Village Traffic Spot Speed Study Data and Analysis

Preliminary Version

Revision History

Date	Rev.	Name	Comment
12/17/2014	0.1	A. Patnaude	Working Draft (shared w/ Amherst PD & DPW)
12/28/2015	0.2	A. Patnaude	Incorporated remaining data sets (draft version sent for internal review and overview given at 1/13/15 Village Strategic Planning meeting)
1/31/2015	0.3	A. Patnaude	Incorporated the new data collection efforts initiated w/ Amherst PD
2/xx/2015	1.0	A. Patnaude	First Draft (approved by working group)

- The intended audience for this report is the Traffic & Safety Working Group. However, the traffic speed graphs, volume graphs and initial observations are of general interest.
  - This document will remain "Preliminary" until reviewed and approved by the Traffic & Safety Working Group.
- This report purposefully avoids proposing any traffic mitigation strategies, its sole purpose is a quantitative problem statement .
- This report is intended to be a working document meaning revisions will be made as other data sets are analyzed or refinements in the analysis are required.

Acknowledgement

- Special Thanks to Matt Waitkins at NRPC for his help and interest in providing the needed data sets to perform this analysis.

Data Reduction
Field Observations to Frequency Table

Field Observations

Vehicle	Speed (mph)
Car 1	20
Car 2	7
Car 3	11
Bus 1	17
Bus 2	21
Car 4	17
Car 5	5
Car 6	25
Truck 1	30
Car 7	11
Car 8	7
Car 9	18
Truck 2	29
Car 10	12
Bus 3	10
Bus 4	16
Car 11	24
Car 12	15
Bike 1	17
Car 13	13
Car 14	20
Car 15	23
Car 16	33
Car 17	18
Truck 3	40
Truck 4	23
Bike 2	4
Car 18	19
Car 19	16
Car 20	28

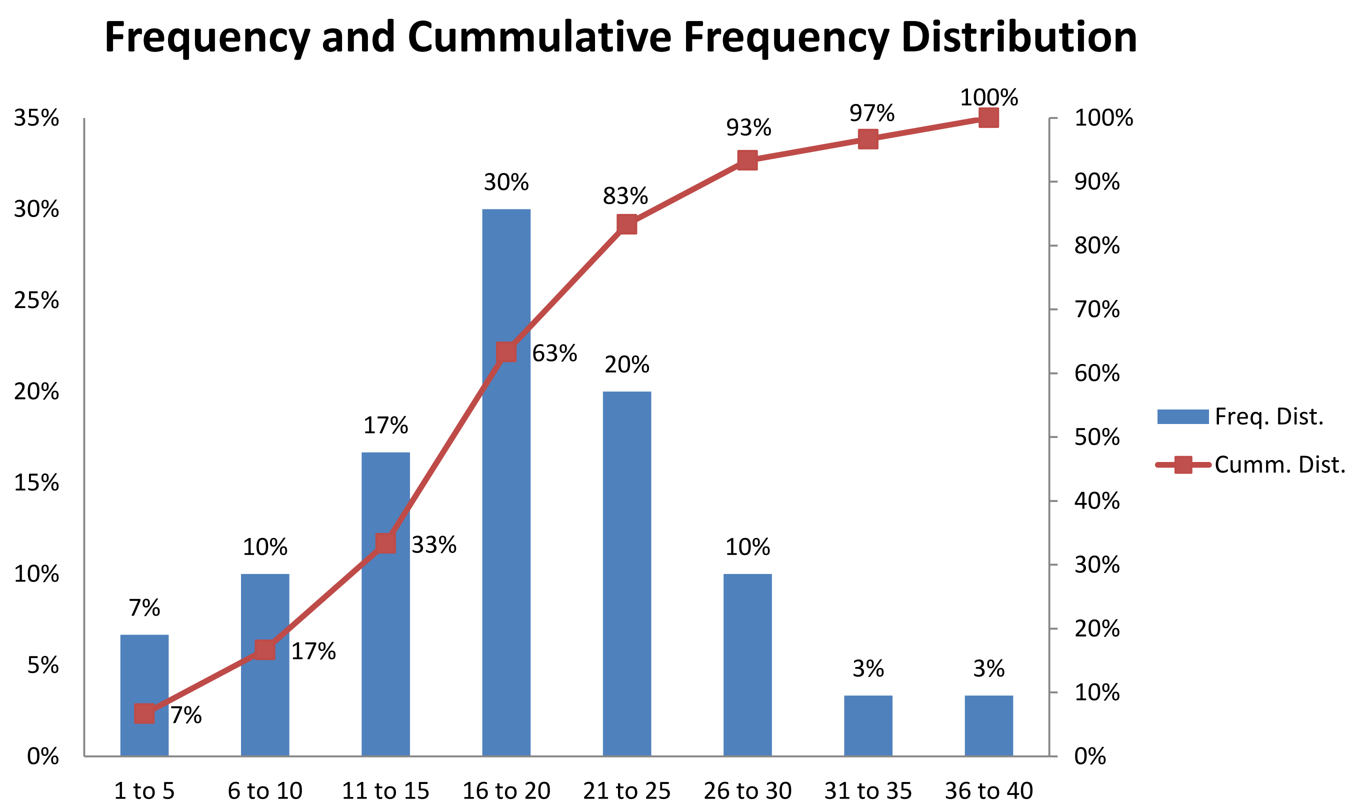
Reduction of
many observations

into a possibly much
smaller number of buckets

Frequency Table with 5 mph Buckets

Speed (mph)	Frequency	% Frequency	Cummulative Speed (mph)	Cummulative Frequncy	% Cummulative Frequency
1 to 5	2	7%	1 to 5	2	7%
6 to 10	3	10%	1 to 10	5	17%
11 to 15	5	17%	1 to 15	10	33%
16 to 20	9	30%	1 to 20	19	63%
21 to 25	6	20%	1 to 25	25	83%
26 to 30	3	10%	1 to 30	28	93%
31 to 35	1	3%	1 to 35	29	97%
36 to 40	1	3%	1 to 40	30	100%

Data Reduction
Frequency and Cumulative Distribution



- Graphical representation of previous frequency table

Measure of Central Tendency
Mean

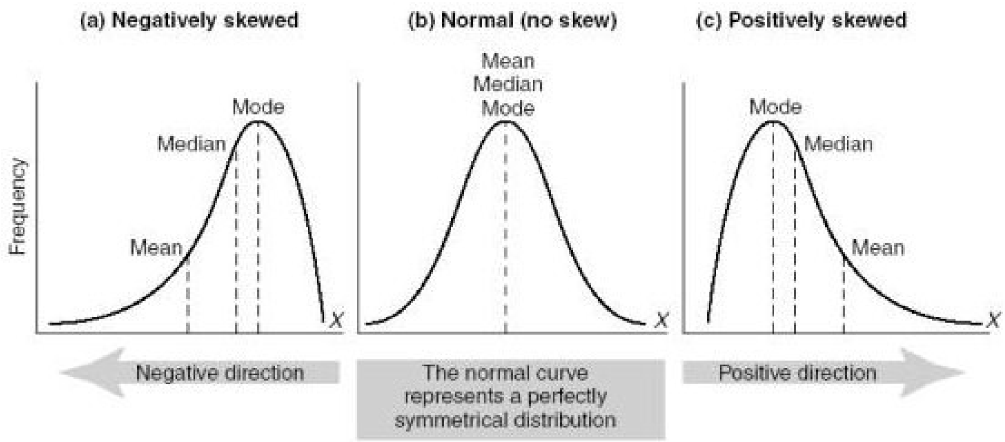
- Mean (μ) – the first moment or physically represents the center of gravity of a probability distribution
- The estimate of the mean ($\hat{\mu}$) calculated from the frequency distribution is given by:

$$\hat{\mu} = \frac{1}{N}\sum_{i=1}^{M} f_i \cdot mp_i$$

  - Where N is the total number of observations
  - M is the total number of frequency bins or buckets
  - f_i is the frequency count for the i^{th} point in the frequency distribution
  - mp_i is the mid-point of the frequency bin or bucket
- Physical Interpretation: The mean is the speed at which the frequency distribution would balance.

More Measures of Central Tendency

- Median – The speed that divides the distribution into equal parts.
  - There are as many observations higher than the median as there are lower than the median
- Mode – The single value speed that is most likely to occur.



- Pace – the 10 mph increment in which the highest percentage of drivers are observed.

Measures of Dispersion

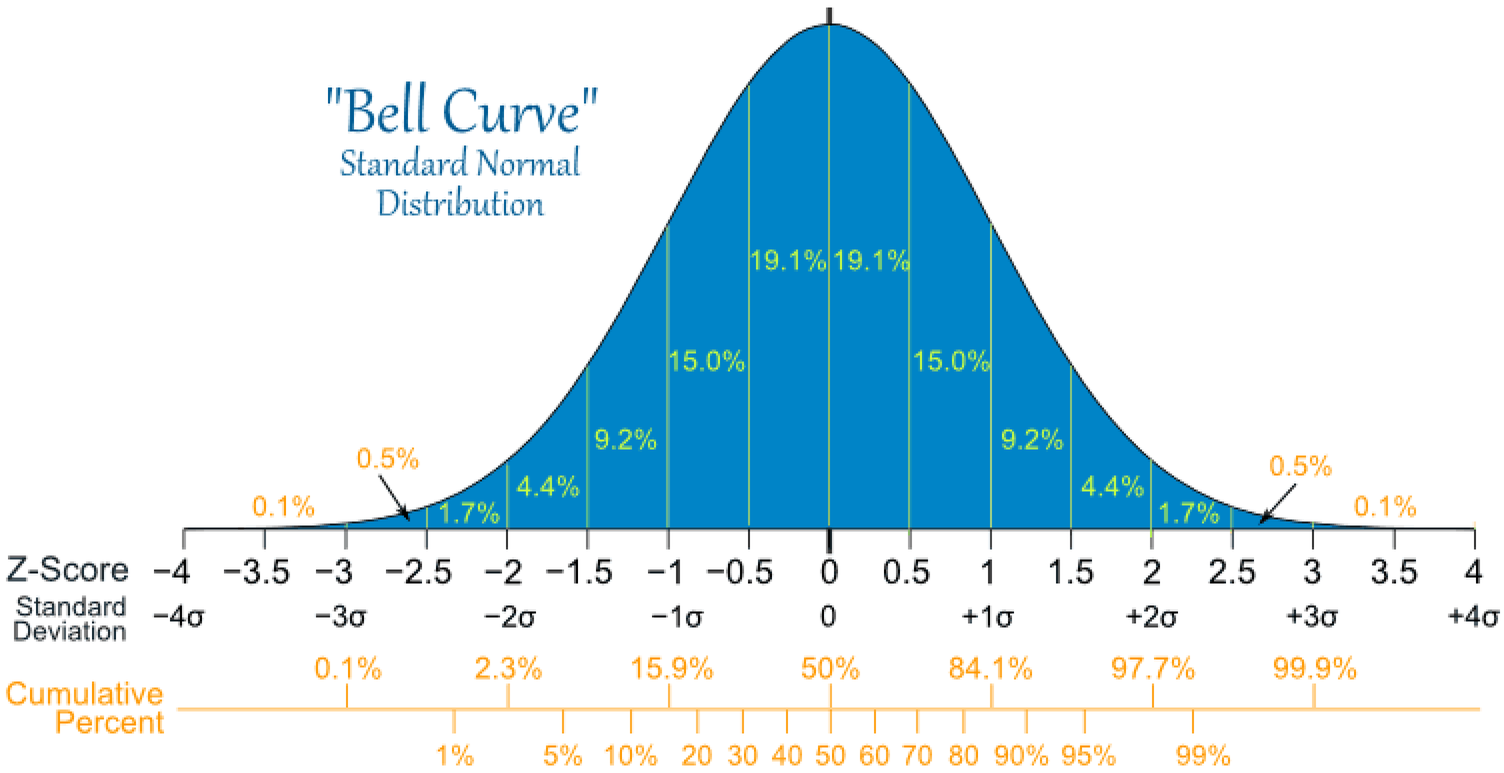
- Variance (σ^2) – the 2nd moment or physically represents the moment inertia of a probability distribution
- The estimate of the variance ($\hat{\sigma}^2$) calculated from the frequency distribution is given by:

$$\hat{\sigma}^2 = \frac{1}{N}\sum_{i=1}^{M} f_i \cdot (mp_i - \hat{\mu})^2$$

  – Where N is the total number of observations
  – M is the total number of frequency bins or buckets
  – f_i is the frequency count for the i^{th} point in the frequency distribution
  – mp_i is the mid-point of the frequency bin or bucket
  – $\hat{\mu}$ is the estimate of the mean previously described
- Physical Interpretation: Given the frequency distribution was spinning about the center of gravity (mean)
  – The moment of inertia is the measure of how difficult it would be to stop the frequency distribution from spinning
  – Figure skaters pull in their arms to decrease their moment of inertia there by increasing angular velocity (this is the conservation of angular momentum)
- Standard Deviation (σ) – simply the square root of the variance

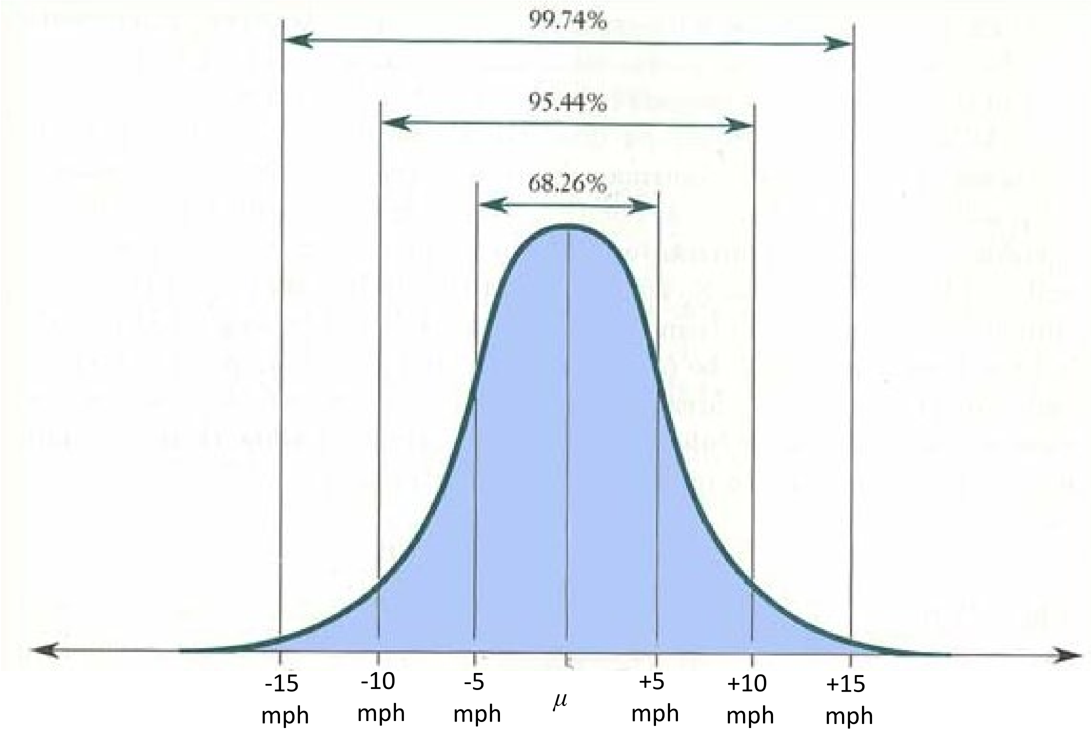
Normal Gaussian Distribution
(aka Bell Curve)

- Most speed distributions tend to be statistically normal
  - The frequency distribution can be fully described with just the mean and variance
  - The standard deviation has a well known relationship to both the cumulative and frequency distribution



Free Flow Speed Distribution

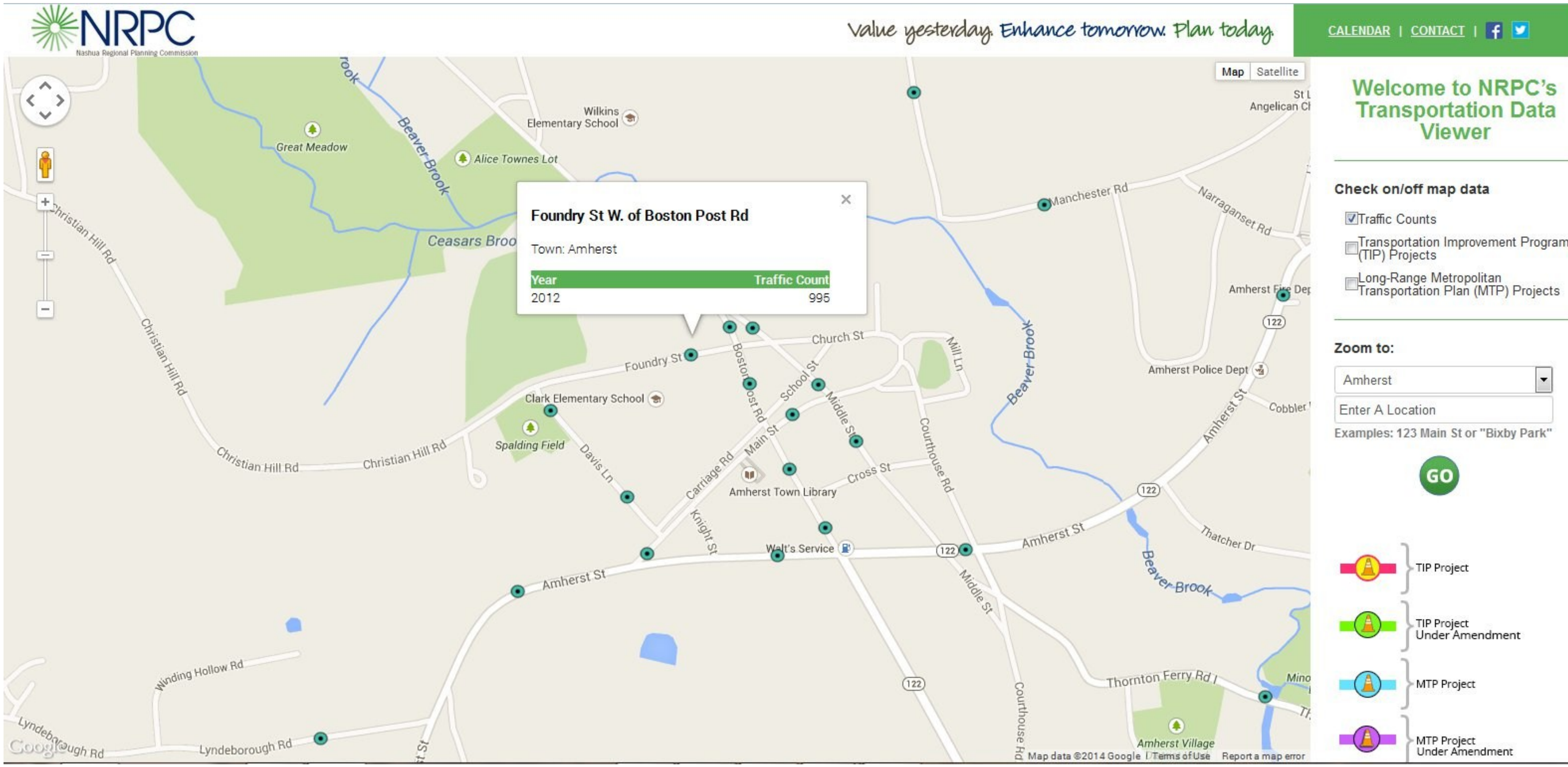
- Free flowing traffic is traffic where there are no constraints placed on a driver by other vehicles on the road
  - Traffic is said not be free flowing when it exceeds some critical flow density that is found at maximum throughput
- Typically free-flowing traffic has a standard deviation of 5 mph
  - 10 mph Pace contains approximately 68% of the speed observations



Effective Speed Limit within a Free Flow Distribution

- The 85th percentile speed reflects the collective judgment of the vast majority of drivers as to a reasonable speed for given traffic and roadway conditions.
  - Notice the 85% cumulative speed is approximately one standard deviation above the mean speed
  - The Manual on Uniform Traffic Control Devices (MUTCD) recommends that the speed limit near the 85th percentile speed of free-flowing traffic.
  - For our purposes we will be using it as the effective speed limit for an existing population as to compare with the posted speed limit
    - Its original purpose was for the operating speed method setting speed limits
- From the previous typical speed frequency distribution w/ standard deviation of 5mph
  - 85% of the traffic is traveling at the speed limit or below
  - 10% of the traffic is traveling at the speed limit to 5 mph above
  - 4.8% of the traffic is traveling at the 5mph to 10 mph above the speed limit
    - Warning might be issued
  - 0.2% of the traffic is traveling at the 10 mph above the speed limit
    - Citation might be issued
- For example, given an approx. 6,000 cars/day on Boston Post Road this could equate to (assuming an impractical 24/7 police presence):
  - 288 warnings/day
  - 12 citations/day
  - Or put another way, a random 1-hour daily police spot check could result on average in 12 warnings and 1 citation every other day for conforming traffic.
- So even with a traffic population effectively obeying the speed limit per MUTCD guidelines, there may be warnings and citations issued

