85 percentile threshold for compliance rates in the school speed zone, Scott Lake Elementary School could be a viable candidate for the implementation of advanced warning signs in school speed zones; therefore, further analysis is required to determine whether such treatment is the most appropriate solution at this specific location.

Charles R. Drew Elementary School **-** The school speed zone implemented on the 5-lane NW 17th Avenue segment is situated such that speed data was collected for the northbound direction of traffic. Data was collected in this direction to ensure that the speed data is not corrupted by upstream traffic control devices.

A speed data analysis was conducted for Henry Charles R. Drew Elementary School based on the data collected and presented herein. Data revealed that more than 93% of drivers were traveling at less than 20 miles per hour on NW 17th Avenue during the morning and afternoon school speed zone times. Since this exceeds the 85% percentile threshold for compliance rates in the school speed zone, no speeding problem was recorded in this school speed zone at this time. Therefore, advanced warning signs are not recommended on NW 17th Avenue.

Henry M. Flagler Elementary School **-** The school speed zone implemented on the 5-lane SR-968/West Flagler Street segment is situated such that speed data was collected for the eastbound direction of traffic. Data was

collected in this direction to ensure that an uninterrupted flow of vehicles enters the school speed zone, so their speeds are not corrupted by upstream traffic control devices.

A speed data analysis was conducted for Henry M. Flagler Elementary School based on the data collected and presented herein. Data revealed that 93% of drivers were traveling at less than 20 miles per hour on West Flagler Street during the morning and afternoon school speed zone times. Since this exceeds the 85% percentile threshold for compliance rates in the school speed zone, no speeding problem was recorded in this school speed zone at this time. Therefore, advanced warning signs are not recommended on West Flagler Street.

Lake Stevens Elementary School – A school speed zone is implemented on the 6-lane urban arterial SR-860/Miami Gardens Drive in front of Lake Stevens Elementary School. A review of the geometric layout of the roadway segment revealed that the optimum traffic flow direction to collect speed data is westbound as it resembles an uninterrupted flow segment with few upstream traffic control devices that would affect speed data collection.

A speed data analysis was conducted for Lake Stevens Elementary School based on the data collected and presented herein. Data revealed that 96% of drivers were traveling at less than 20 miles per hour on the study segment of Miami Gardens Drive as they entered the school speed zone during the morning and afternoon. Since this exceeds the 85% percentile threshold for compliance rates in the school speed zone, no speeding problem was identified in this school speed zone at this time. Therefore, advanced warning signs are not recommended on Miami Gardens Drive.

Before and After Study on a Pilot Location. To properly evaluate the effectiveness of the implantation of advanced warning in school speed zones, the collection of speed and crash data before and after implementation is important. It is recommended that speed data be collected at spot locations in the regular posted speed limit area and within the reduced school zone speed limit area. These spot locations should be for both directions of traffic flow, assuming two-way flow exists. Further, the speed data should be collected for the duration of the active school zone times, and then compiled to calculate the 85th Percentile Speeds and the Mean Speeds at each spot location. Plotting this data will allow for a spatial comparison of the reduced travel speeds to the regular school zone speed limits to determine if and where motorists are adhering to the reduction in speed as a result of the implanted warning signs. Also, this performance measure could identify the need for additional education and/or enforcement to encourage drivers to obey the posted speed limits. As a result of a presentation given to the Miami-Dade County Public Schools' Community Traffic Safety Team on November 9th 2011, three candidate school locations for possible implantation of an engineering treatment to improve speed limit compliance where possible excessive speeding within the school zone may be present have been identified. Additionally, Scott Lake Elementary School has been identified as a possible candidate to be further analyzed for the implementation of advanced warning signs. These locations must be further analyzed using the criteria for implementing advanced warning in school speed zones provided in this report to determine if such a solution is viable. The proposed schools are:

- Zelda Glazer Middle School (15015 SW 24 St, Miami, FL – posted speed 40 mph)
- Leisure City K-8 Center (14950 SW 288 St, Homestead, FL – posted speed 40 mph)
- David Lawrence K-8 Center (15000 Bay Vista Blvd, North Miami, FL – posted speed 35 mph)
- Scott Lake Elementary School (1160 NW 175 St, Miami, FL – posted speed 30 mph)

These same performance measures can be used to help periodically monitor the performance of advanced warning in school speed zones once they are implemented. Monitoring performance should be performed on a regular basis, particularly during the first few years of its implementation, to ensure the treatment is functioning properly and satisfying its intended objective. The same data collected for the performance measures noted above should be collected for a "post" installation comparison analysis.

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