NRPC Traffic Data
Web-Based Traffic Count Map

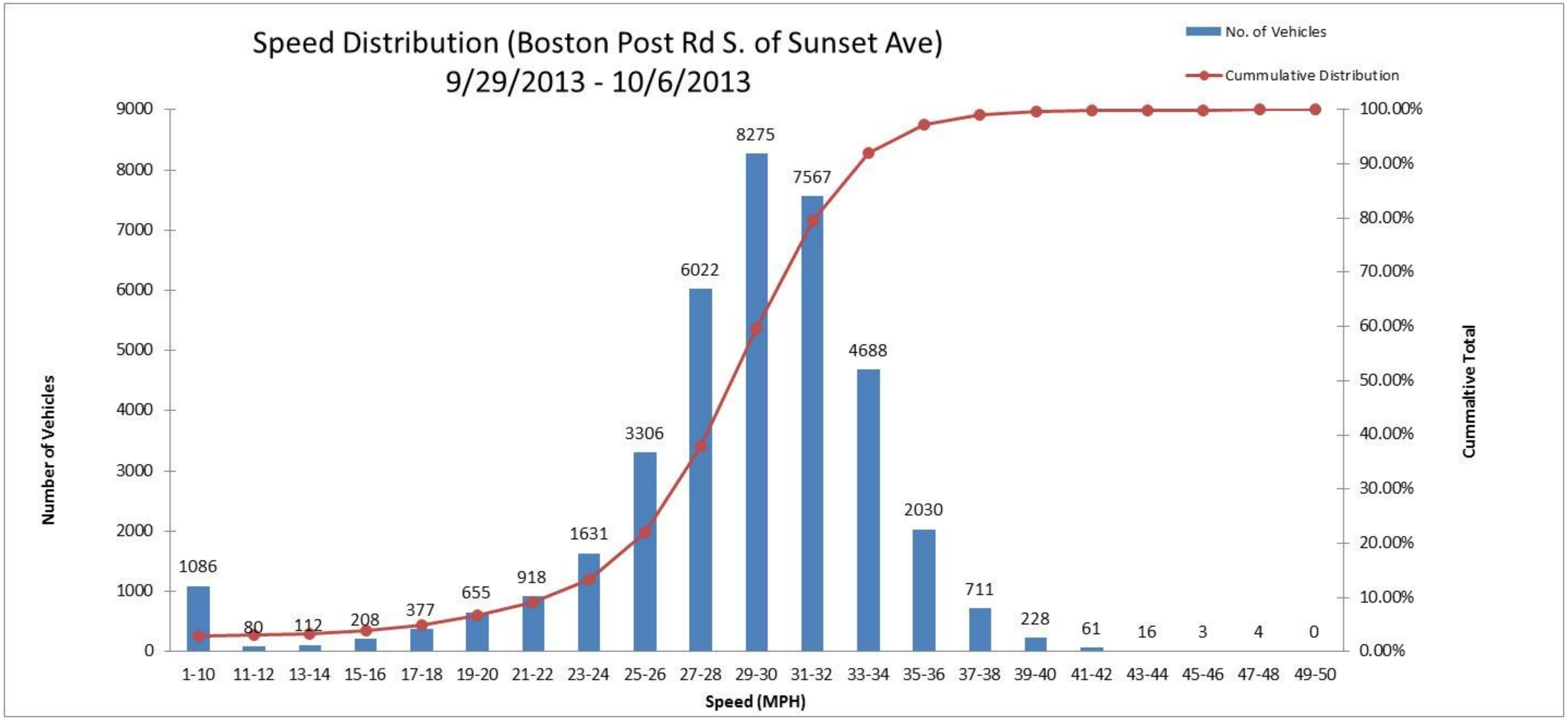


Example Data Set Walk Through

Boston Post Rd S. of Sunset Ave

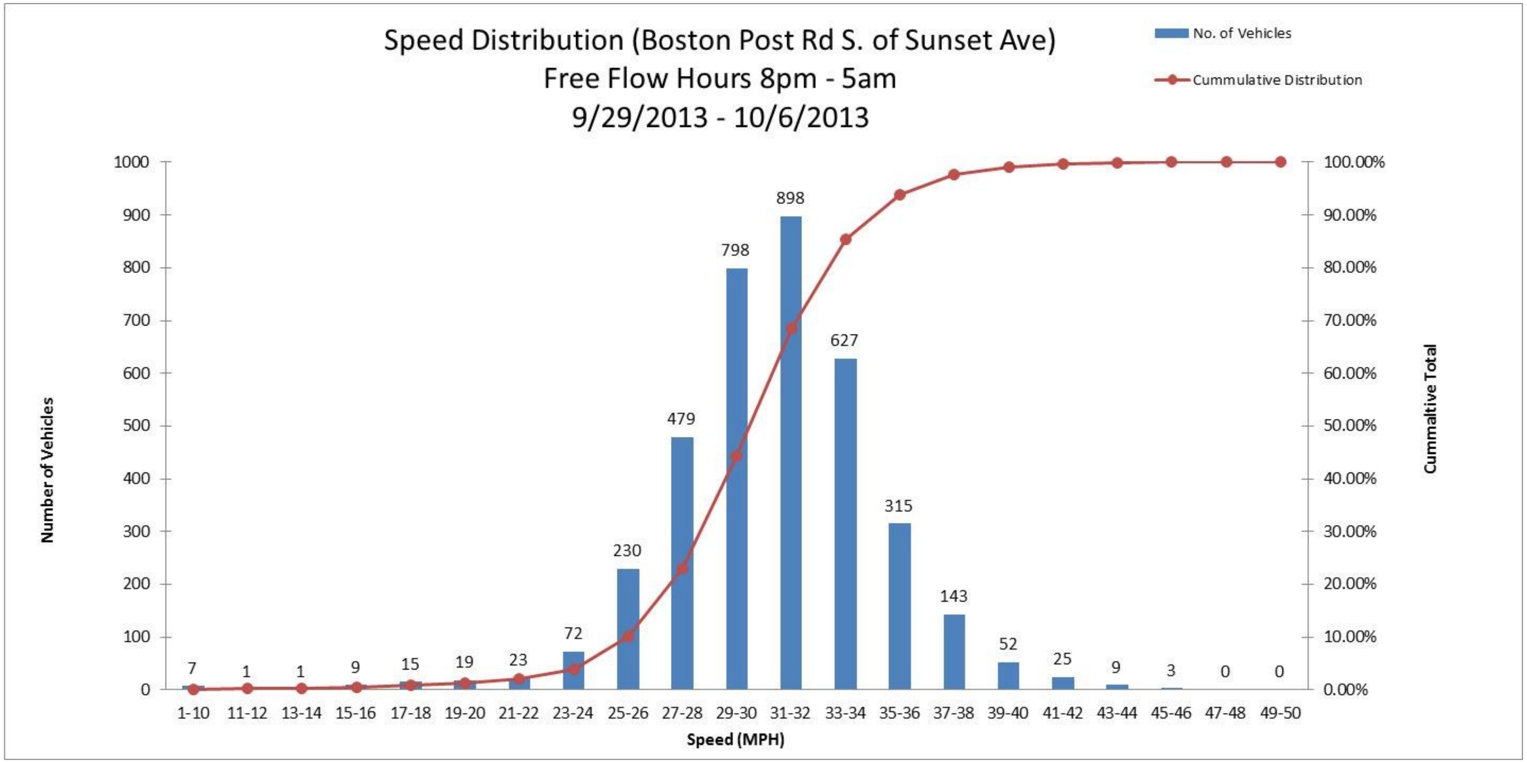
- Data Set Summary:
  - Site Code: 013546
  - 11:00am on Sunday 9/29/2013 thru 8:00am on Sunday 10/6/2013
  - 37,978 speed and vehicle type observations (including northbound and southbound)

Combined NB & SB Stats



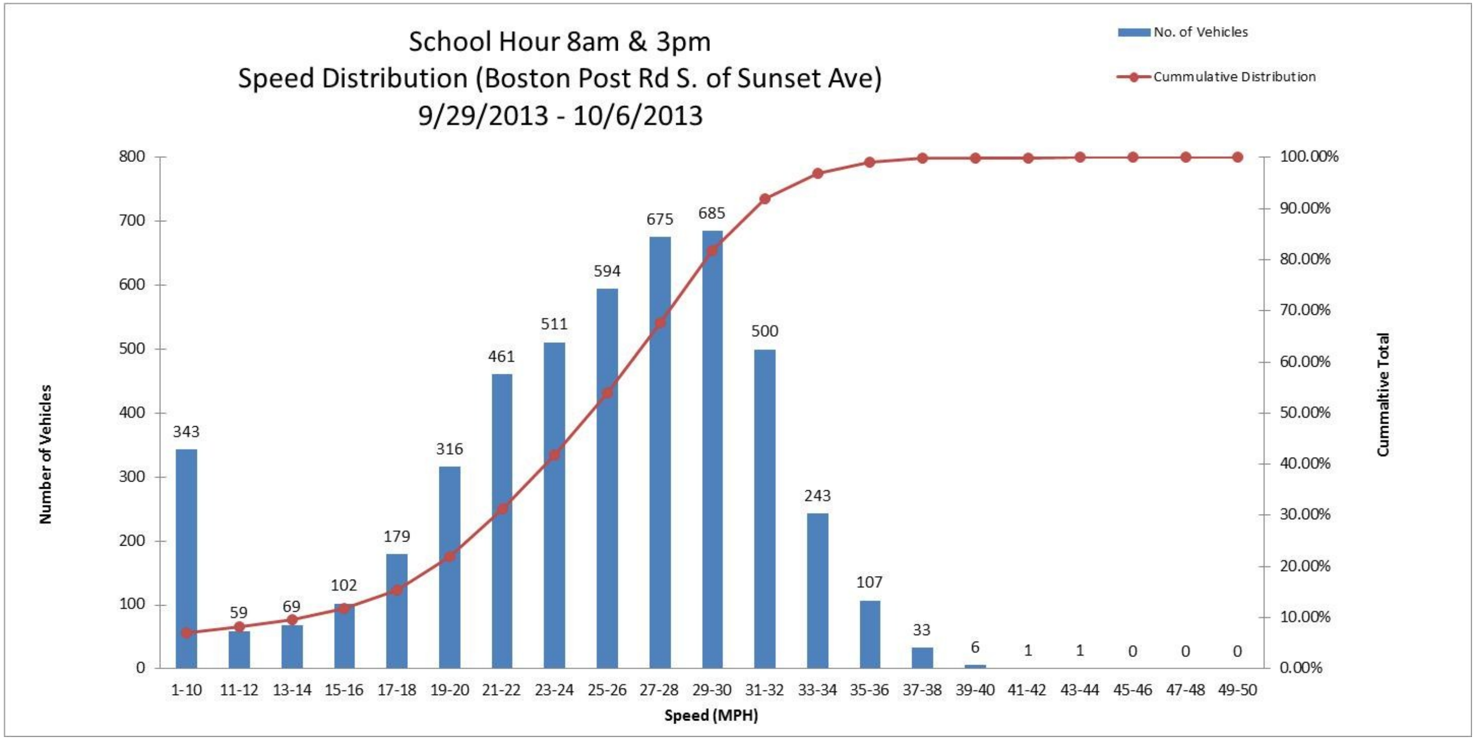
- 85% cumulative speed of 32.9 mph
  - Combined Northbound and Southbound traffic
- 10 mph pace of 25 mph - 34 mph containing 79.8% of the observed traffic
- Mean of 28.7 mph with a median of 29.1 mph (slightly skewed)
- Standard Deviation of 5.8 mph

Combined NB & SB Free Flow Stats



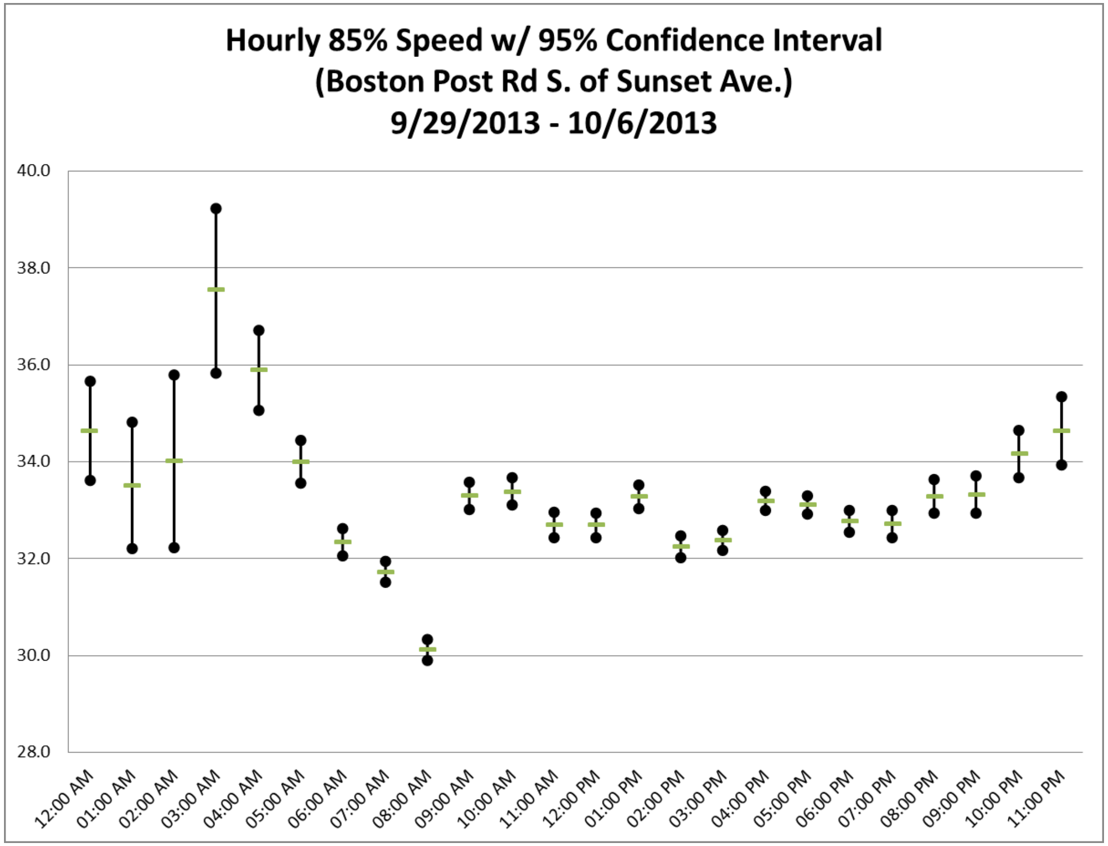
- 85% cumulative speed of 34.0 mph
- 10 mph pace of 27 mph – 36 mph containing 83.7% of the observed traffic
- Mean of 30.9 mph with a median of 30.5 mph (slightly skewed)
  - approaching normal as expected
- Standard Deviation of 4.0 mph

Combined NB & SB School Hour Stats



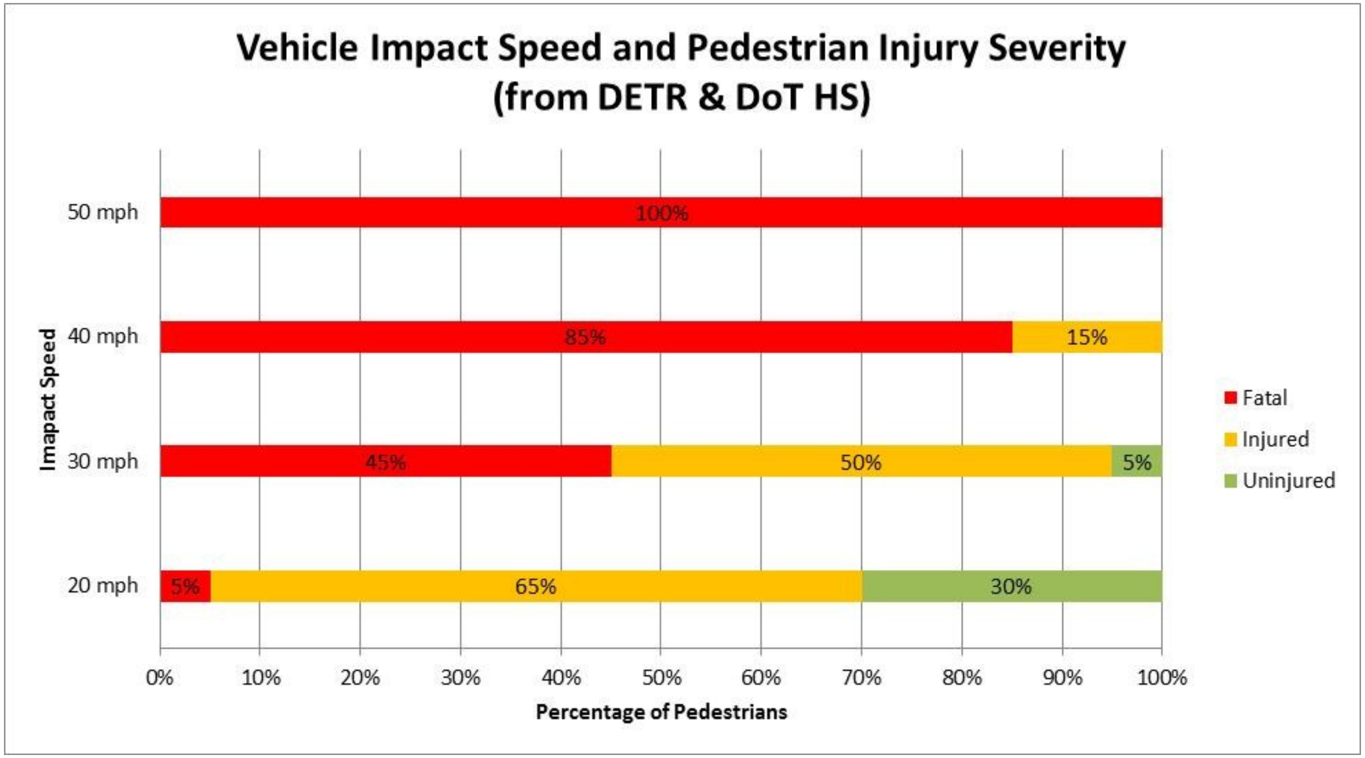
- 85% cumulative speed of 30.6 mph
- 10 mph pace of 23 mph - 32 mph containing 60.7% of the observed traffic
- Mean of 24.5 mph with a median of 25.4 mph (heavily skewed)
- Standard Deviation of 7.3 mph

85% Cumulative Speed vs. Time of Day



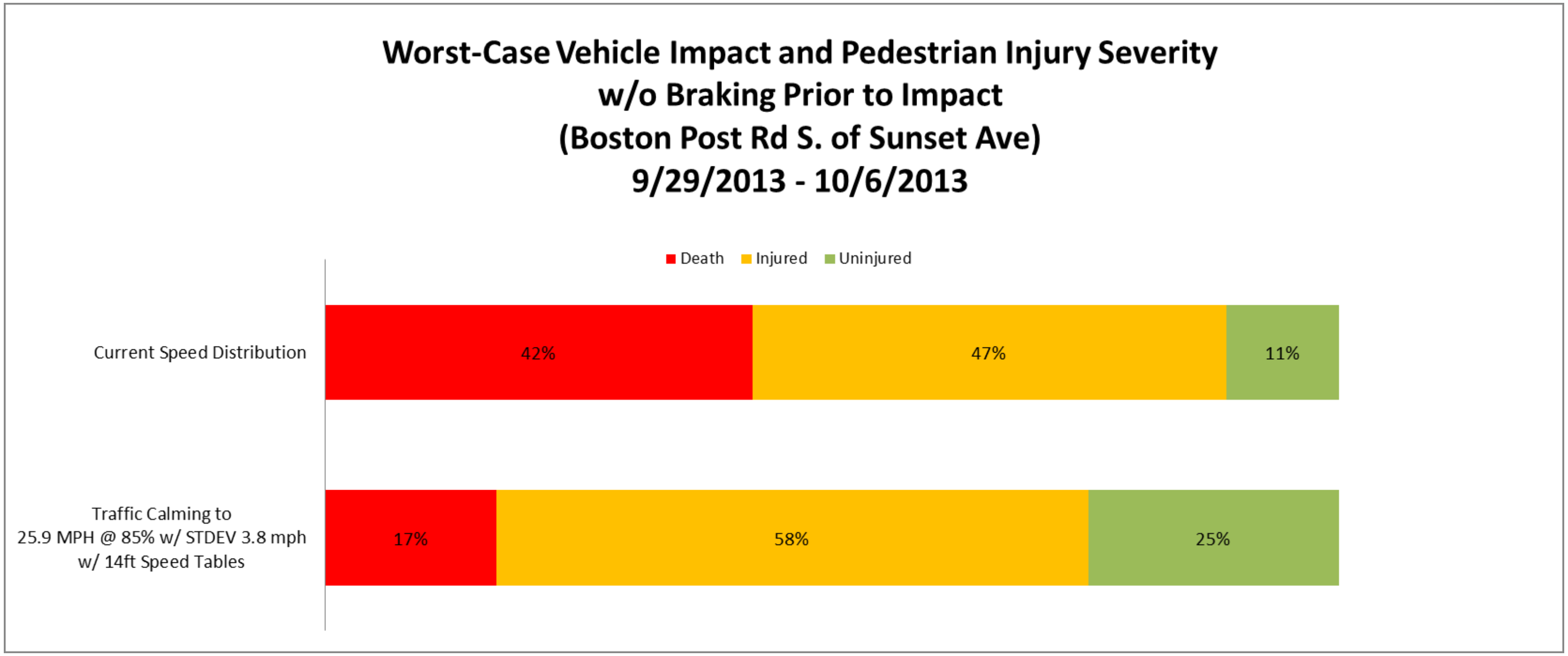
- Highest 85% speeds seen on off hours
  - Particularly very early in the morning during pre-commute hours
- Lowest 85% speeds seen during morning school hour
  - Still well above posted speed limit
  - Morning traffic congestion seemingly the largest contributor to downward shift, otherwise the 3:00 school hour would have a similar 85% cumulative speed due to changes in collective judgment

DoT HS Injury/Fatality Stats



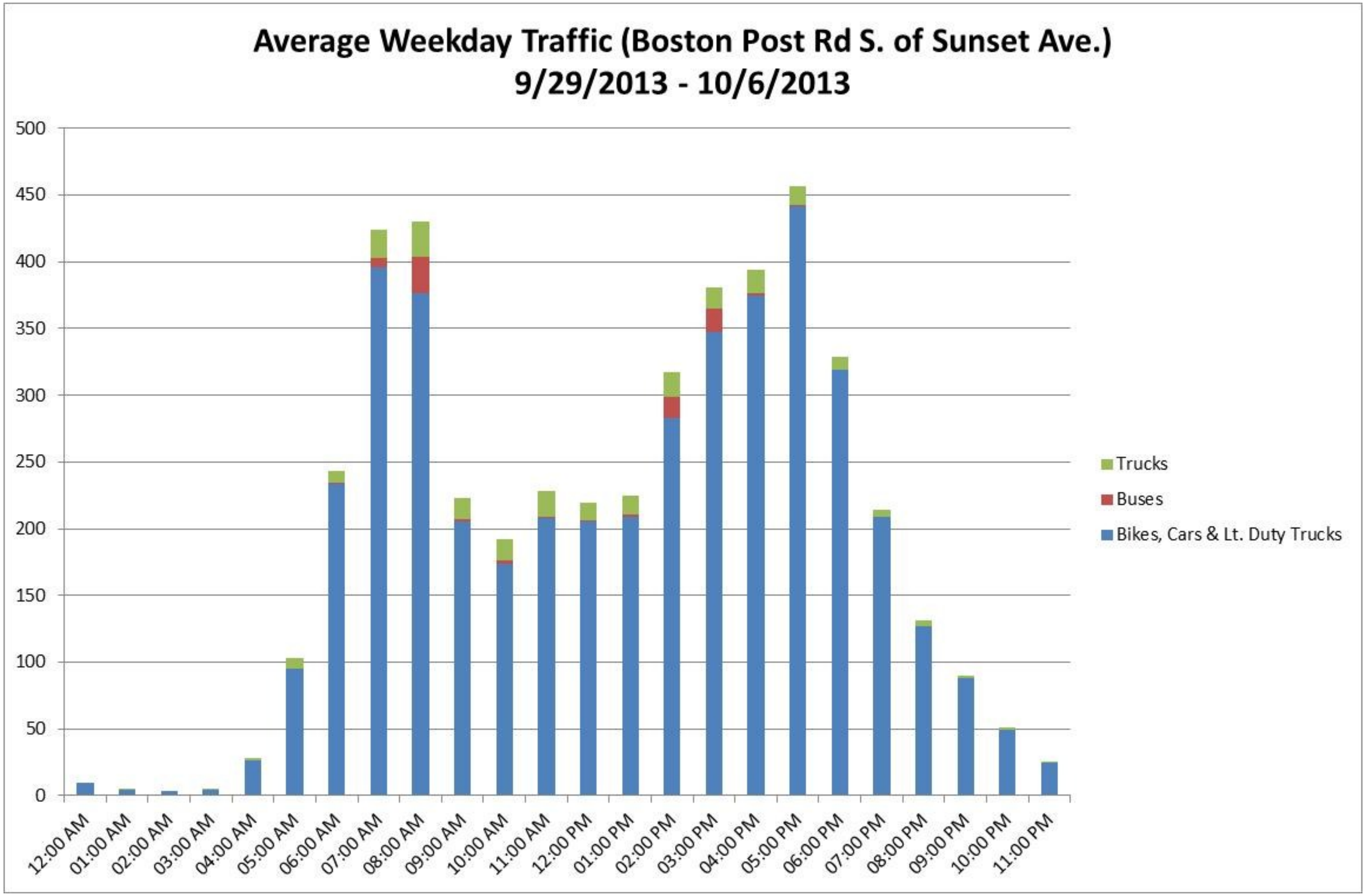
- DERT (UK Department of Environmental, Transport and Regions) leaflet for 20 mph, 30 mph, and 40 mph injury rate is widely referenced and thusly used here
- This was augmented with the fairly uniform conclusion (ref. DoT HR 809 021) that pedestrian fatality is nearly 100% for vehicles traveling above 50 mph
- These injury stats clearly show why a 25 mph speed limit is favored for residential areas
- There exist other pedestrian injury and vehicle speed studies that yield slightly different fatality and injury rates
  - Ex. 2011 Report from the AAA Foundation for Traffic Safety

Application of DoT HS Stats

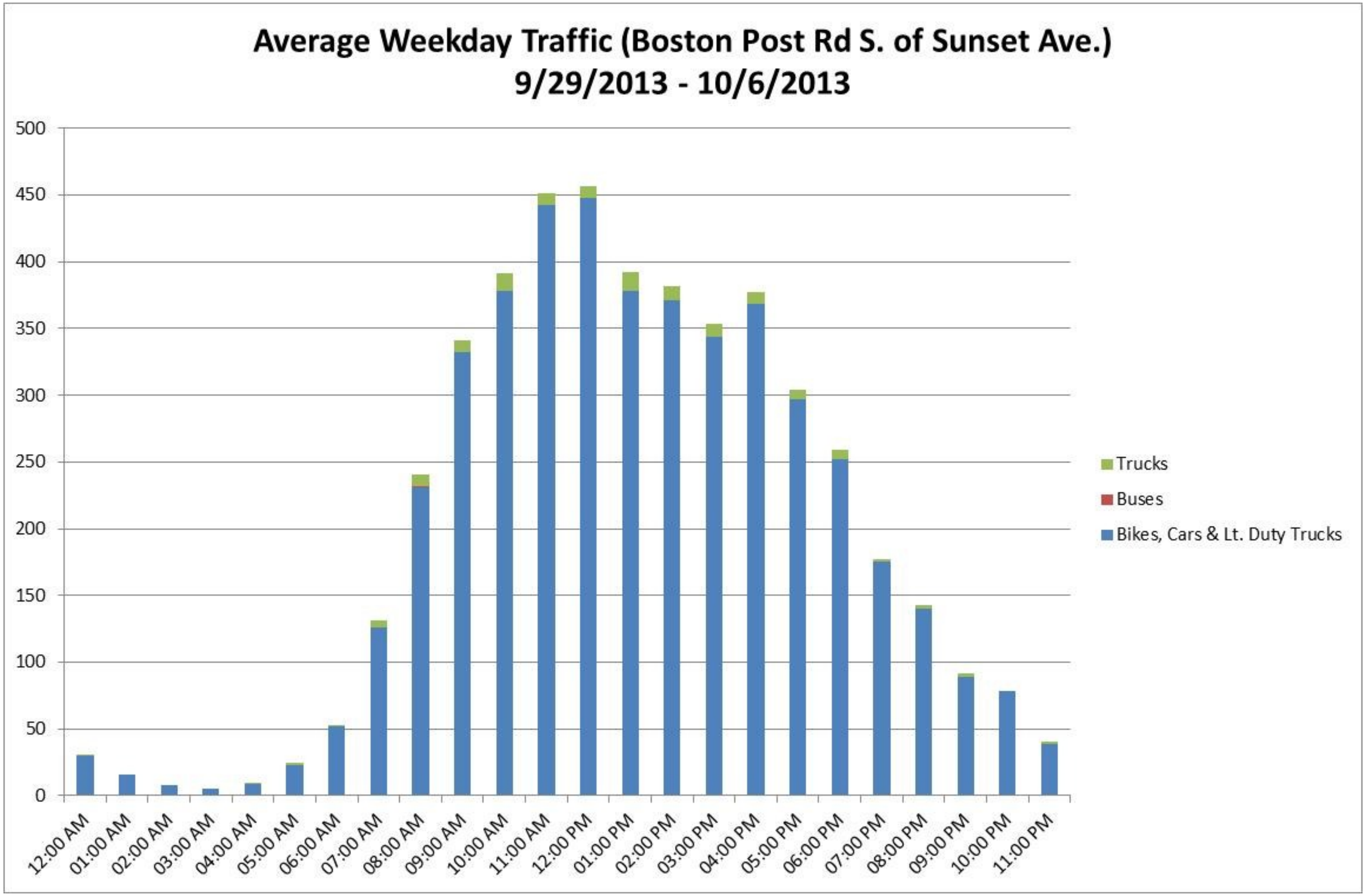


- **Caution must be used** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **zero** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **example only**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in depicting the improvements in safety for the worst-case scenario by having the overall population speed be essentially conforming to the posted speed limit

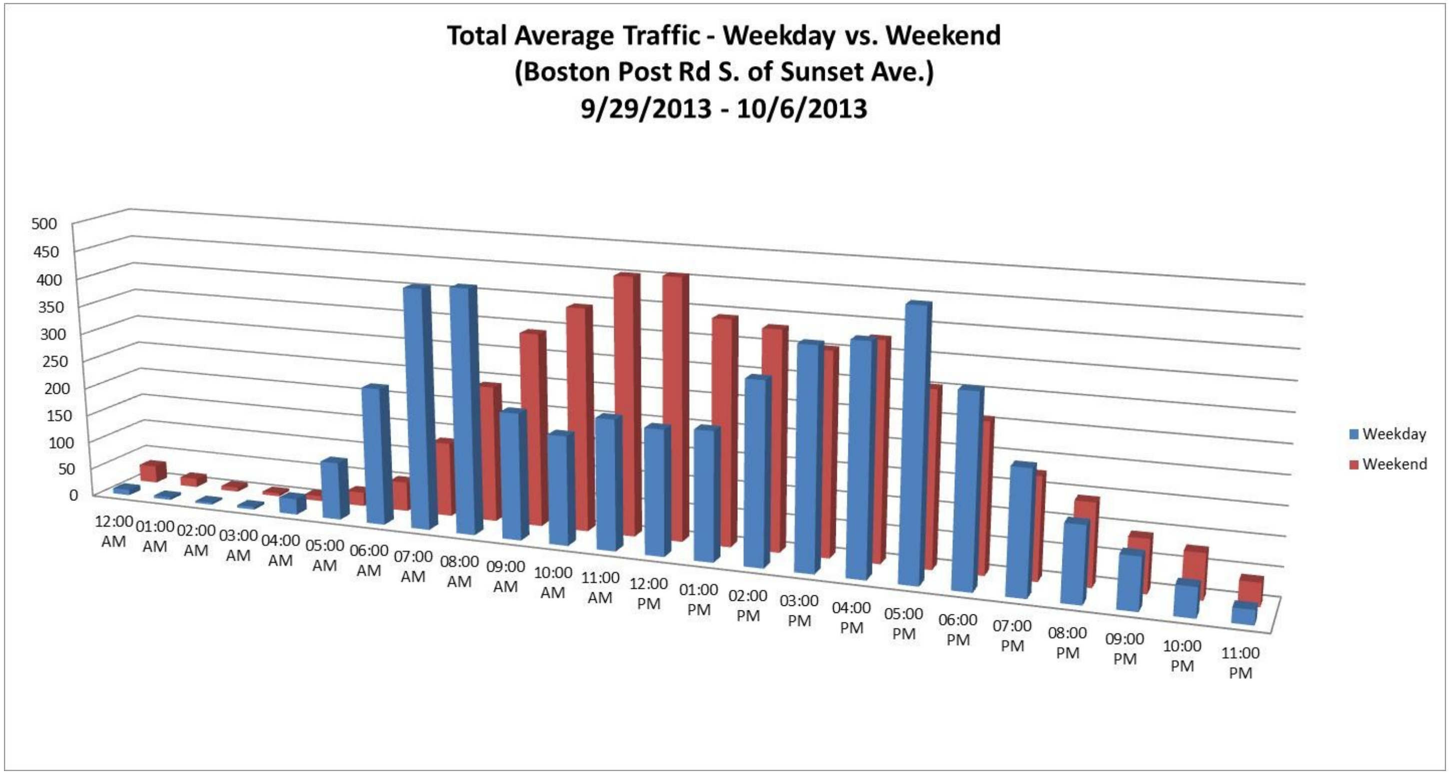
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Assuming there is a significant percentage of cut-through traffic during peak commuting hours:
  - The fact that the weekend peak volume equals weekday peak volume is highly suggestive that there is a significant percentage of cut-through traffic at every hour for the entire week.

Preliminary Observations
Boston Post Rd S. of Sunset Ave

- Effective Speed Limit: 33 mph
- Posted Speed Limit: 25 mph
- Northbound and Southbound Speed Differential: 0.0 mph
  - for 85% cumulative speed
- This location has the unfortunate confluence of one of the worst conforming traffic speeds (thus far studied) and high volume of school aged pedestrian traffic
- The 8 am school hour has the best conformance but is likely due to congestion rather than adjustments in the collective judgment
- Off-peak commute volumes suggest significant percentage of cut-through traffic at all times
  - For example: Peak weekday commute volume matches weekend peak volume
  - Cut-through traffic defined as volume levels not explained by Amherst residents
  - It is not known if the percentage of cut-through traffic varies or is constant throughout the day

Potential Future Collection and Analysis

- Fill-in major gaps for existing spot speed study traffic data
  - Amherst PD has new traffic volume and speed collection devices that will be used to this end
    - May require some calibration for effective comparison
    - The collection of the additional data has been initiated – weather and road conditions permitting
  - Amherst DPW has some historical data which might be harvested
  - Mack Hill Road is currently the largest such omission being the second highest volume road in the Village (per NRPC traffic count data)
- Data could potentially be used to create a one-page traffic “heat” map of the village to further aid in data reduction and visualization/understanding of the problem statement
- It may be prudent to baseline traffic volume for all roads in the Village for the purposes of monitoring changes in driver behavior with the potential introduction of traffic calming measures.
  - This represents a fairly significant effort that would need to occur in a relatively short space of time
  - Would allow for traffic flow analysis at intersections

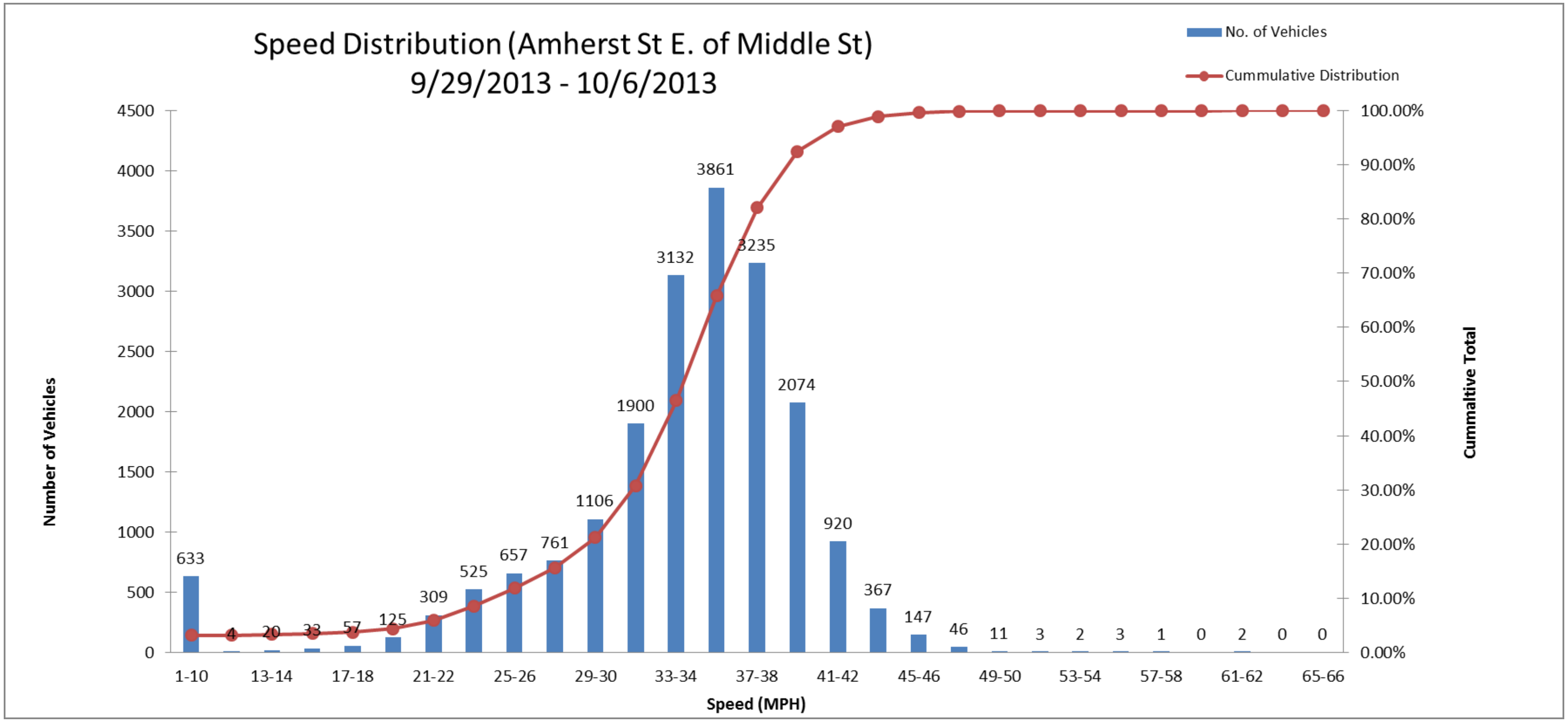
Appendix – Analyzed Data Sets

- Notes:
  - The locations for the data can be found at the NRPC traffic count map
    - http://www.nashuarpc.org/transview
    - **Caution:** The speed and volume data are localized to the point shown on the map, both may vary at different locations along the same road.
  - If not specified the traffic should be assumed to be bi-directional
  - There was little attempt made at reducing the data further, rather it was thought to let the data speak for itself at this early stage.
    - Further graphical reductions such as a one page “Village Traffic Heat Map” will require additional data plus some decided guidelines on what is considered acceptable conforming traffic
  - Analysis was performed on Amherst St. for the purposed of understanding the characteristics of a major thoroughfare
    - The location of Amherst St. East of Middle St. on the NRPC map is part of Rt. 122
    - Amherst St. also represent another major bi-section of the historical district
    - DoT HS death and injury stats were not applied to this set as it was not considered a major school pedestrian route

Amherst St E. of Middle St Data Set

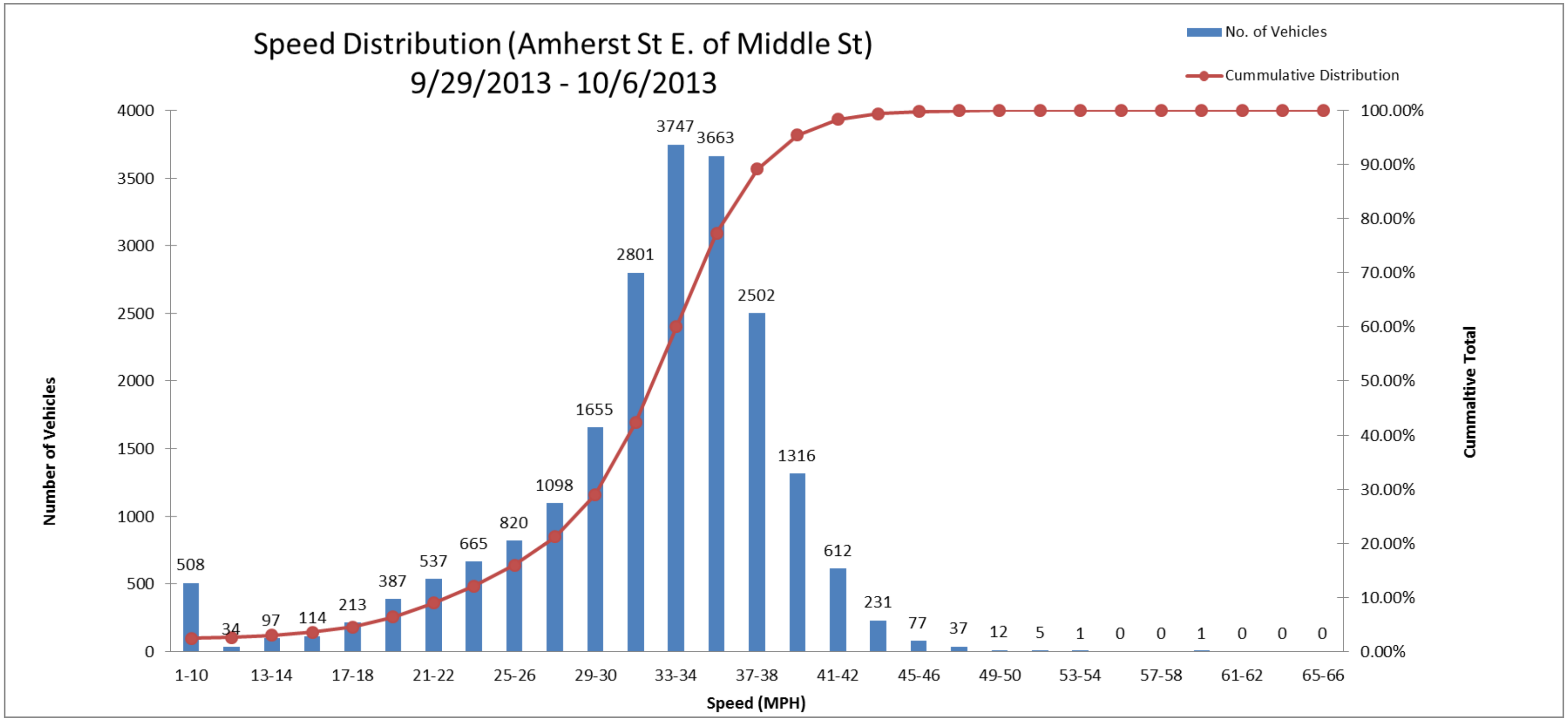
- Data Set Summary:
  - Site Code: 013543
  - 11:00am on Sunday 9/29/2013 thru 7:00am on Sunday 10/6/2013
  - 41,068 speed and vehicle type observations (including eastbound and westbound)

Eastbound Stats



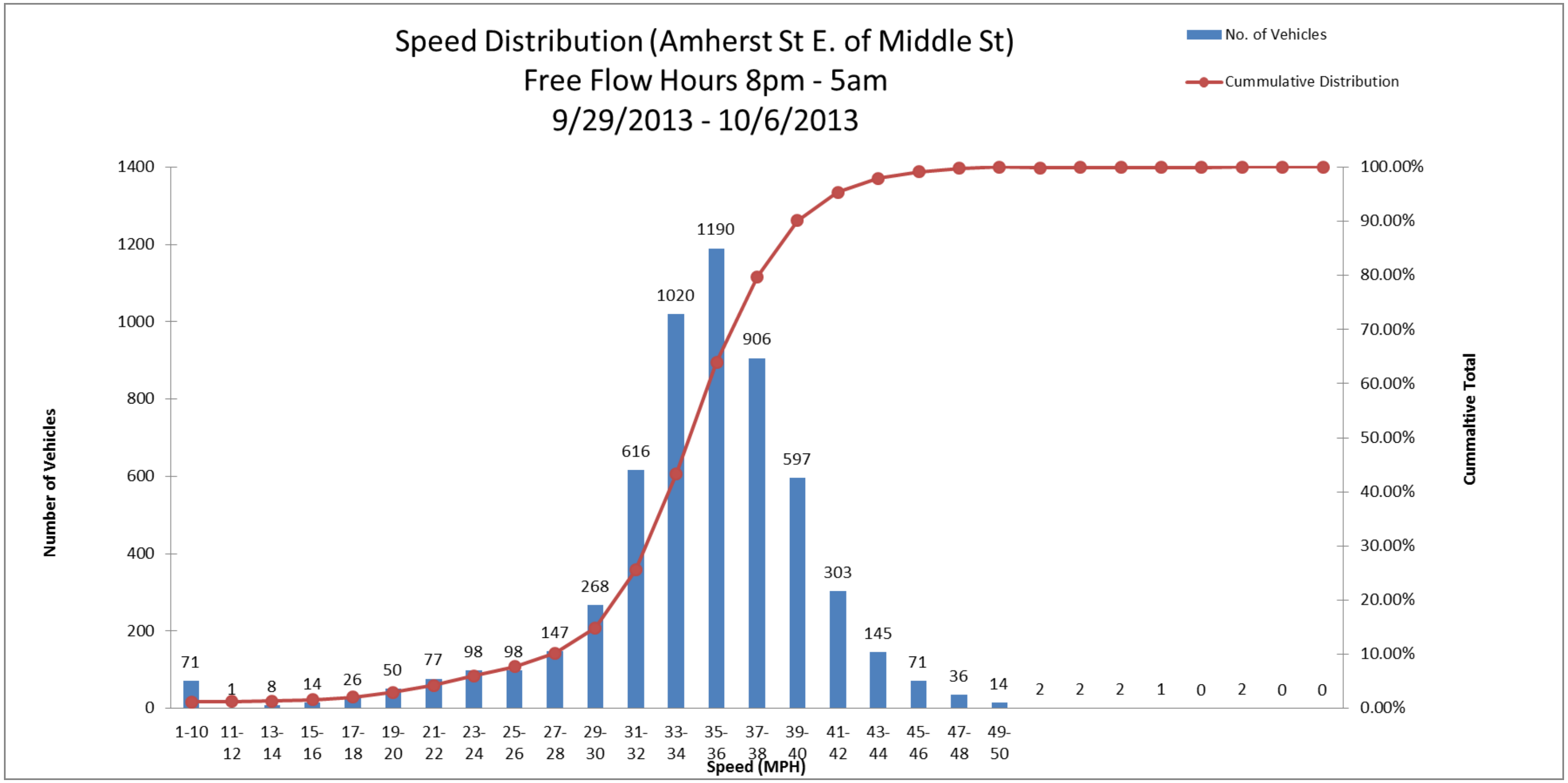
- 85% cumulative speed of 38.6 mph
- 10 mph pace of 31 mph - 40 mph containing 71.2% of the observed traffic
- Mean of 33.4 mph with a median of 34.4 mph (essentially normal)
- Standard Deviation of 7.2 mph

Westbound Stats



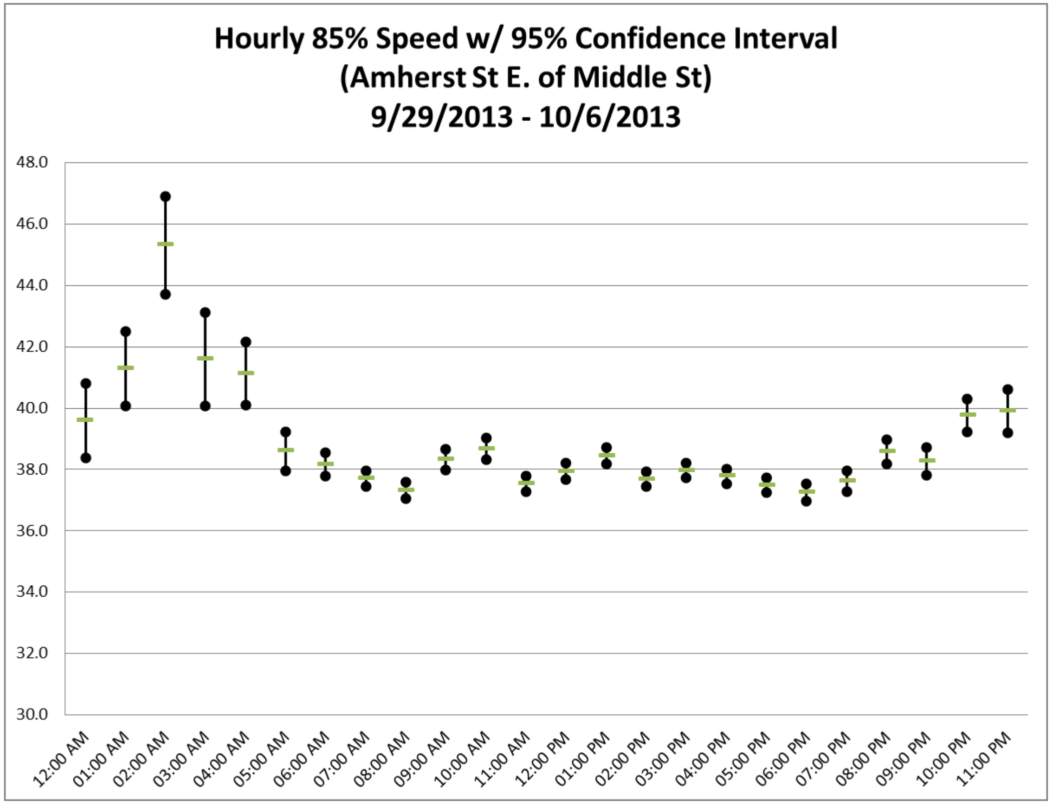
- 85% cumulative speed of 37.3 mph
- 10 mph pace of 29 mph - 38 mph containing 68.0% of the observed traffic
- Mean of 32.0 mph with a median of 32.9 mph (slightly skewed)
- Standard Deviation of 7.1 mph

Combined EB & WB Free Flow Stats



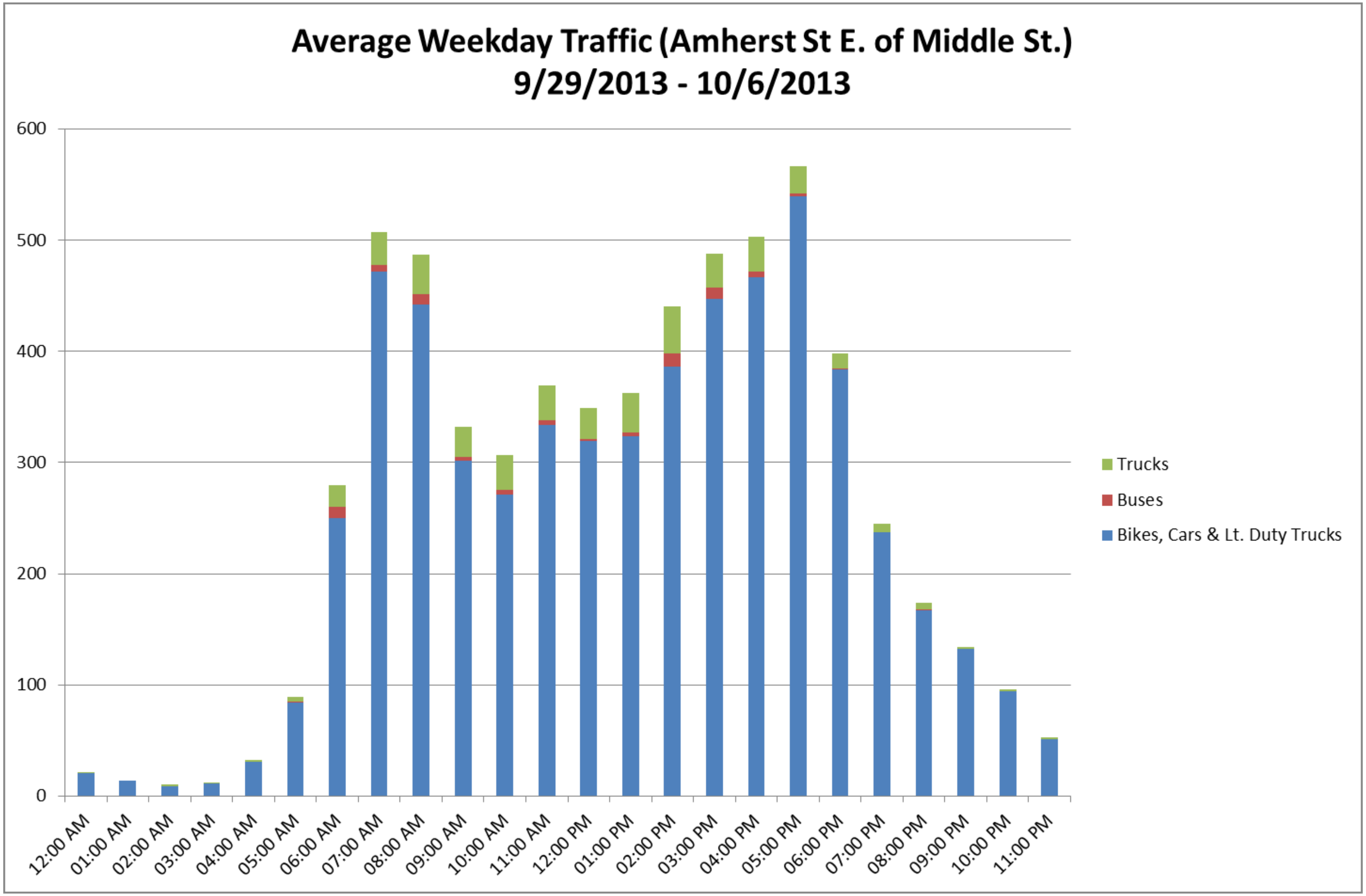
- 85% cumulative speed of 39.0 mph
- 10 mph pace of 31 mph - 40 mph containing 75.2% of the observed traffic
- Mean of 34.5 mph with a median of 34.6 mph (normal)
- Standard Deviation of 6.1 mph

85% Cumulative Speed vs. Time of Day

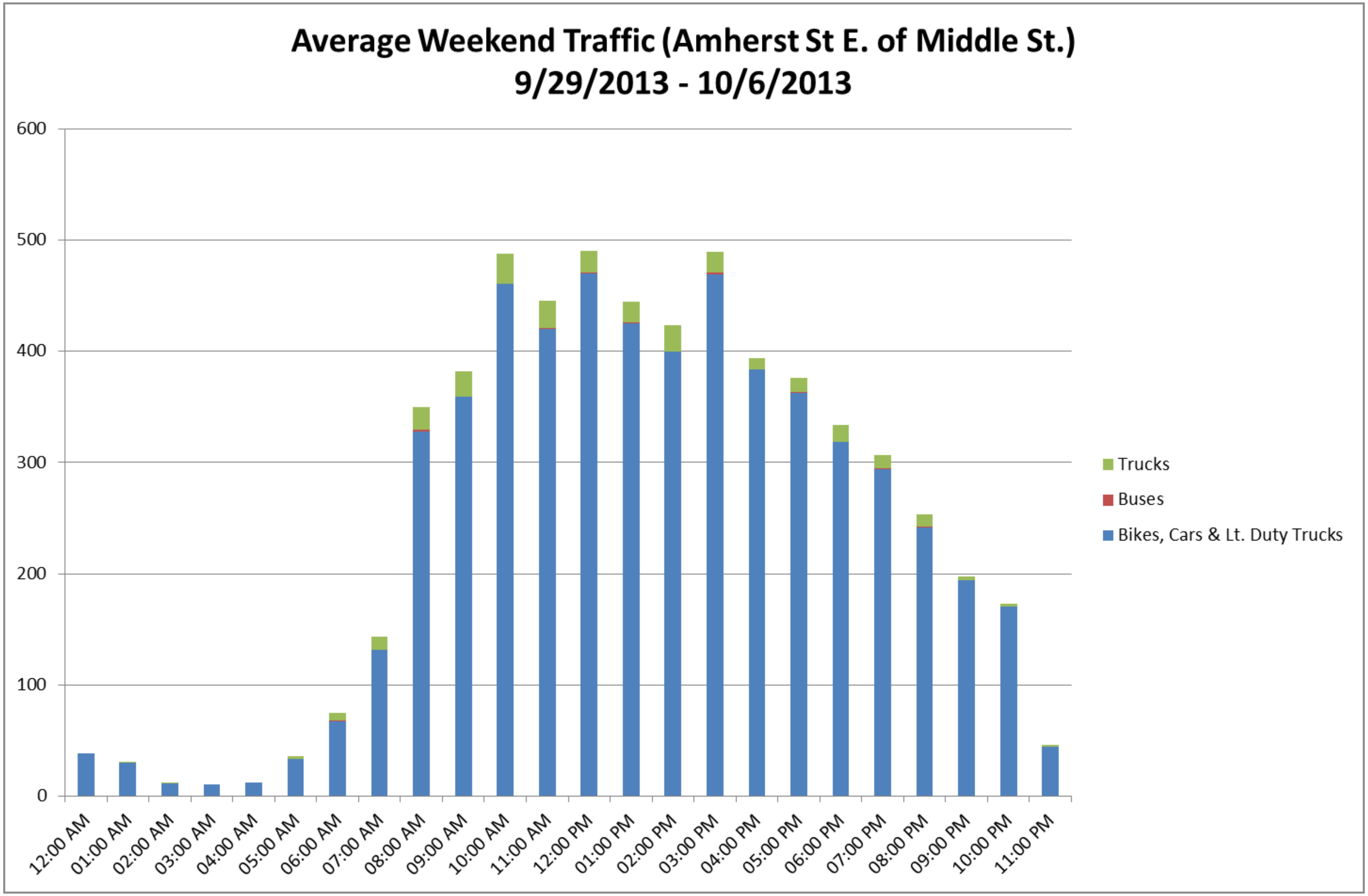


- Highest 85% speeds seen on off hours
  - Particularly very early in the morning even accounting for larger confidence interval due to smaller sample size
- Fairly consistent 85% speed from 5:00am thru 8:00pm

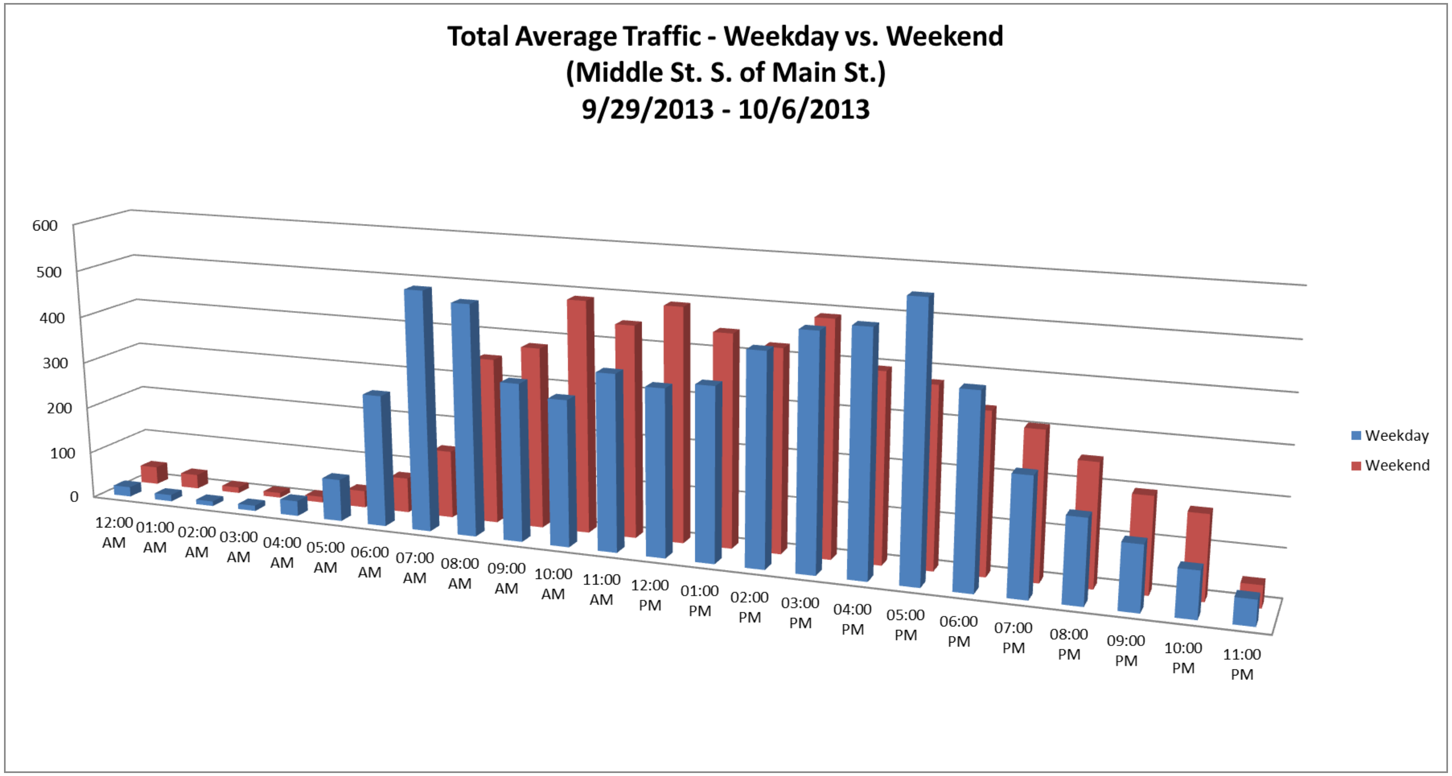
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Assuming there is a some percentage of cut-through traffic during peak commuting hours:
  - The fact that the weekend peak volume equals weekday peak volume is highly suggestive that there is a similar percentage of cut-through traffic at every hour for the entire week.

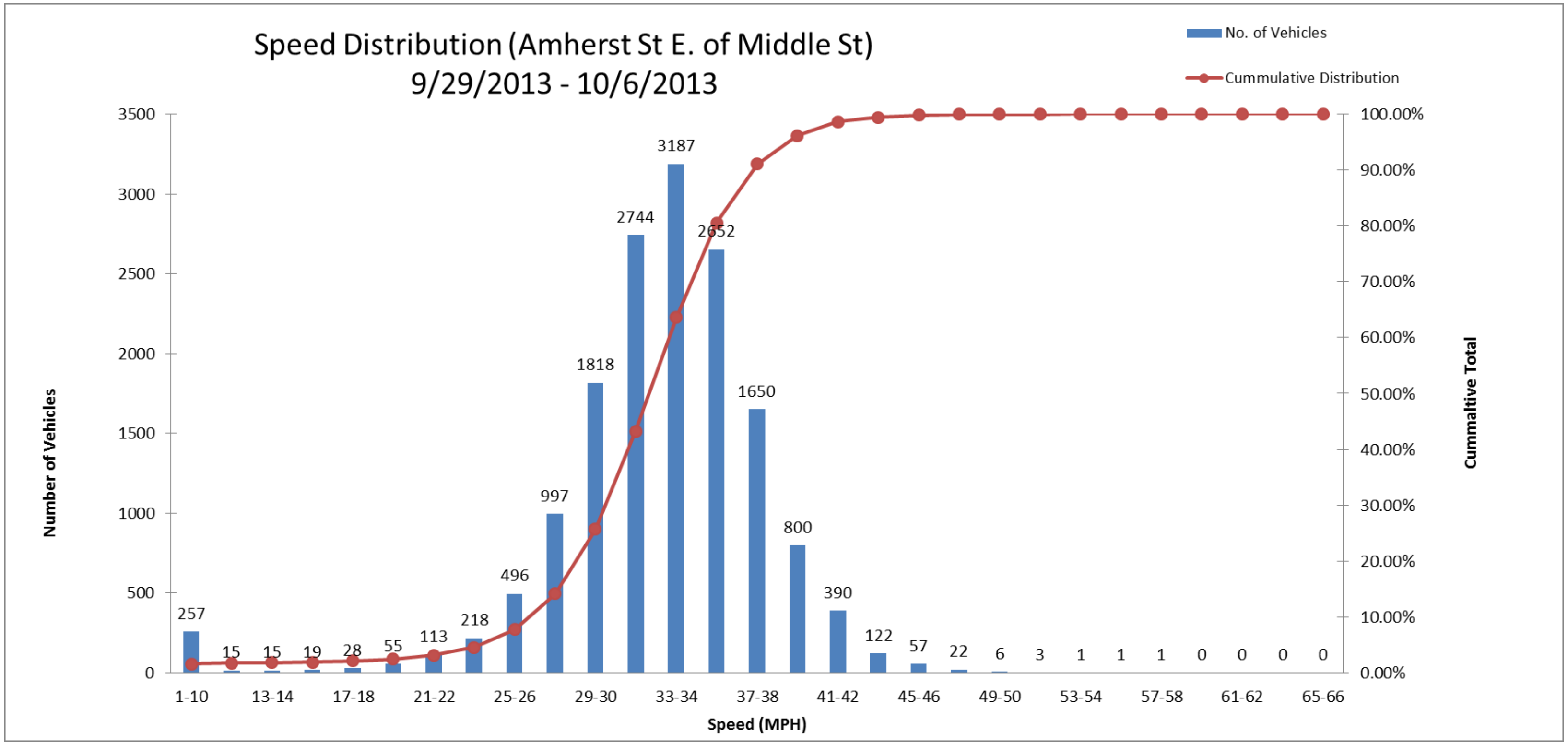
Preliminary Observations
Amherst St E. of Middle St

- Effective Speed Limit: 37.9 mph
- Posted Speed Limit: 35 mph
- Eastbound and Westbound Speed Differential: 1.3 mph
  - for 85% cumulative speed
  - Basically symmetrical but small reduction in speed inbound to village stoplight may be attributed to collective judgment or congestion.
  - A Speed differential greater than 0.2 mph is statistically significant with a 95% confidence
- Consistent conformance seen from 5:00am thru 8:00pm
- Highest speeds seen in the early morning hours from 1:00am to 5:00am

Amherst St. W. of Boston Post Rd. Data Set

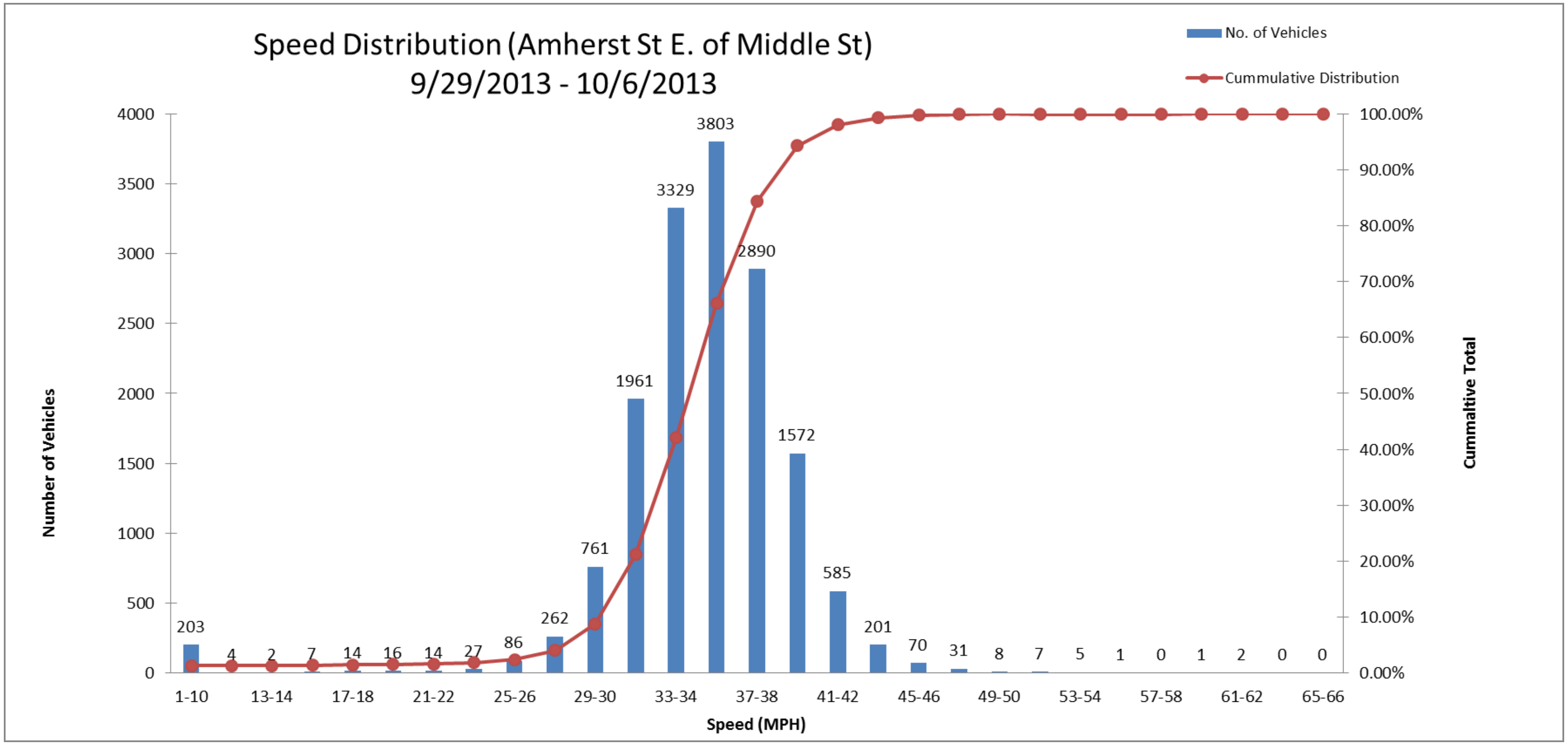
- Data Set Summary:
  - Site Code: 013544
  - 10:00am on Sunday 9/29/2013 thru 10:00am on Sunday 10/6/2013
  - 31,153 speed and vehicle type observations (including eastbound and westbound)

Eastbound Stats



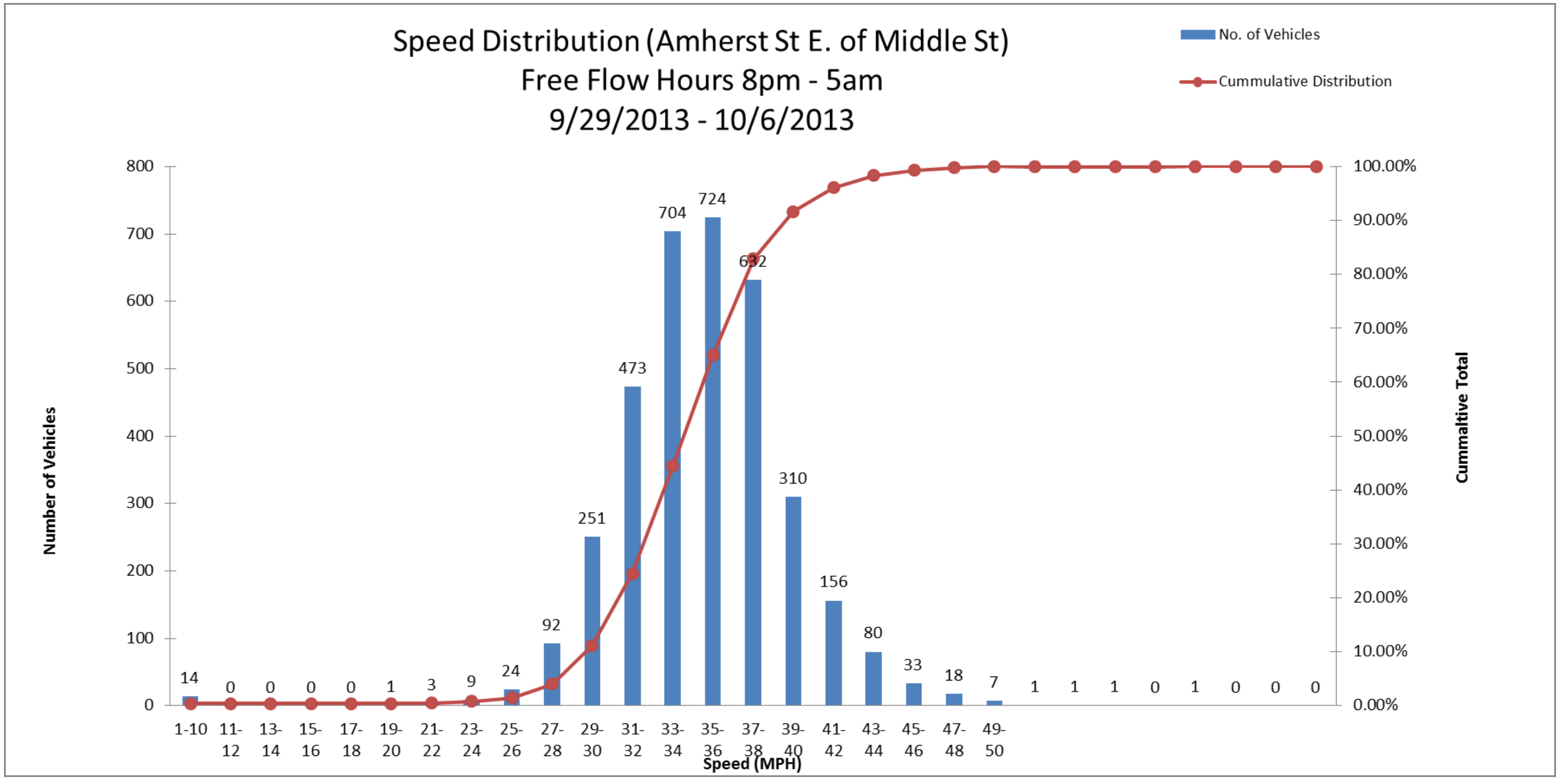
- 85% cumulative speed of 36.9 mph
- 10 mph pace of 29 mph - 38 mph containing 76.9% of the observed traffic
- Mean of 32.6 mph with a median of 34.7 mph (essentially normal)
- Standard Deviation of 5.6 mph

Westbound Stats



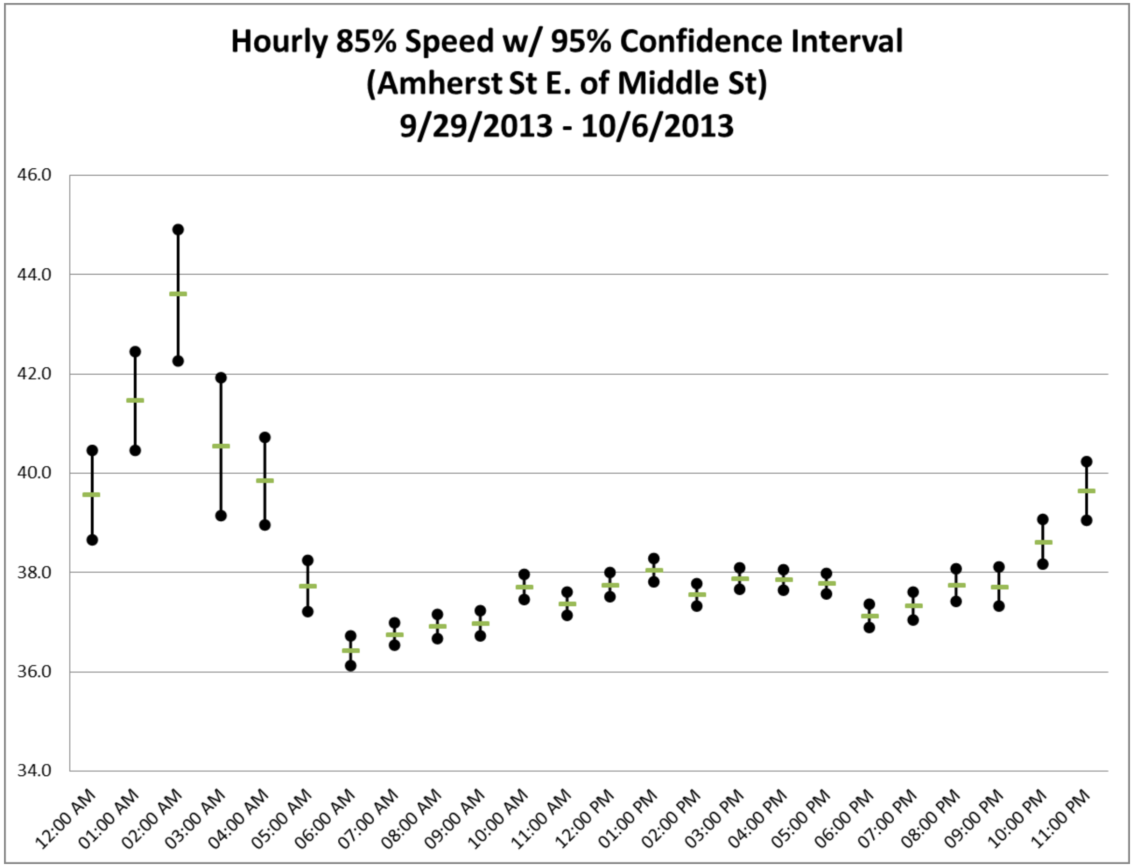
- 85% cumulative speed of 38.1 mph
- 10 mph pace of 31 mph - 40 mph containing 85.5% of the observed traffic
- Mean of 34.8 mph with a median of 34.7 mph (essentially normal)
- Standard Deviation of 5.2 mph

Combined EB & WB Free Flow Stats



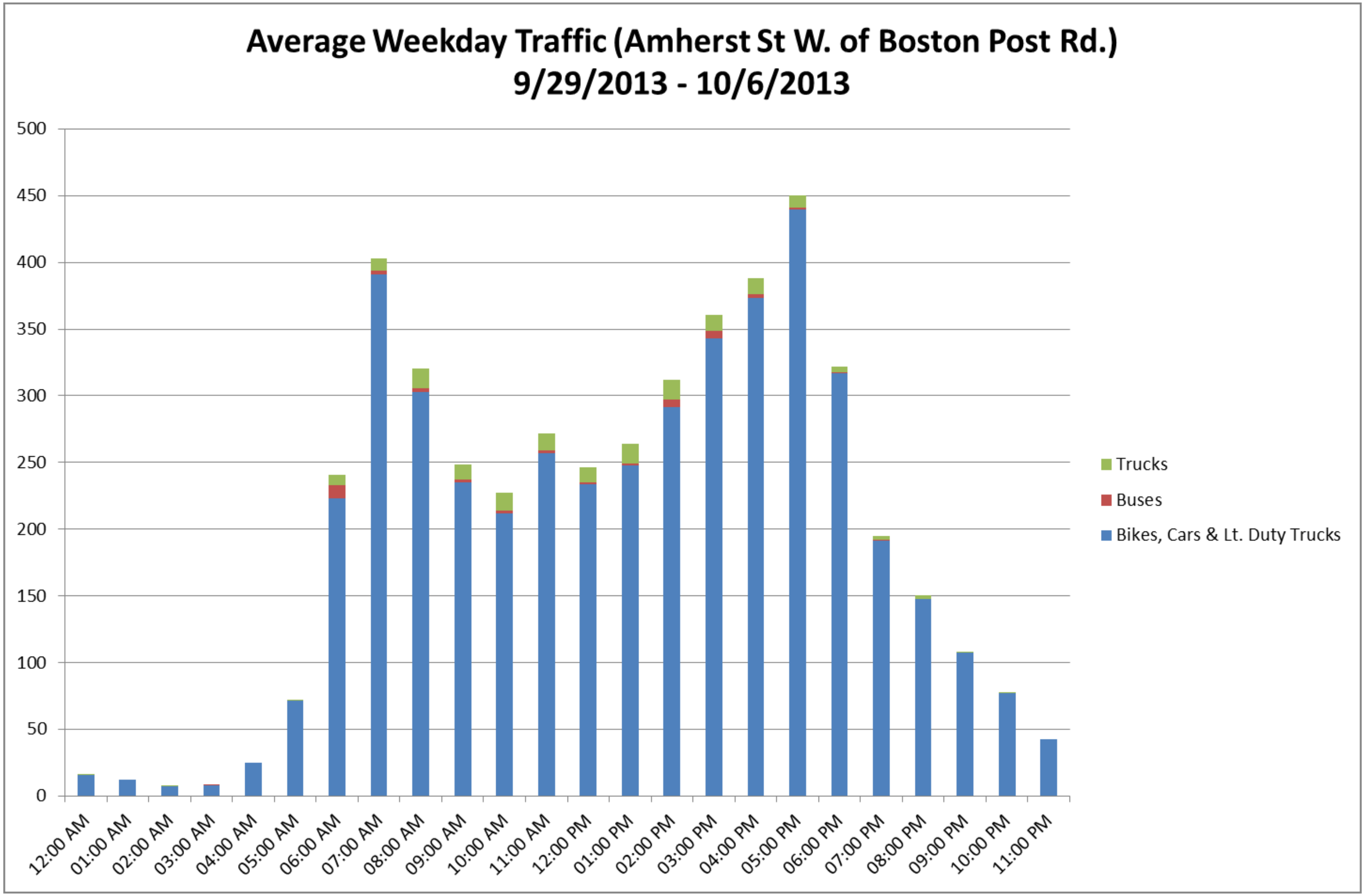
- 85% cumulative speed of 38.5 mph
- 10 mph pace of 31 mph - 40 mph containing 80.4% of the observed traffic
- Mean of 35.1 mph with a median of 34.5 mph (slightly skewed)
- Standard Deviation of 4.4 mph

85% Cumulative Speed vs. Time of Day

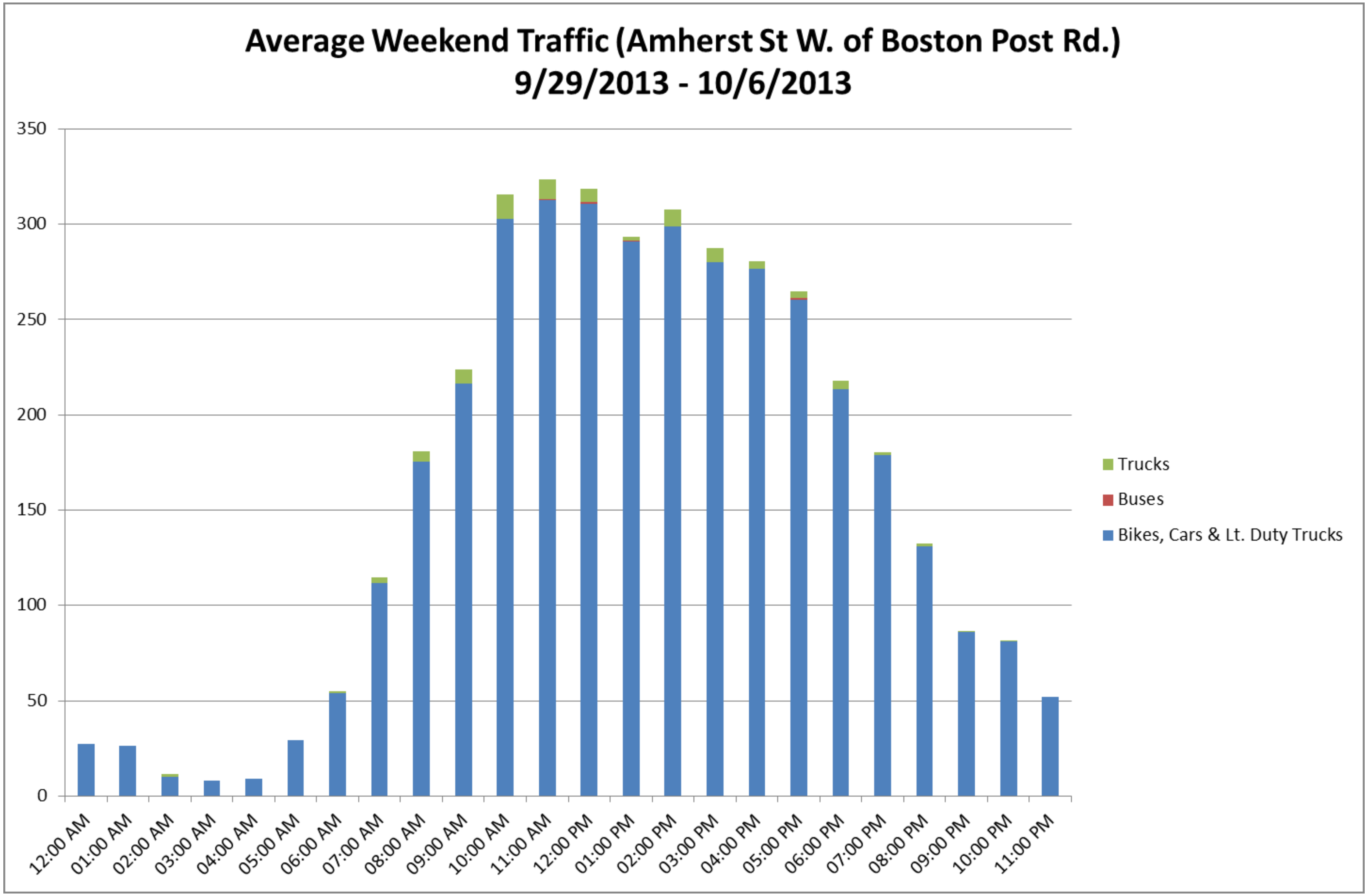


- Highest 85% speeds seen on off hours
  - Particularly very early in the morning even accounting for larger confidence interval due to smaller sample size
- Fairly consistent 85% speed from 5:00am thru 10:00pm

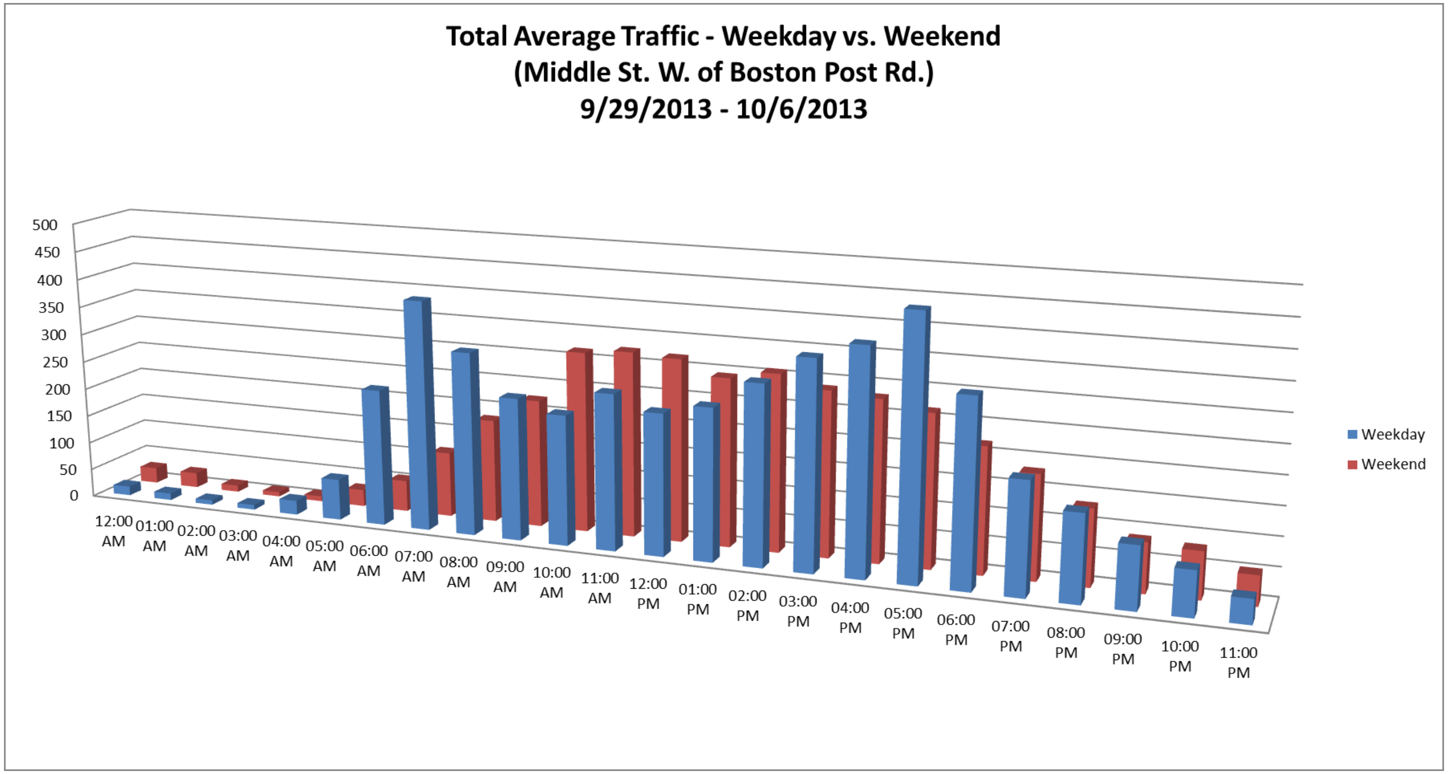
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Assuming there is a some percentage of cut-through traffic during peak commuting hours:
  - The fact that the weekend peak volume exceeds the mid-day weekday trough volume is suggestive that there is a some reduced percentage of cut-through traffic during the weekend.

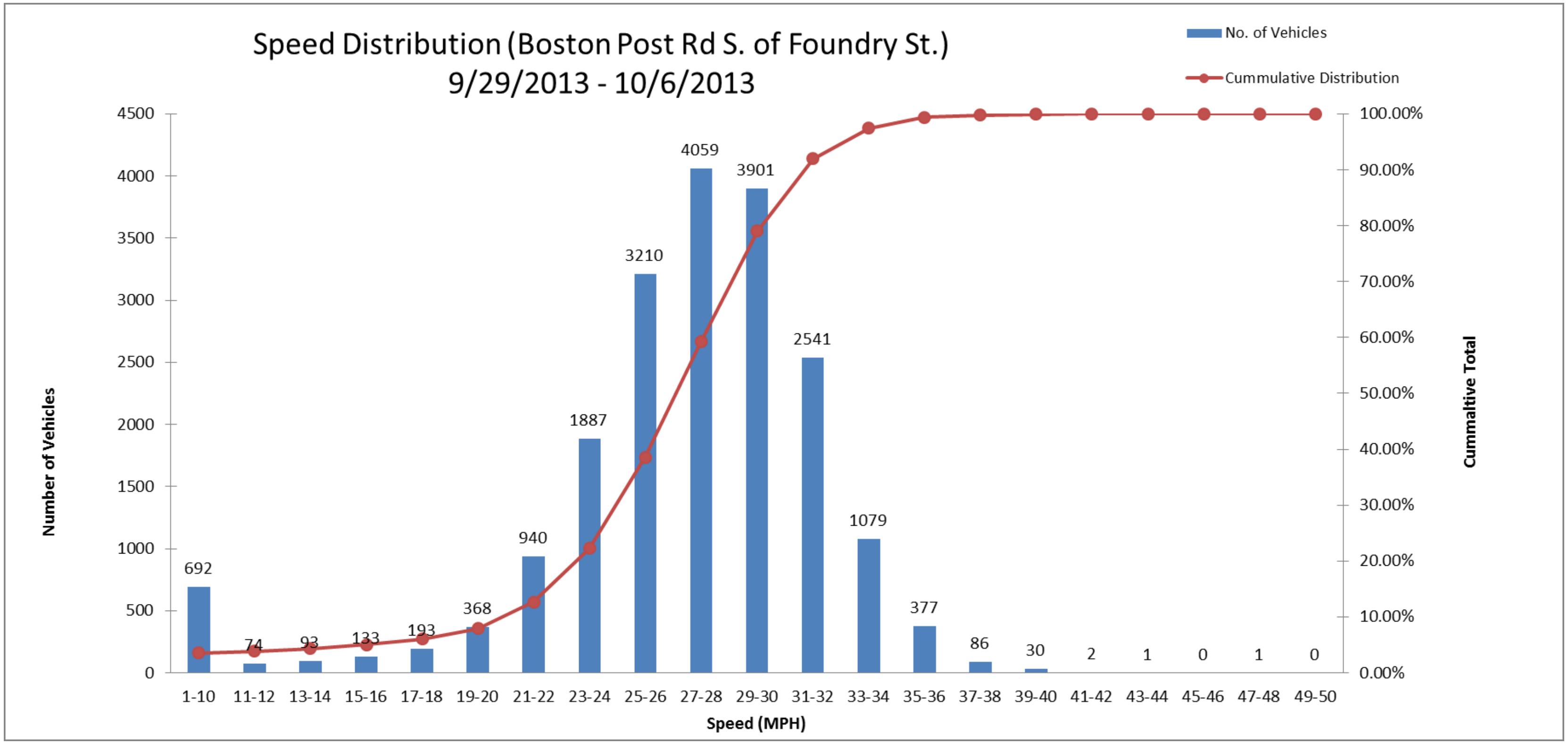
Preliminary Observations
Amherst St. W. of Boston Post Rd.

- Effective Speed Limit: 37.6 mph
- Posted Speed Limit: 35 mph
- Eastbound and Westbound Speed Differential: -1.2 mph
  - for 85% cumulative speed
  - Basically symmetrical but small reduction in speed inbound to village stoplight may be attributed to collective judgment or congestion.
  - A Speed differential greater than 0.2 mph is statistically significant with a 95% confidence
- Consistent conformance seen from 5:00am thru 8:00pm
- Highest speeds seen in the early morning hours from 1:00am to 5:00am

Boston Post Rd S. of Foundry St. Data Set

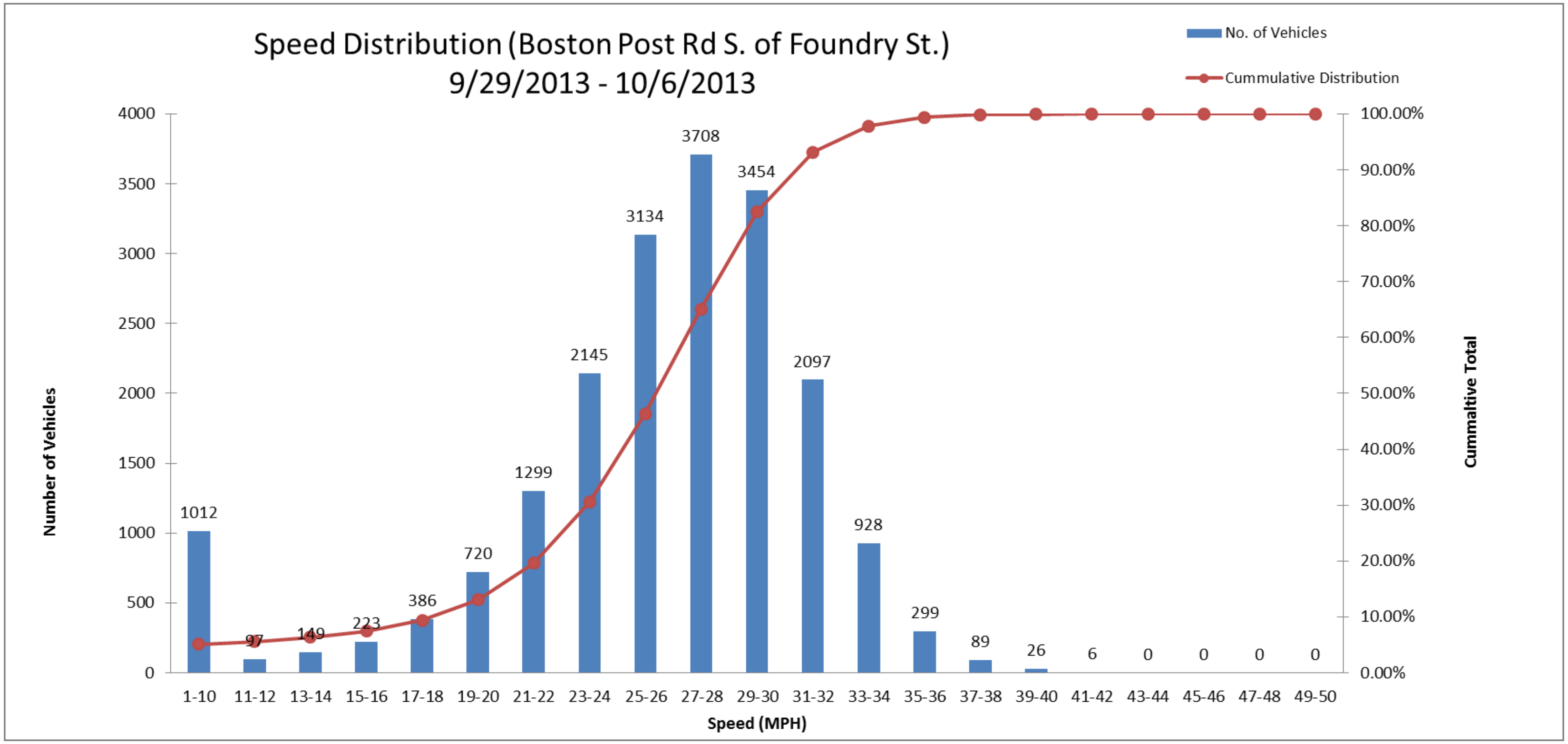
- Data Set Summary:
  - Site Code: 013531
  - 12:00pm on Sunday 9/29/2013 thru 8:00am on Sunday 10/6/2013
  - 39,439 speed and vehicle type observations (including northbound and southbound)

Northbound Stats



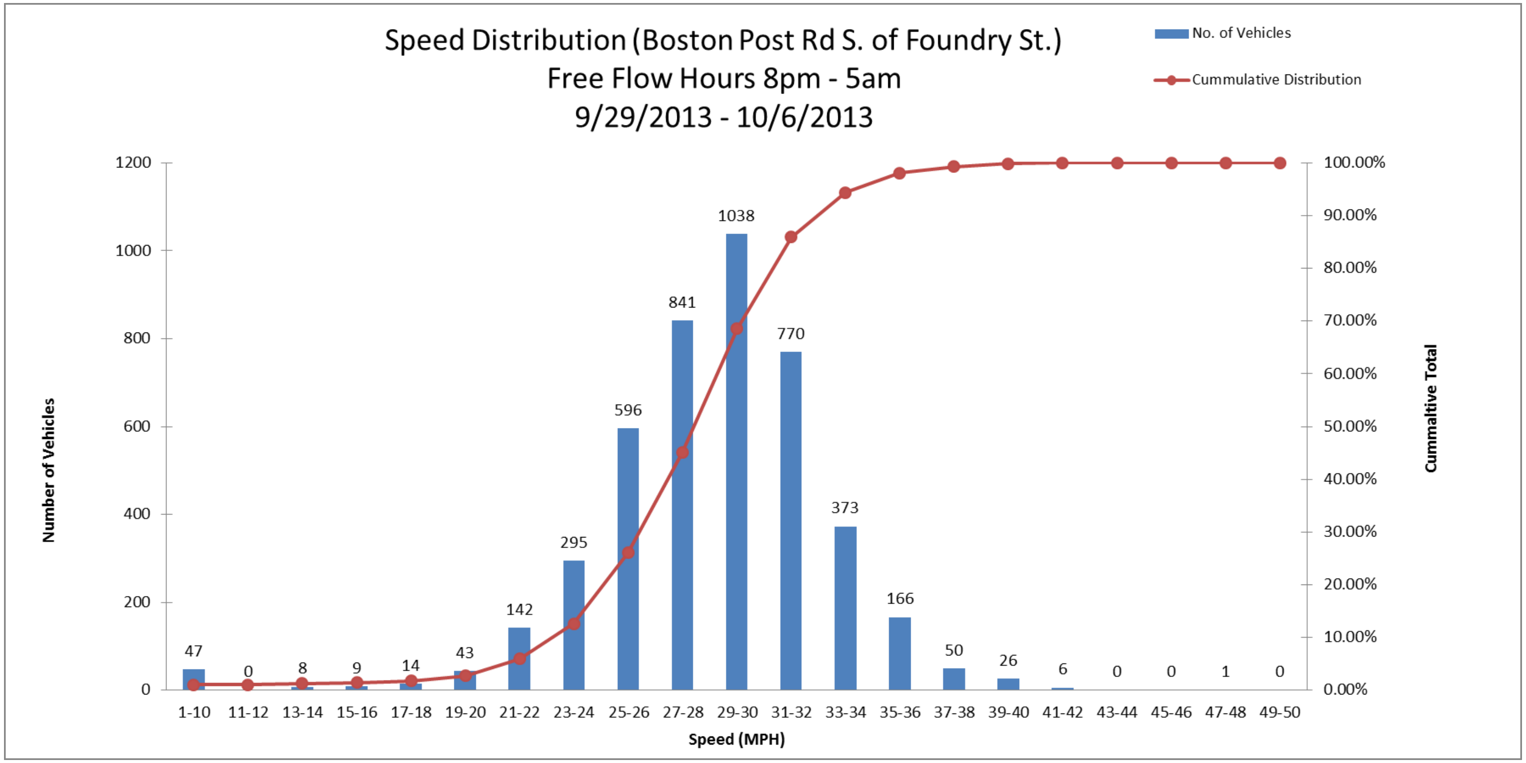
- 85% cumulative speed of 30.9 mph
- 10 mph pace of 23 mph - 32 mph containing 79.3% of the observed traffic
- Mean of 26.7 mph with a median of 27.1 mph (slightly skewed)
- Standard Deviation of 5.7 mph

Southbound Stats



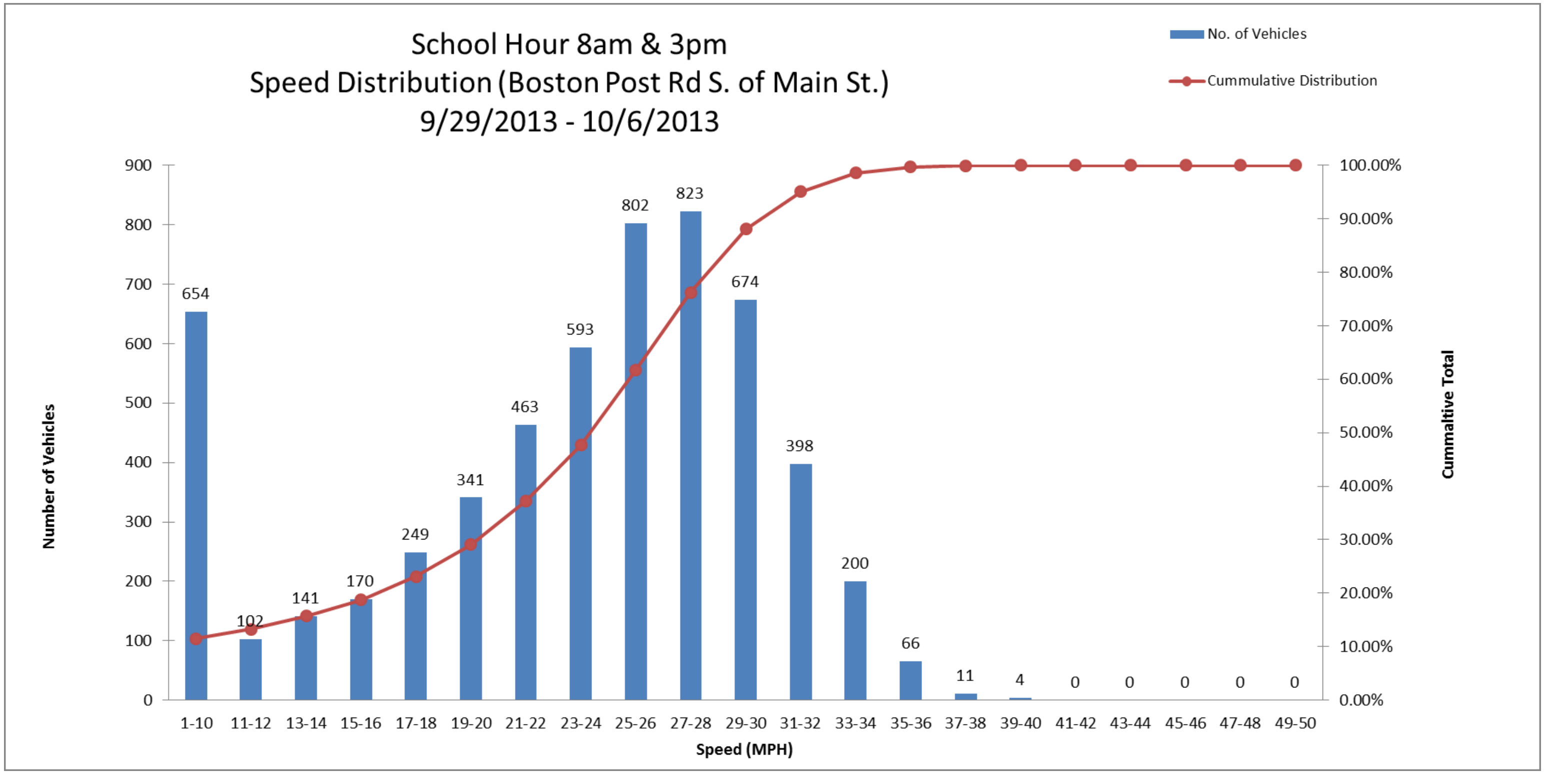
- 85% cumulative speed of 30.5 mph
- 10 mph pace of 23 mph - 32 mph containing 73.5% of the observed traffic
- Mean of 25.7 mph with a median of 26.4 mph (slightly skewed)
- Standard Deviation of 6.4 mph

Combined EB & WB Free Flow Stats



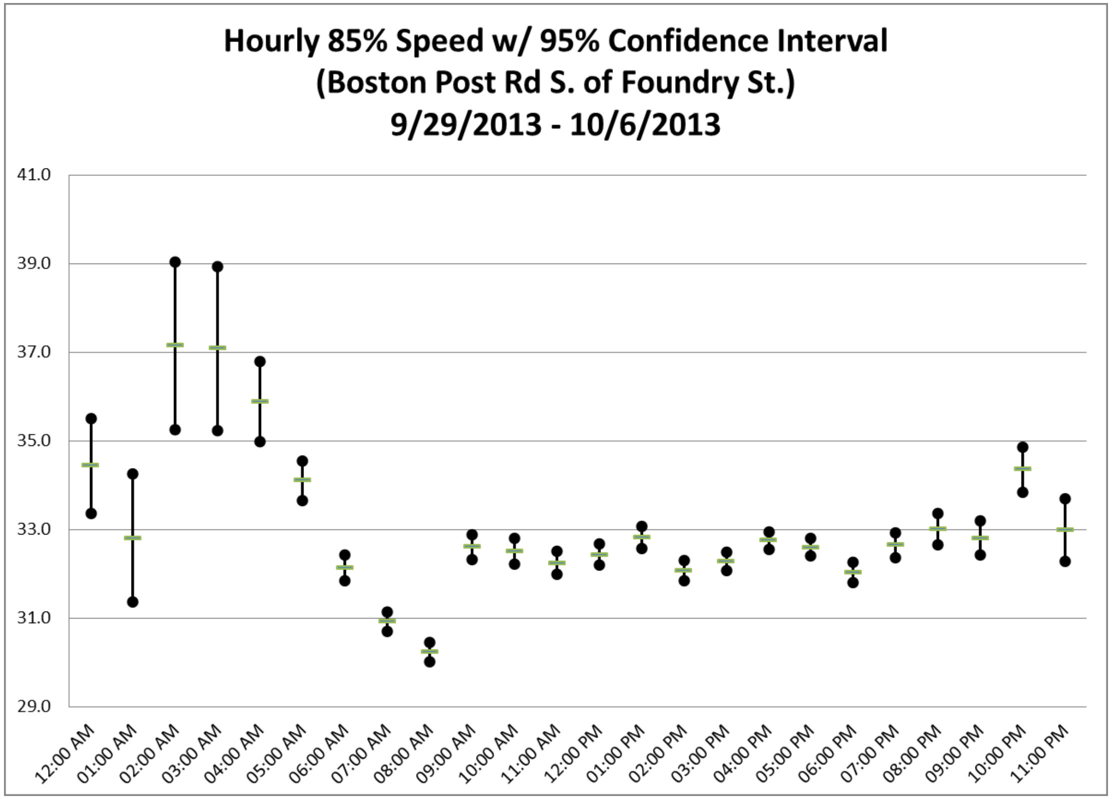
- 85% cumulative speed of 31.9 mph
- 10 mph pace of 25 mph – 34 mph containing 81.8% of the observed traffic
- Mean of 28.6 mph with a median of 28.4 mph (approx. normal)
- Standard Deviation of 4.5 mph

Stats School Hour NB & SB



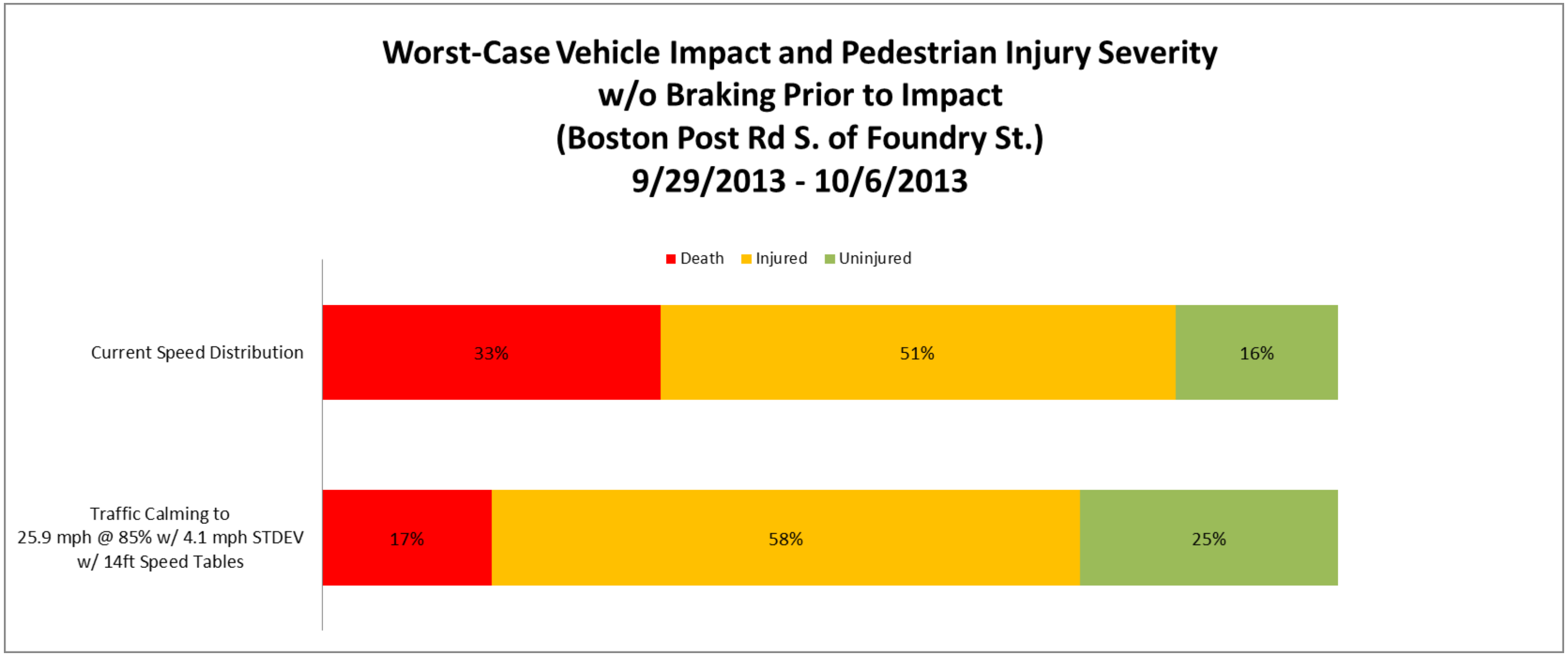
- 85% cumulative speed of 29.5 mph
- 10 mph pace of 21 mph - 30 mph containing 59.0% of the observed traffic
- Mean of 22.7 mph with a median of 24.3 mph (heavily skewed)
- Standard Deviation of 8.0 mph

85% Cumulative Speed vs. Time of Day



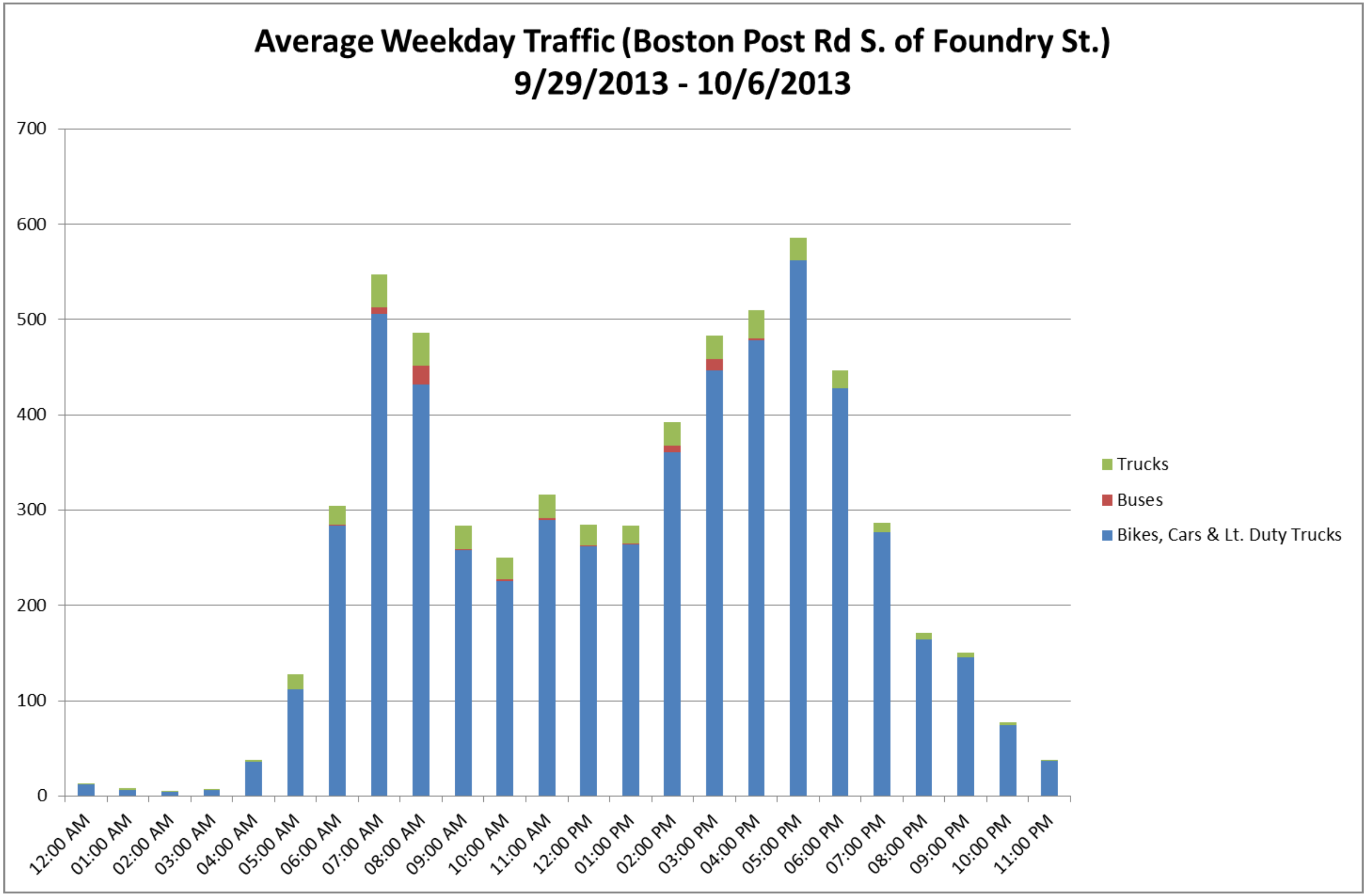
- Highest 85% speeds seen on off hours
  - Particularly very early in the morning during pre-commute hours
- Lowest 85% speeds seen during morning school hour
  - Still well above posted speed limit
  - Morning traffic congestion seemingly the largest contributor to downward shift, otherwise the 3:00 school hour would have a similar 85% cumulative speed due to collective judgment

Application of DoT HS Stats

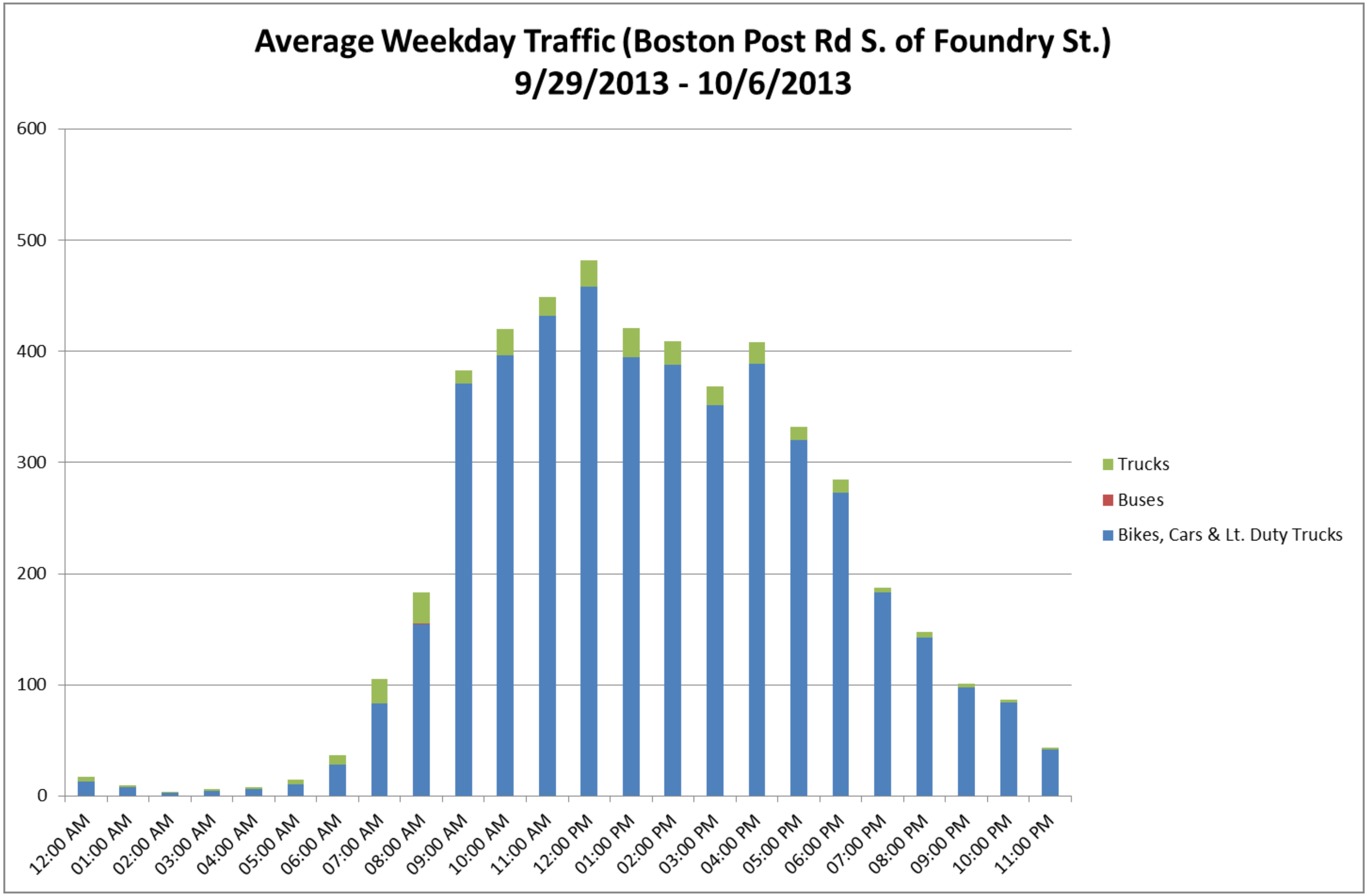


- **<u>Caution must be used</u>** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **<u>zero</u>** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **<u>example only</u>**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in depicting the improvements in safety for the worst-case scenario by having the overall population speed be essentially conforming to the posted speed limit

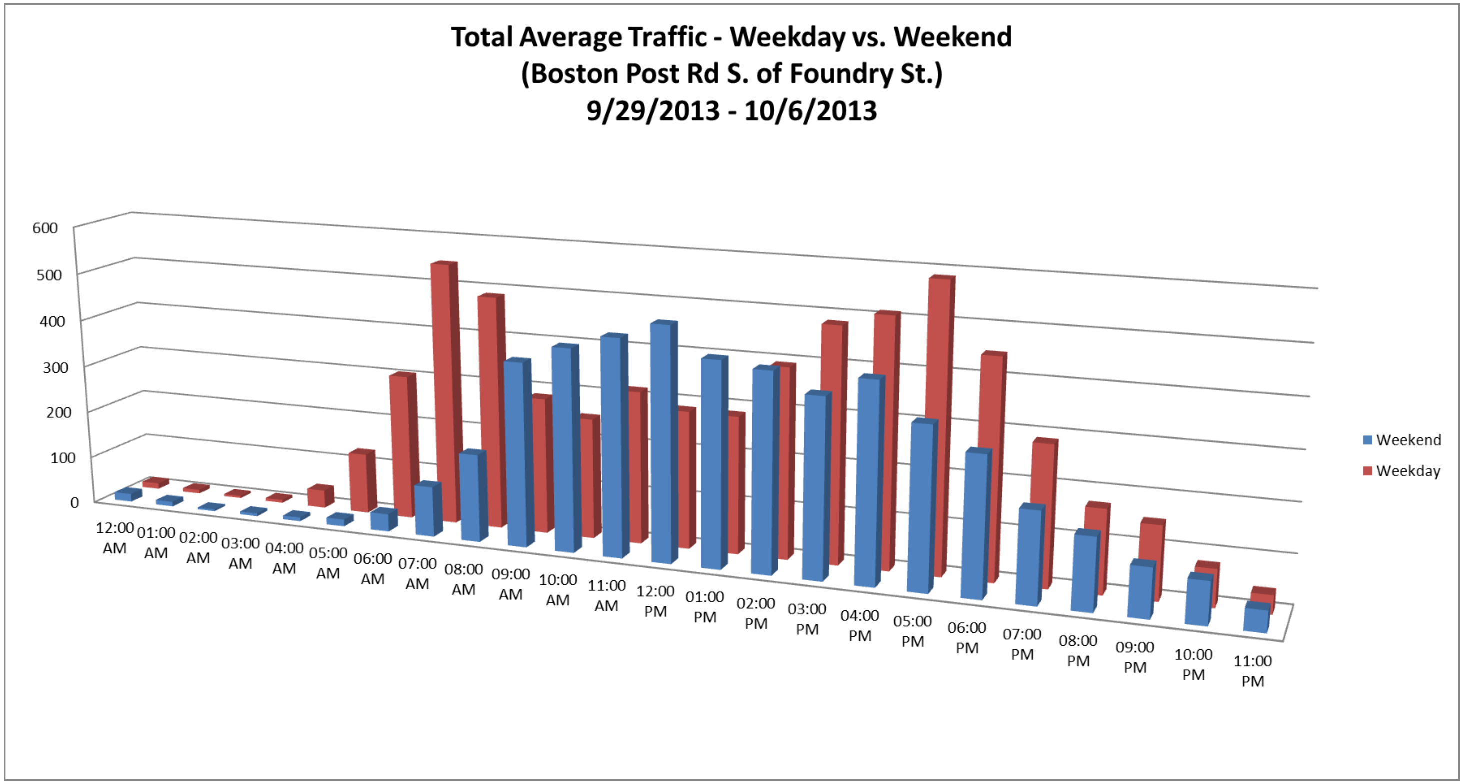
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Assuming there is a significant percentage of cut-through traffic during peak commuting hours:
  - The fact that the weekend peak volume equals weekday peak volume is highly suggestive that there is a significant percentage of cut-through traffic at every hour for the entire week.

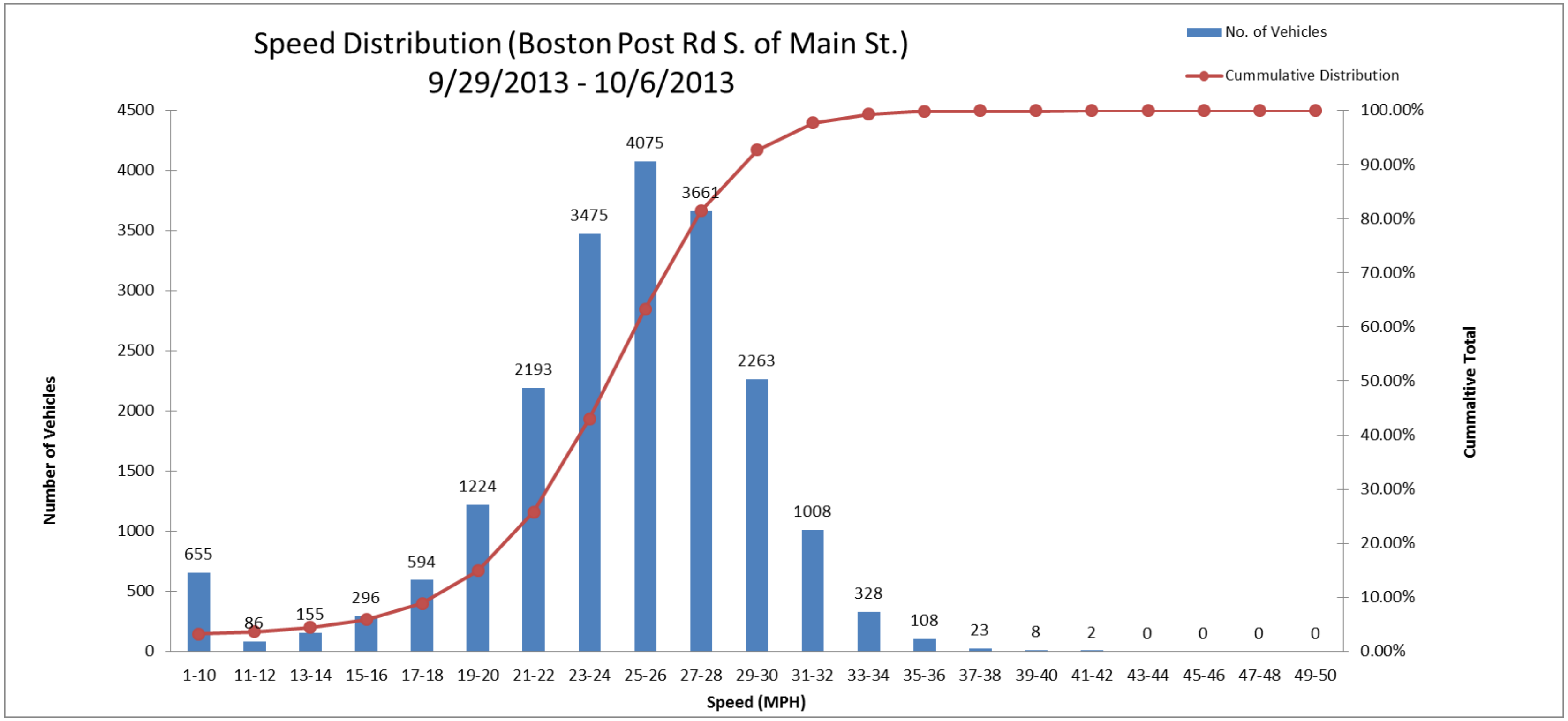
Preliminary Observations
Boston Post Rd S. of Foundry St.

- Effective Speed Limit: 31 mph
- Posted Speed Limit: 25 mph
- Northbound and Southbound Speed Differential: 0.4 mph
  - for 85% cumulative speed
  - Basically symmetrical but small reduction in speed inbound to village may be attributed to collective judgment or congestion.
  - A Speed differential greater than 0.2 mph is statistically significant with a 95% confidence
- Best conformance seen during morning commute (7am – 9am) where again congestion is likely the major factor
- Highest speeds seen in the early morning hours prior to the commute
- Weekday and Weekend volume stats suggest traffic largely dominated by northern Boston Post volumes
  - Other potential feeders such as Foundry St. or Church St. contribute mainly for the weekdays

Boston Post Rd S. of Main St. Data Set

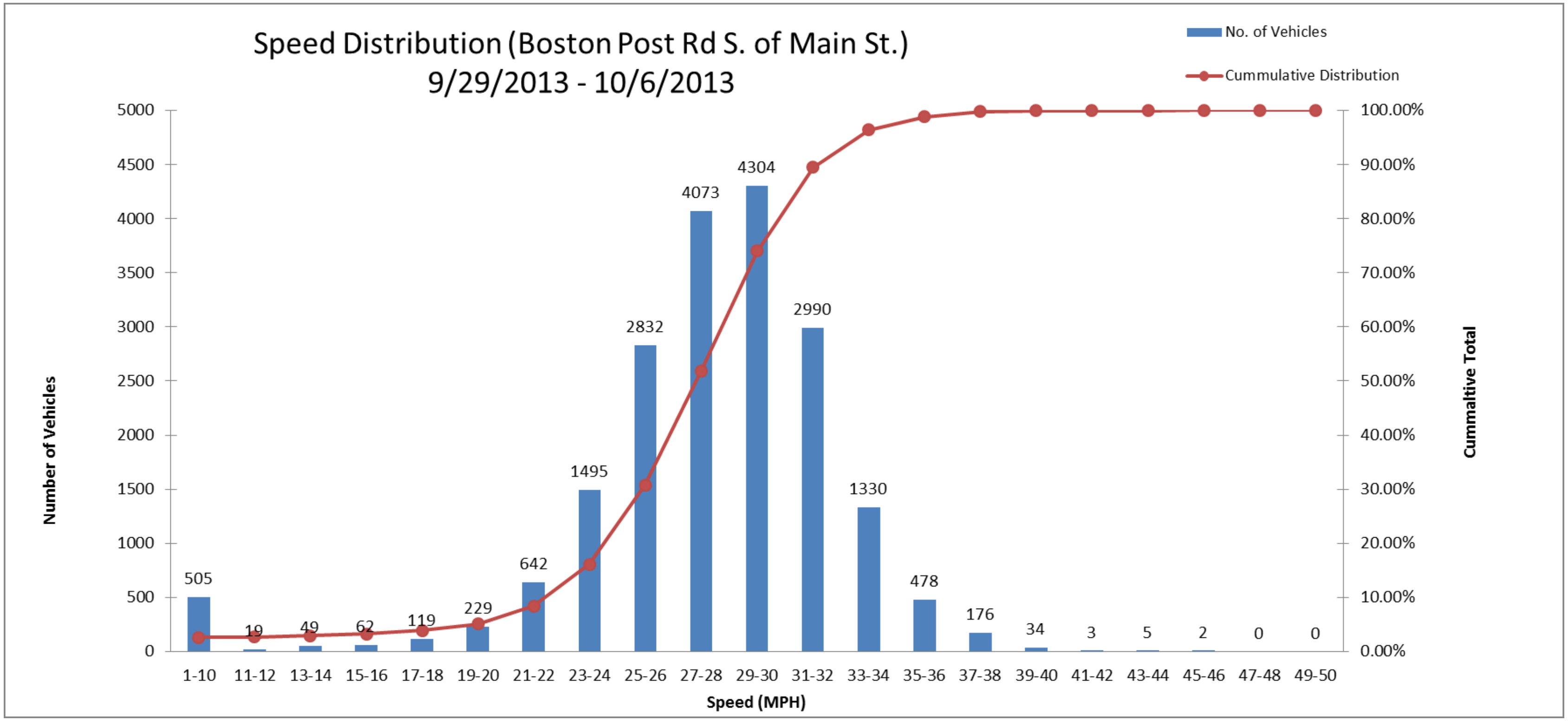
- Data Set Summary:
  - Site Code: 013545
  - 12:00pm on Sunday 9/29/2013 thru 8:00am on Sunday 10/6/2013
  - 39,501 speed and vehicle type observations (including northbound and southbound)

Northbound Stats



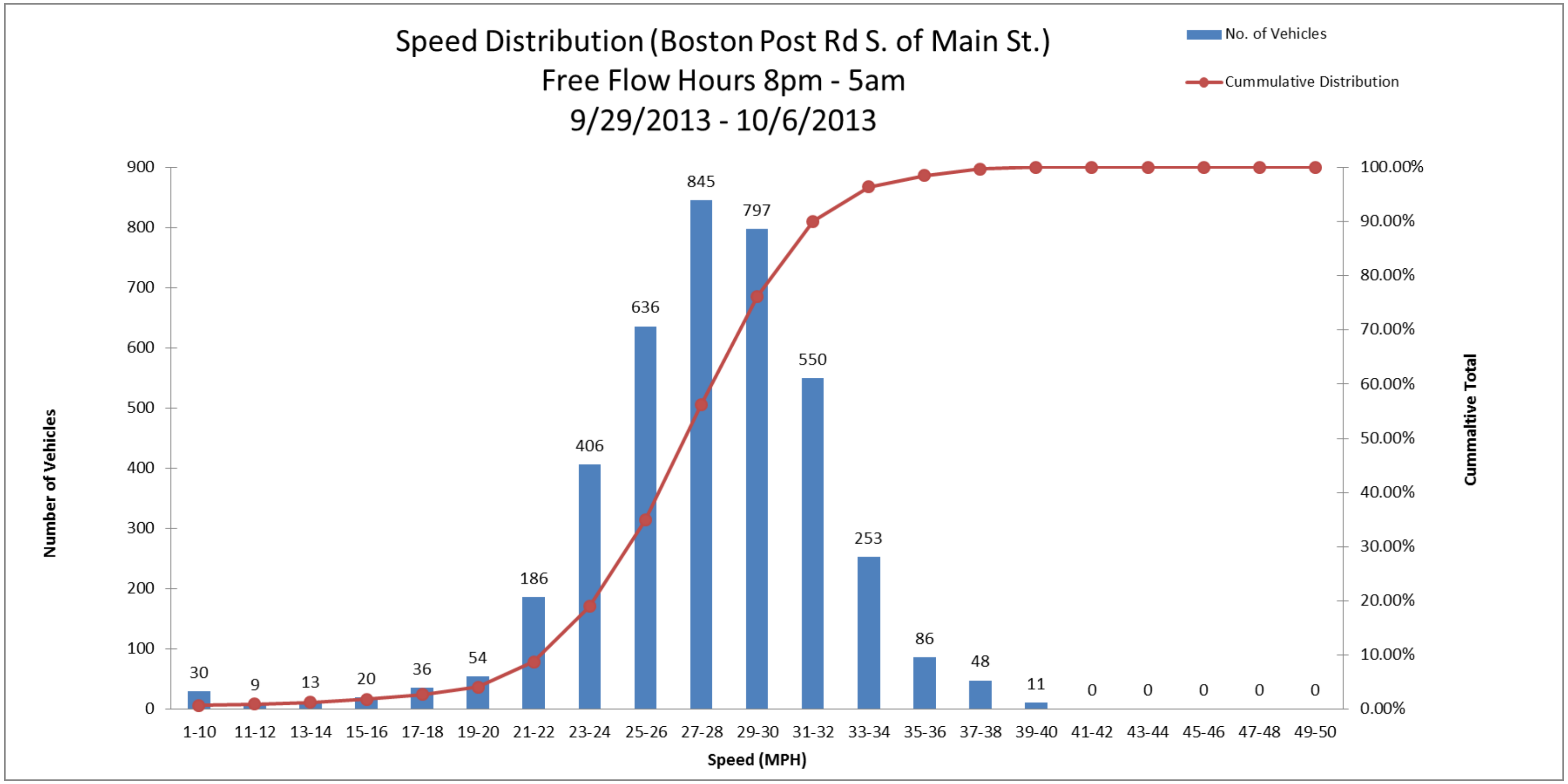
- 85% cumulative speed of 28.6 mph
- 10 mph pace of 21 mph - 30 mph containing 77.7% of the observed traffic
- Mean of 24.5 mph with a median of 24.7 mph (slightly skewed)
- Standard Deviation of 5.3 mph

Southbound Stats



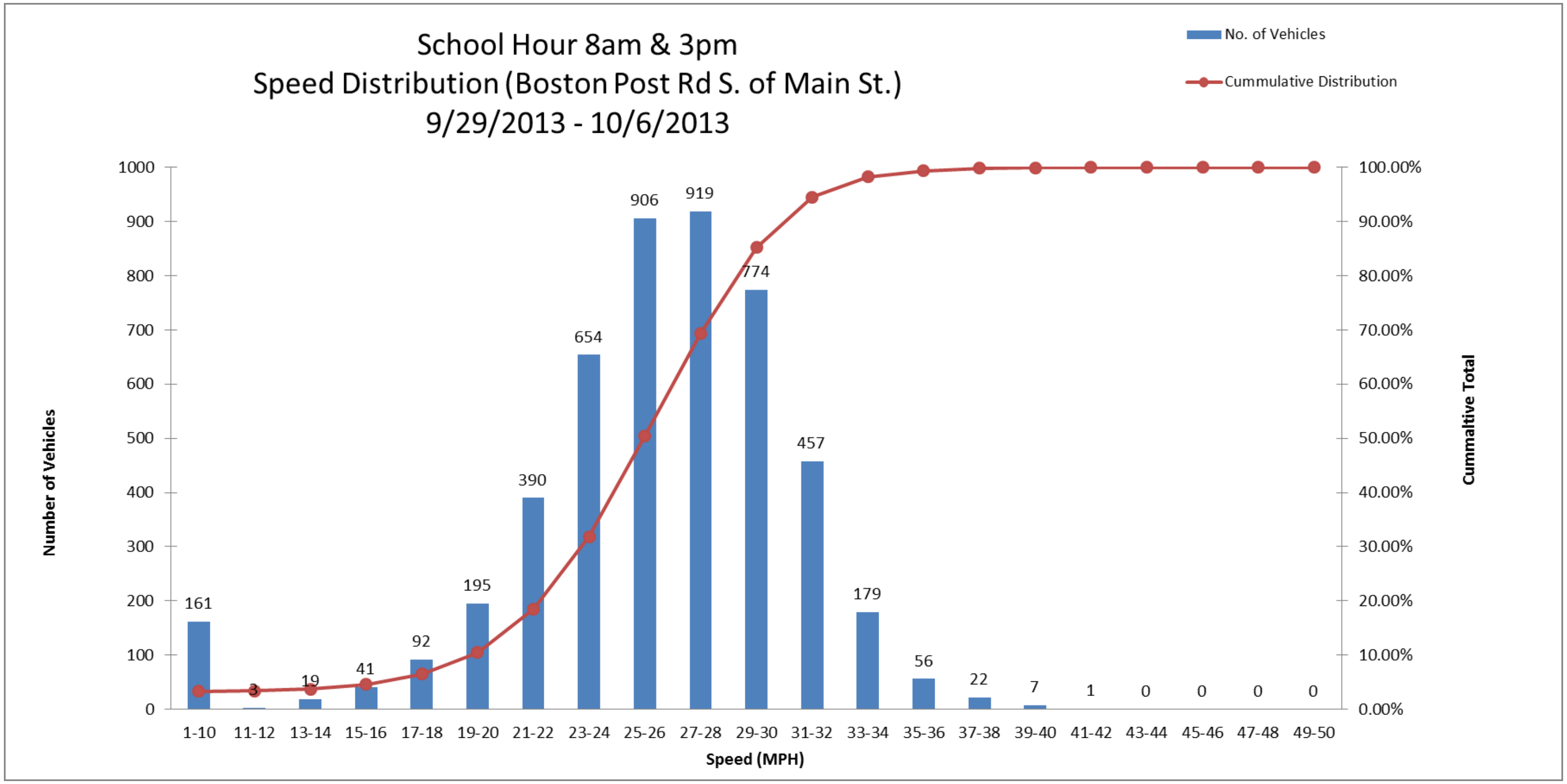
- 85% cumulative speed of 31.4 mph
- 10 mph pace of 23 mph - 32 mph containing 81.1% of the observed traffic
- Mean of 27.7 mph with a median of 27.8 mph (approx. normal)
- Standard Deviation of 5.2 mph

Free Flow Stats
Combined NB & SB



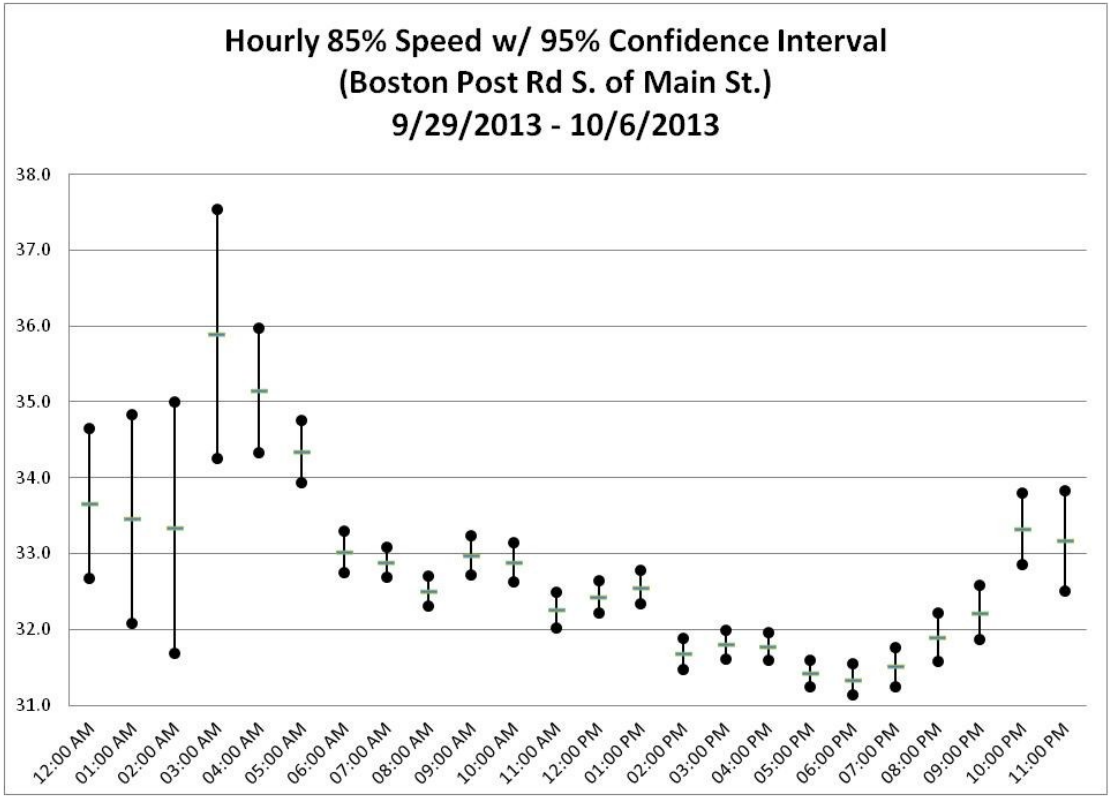
- 85% cumulative speed of 31.3 mph
- 10 mph pace of 23 mph - 32 mph containing 81.3% of the observed traffic
- Mean of 27.6 mph with a median of 27.4 mph (approx. normal)
- Standard Deviation of 4.4 mph

Stats School Hour NB & SB



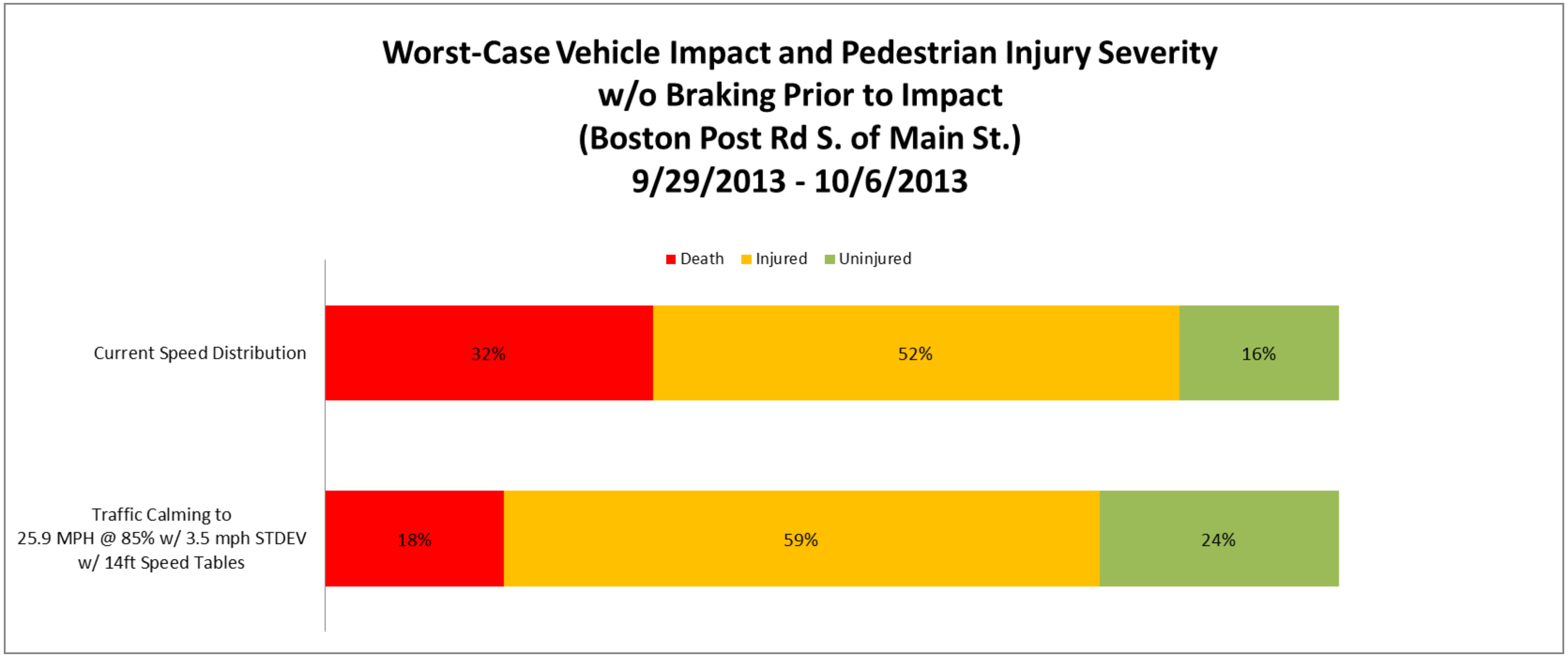
- 85% cumulative speed of 30.0 mph
- 10 mph pace of 23 mph - 32 mph containing 76.1% of the observed traffic
- Mean of 25.8 mph with a median of 25.9 mph (approx. normal)
- Standard Deviation of 5.5 mph

85% Cumulative Speed vs. Time of Day



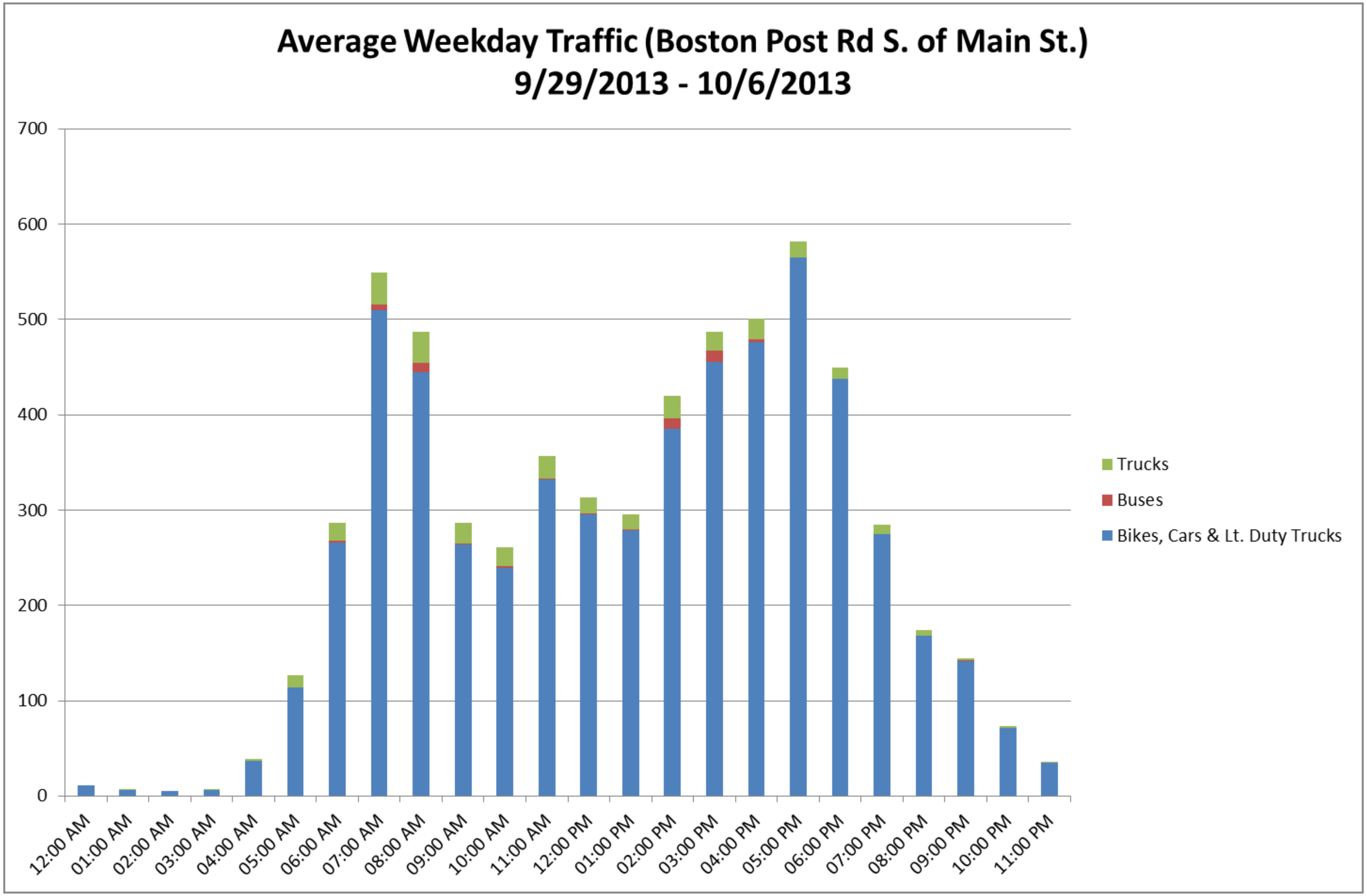
- Highest 85% speeds seen on off hours (late night & early morning)
  - Particularly very early in the morning 2am to 4am
- Lowest 85% speeds seen during morning school hour and around noon
  - both still well above posted speed limit

Application of DoT HS Stats

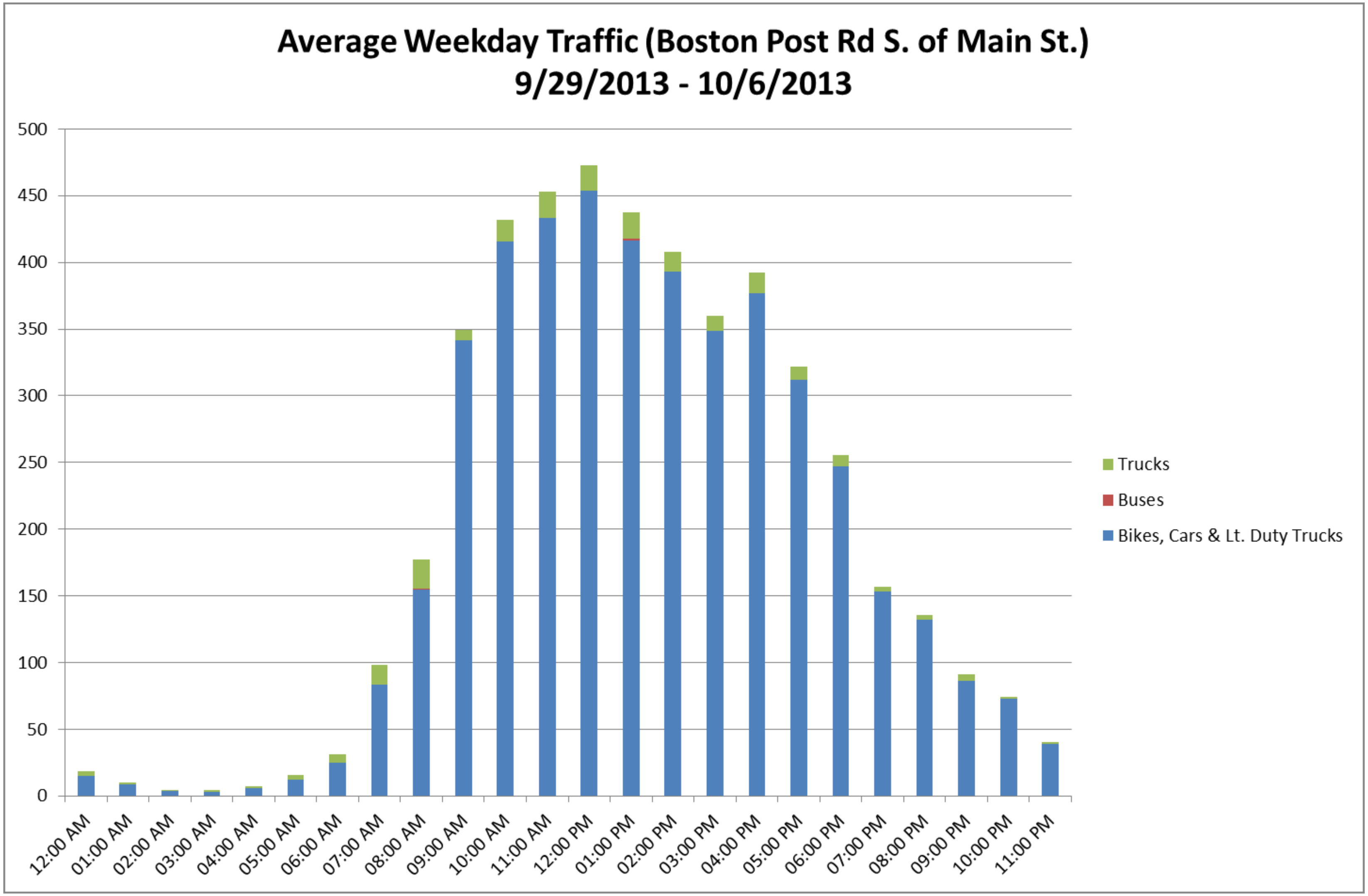


- **Caution must be used** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **zero** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **example only**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in depicting the dramatic improvements in safety for the worst-case scenario by having the overall population speed be essentially conforming to the posted speed limit

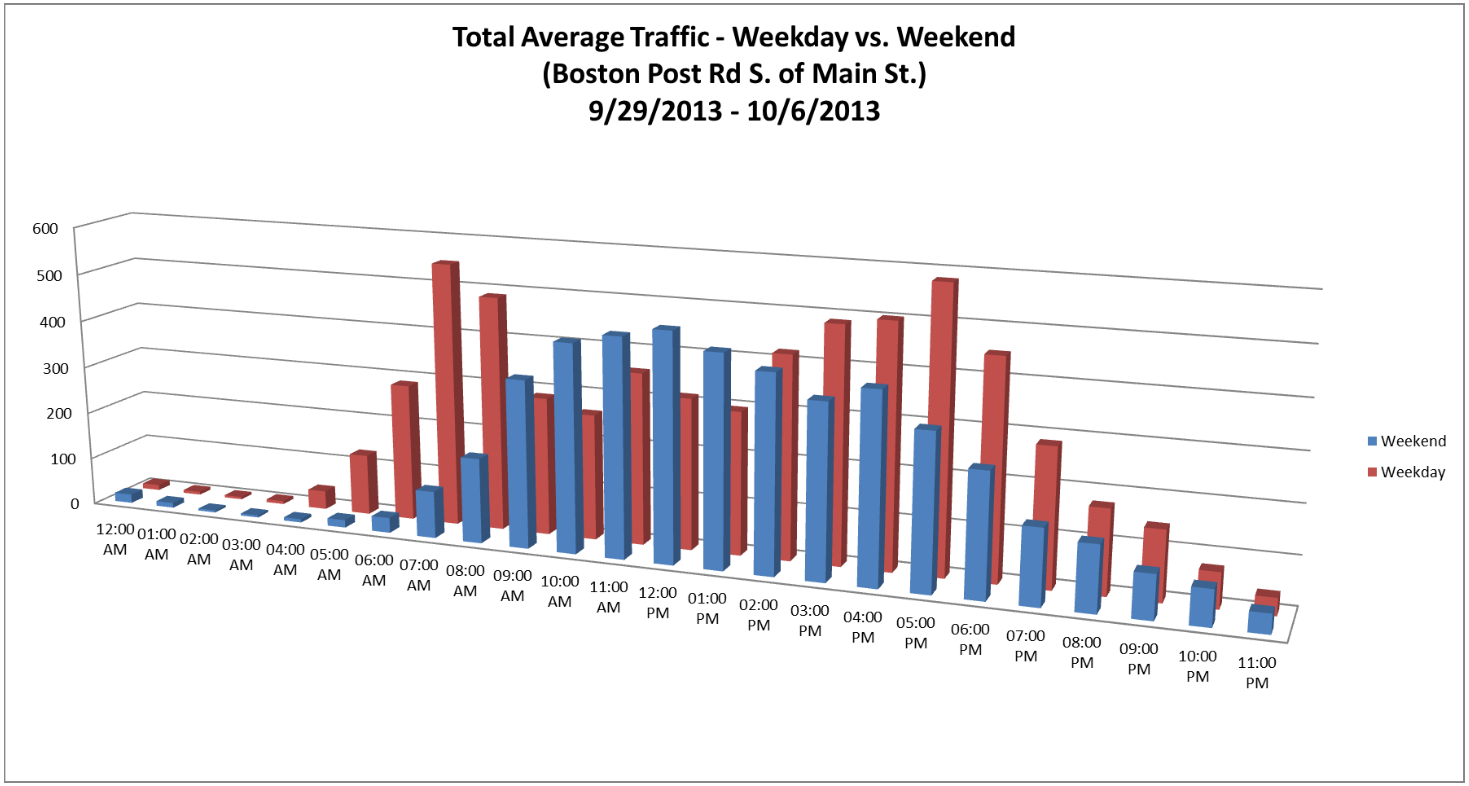
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Weekend volume stats which nearly identical to Boston Post Rd S. of Sunset Ave location suggest traffic largely dominated by northern Boston Post volumes during week-end
  - Not other potential feeders such as Foundry St. or Main St.
- Again comparing to traffic volumes of the Boston Post Rd S. of Sunset Ave location – approximately 80% weekday peak volumes are contributed from northern Boston Post Rd volumes
  - The remaining 20% is due to other feeders such as Foundry St. or Main St.

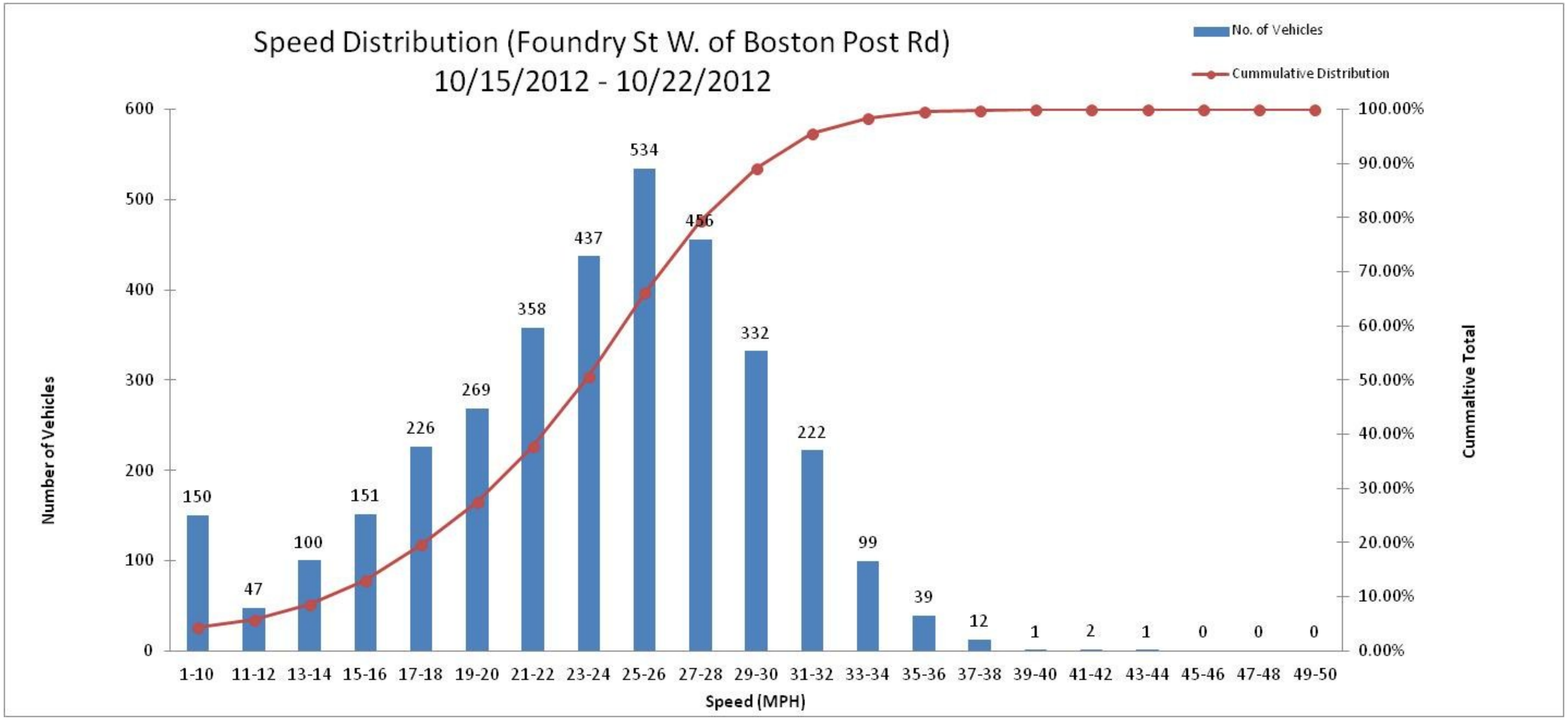
Preliminary Observations
Boston Post Rd S. of Main St.

- Effective Speed Limit: 30 mph
- Posted Speed Limit: 25 mph
- Northbound and Southbound Speed Differential: -2.8 mph
  - for 85% cumulative speed
  - Most likely due to southbound drivers trying to time the light.
  - A Speed differential greater than 0.2 mph is statistically significant with a 95% confidence
- Best conformance seen during evening commute (5pm – 7pm) where again congestion is likely the major factor
- Highest speeds seen in the early morning hours prior to the commute
- Weekday and Weekend volume stats suggest traffic largely dominated by northern Boston Post volumes
  - Other potential feeders such as Foundry St. or Main St. contribute mainly for the weekdays

Foundry St W. of Boston Post Rd. Data Set

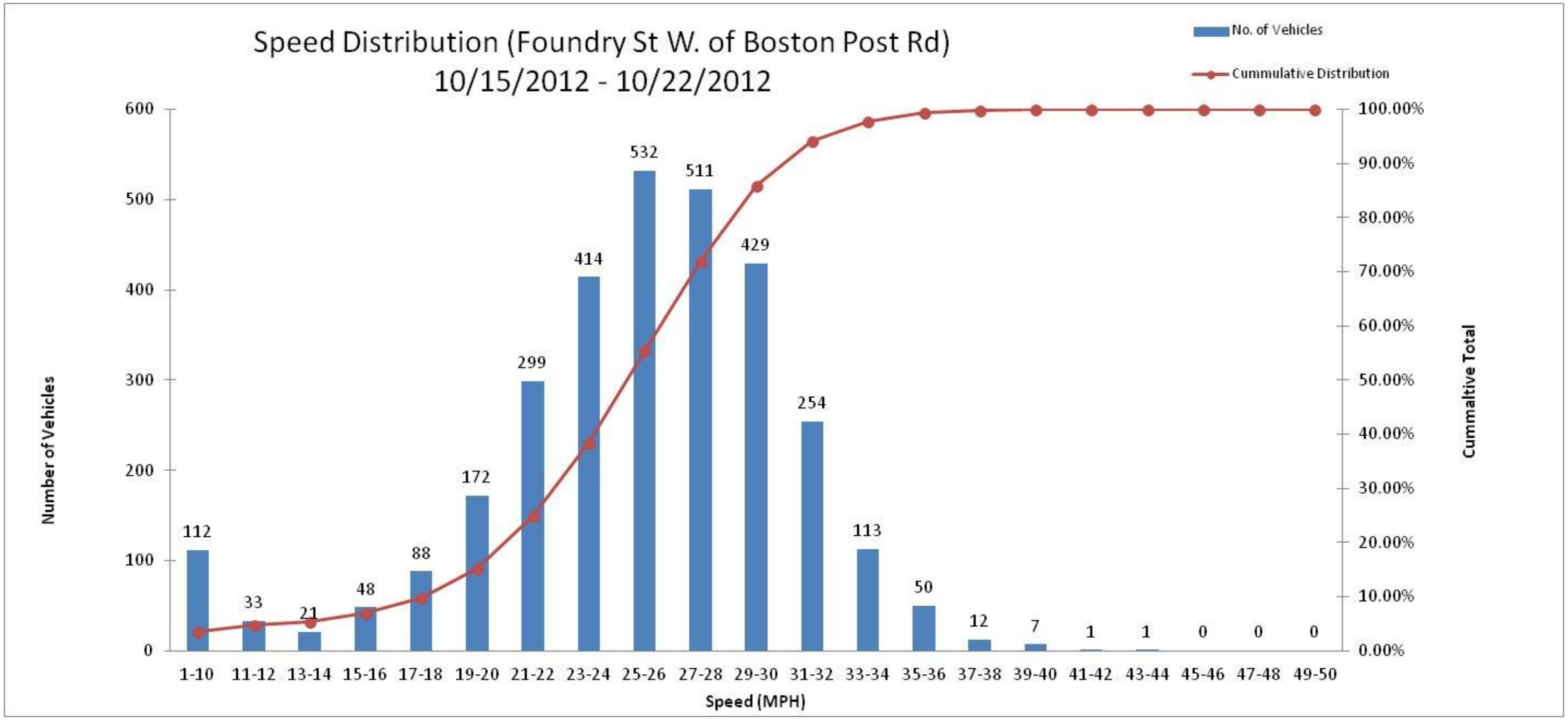
- Data Set Summary:
  - Site Code: AMHERST0FONDRY
  - 1:00pm on Monday 10/15/2012 thru 11:00am on Monday 10/22/2012
  - 6,533 speed and vehicle type observations (including northbound and southbound)

Eastbound Stats



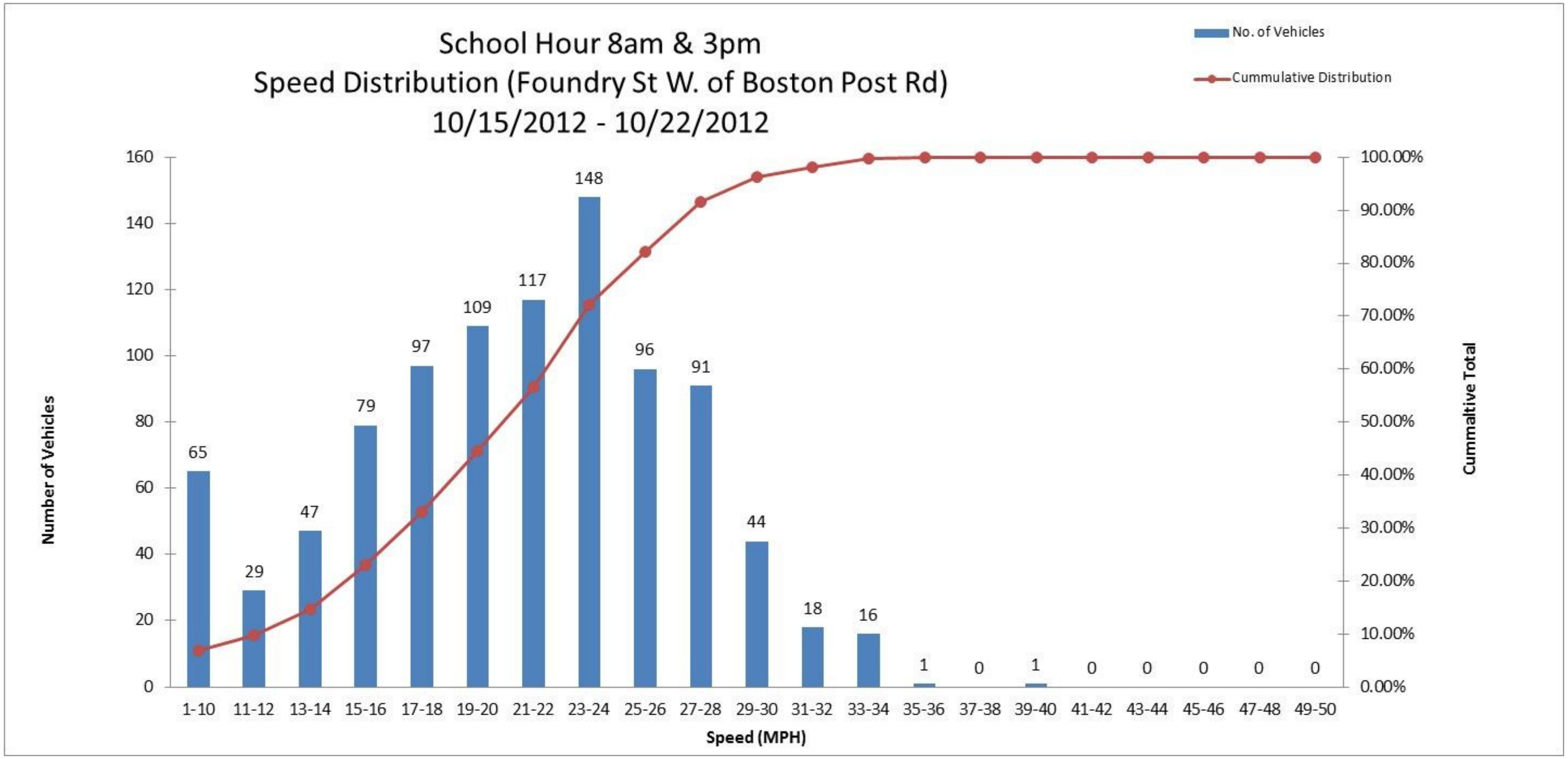
- 85% cumulative speed of 29.2 mph
- 10 mph pace of 21 mph - 30 mph containing 61.6% of the observed traffic
- Mean of 23.4 mph with a median of 23.9 mph (skewed)
- Standard Deviation of 6.5 mph

Westbound Stats



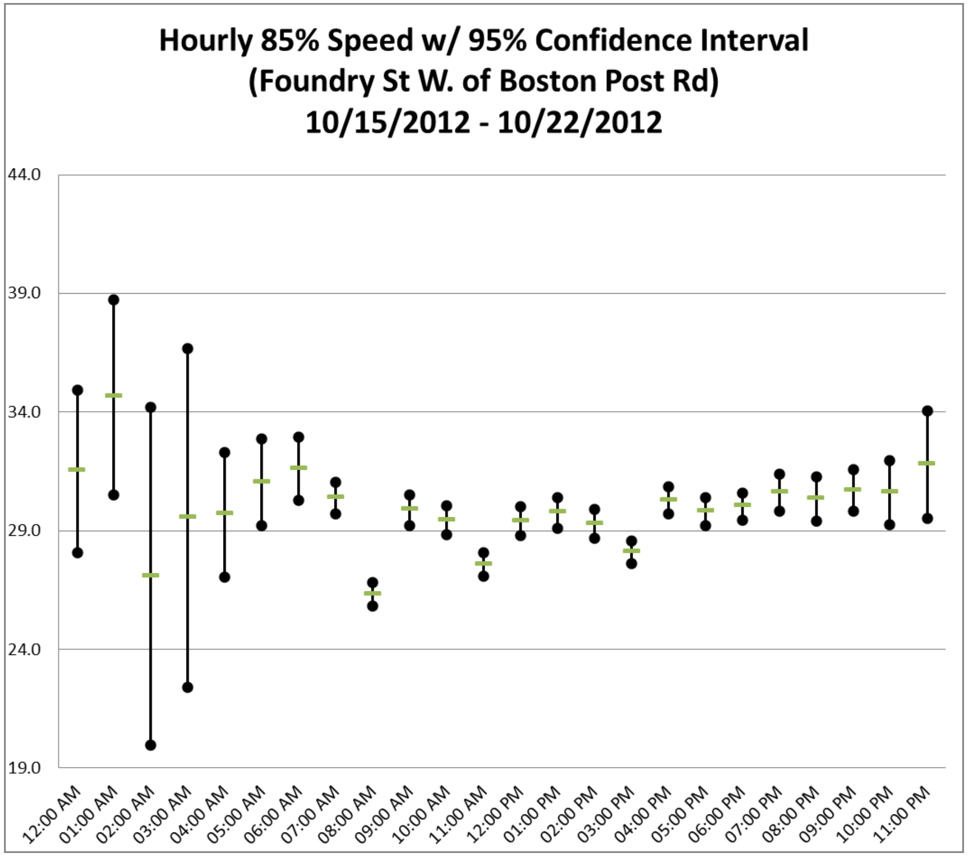
- 85% cumulative speed of 31.8 mph
- 10 mph pace of 21 mph - 30 mph containing 70.6% of the observed traffic
- Mean of 25.1 mph with a median of 27.4 mph (skewed)
- Standard Deviation of 6.0 mph

Stats School Hour NB & SB



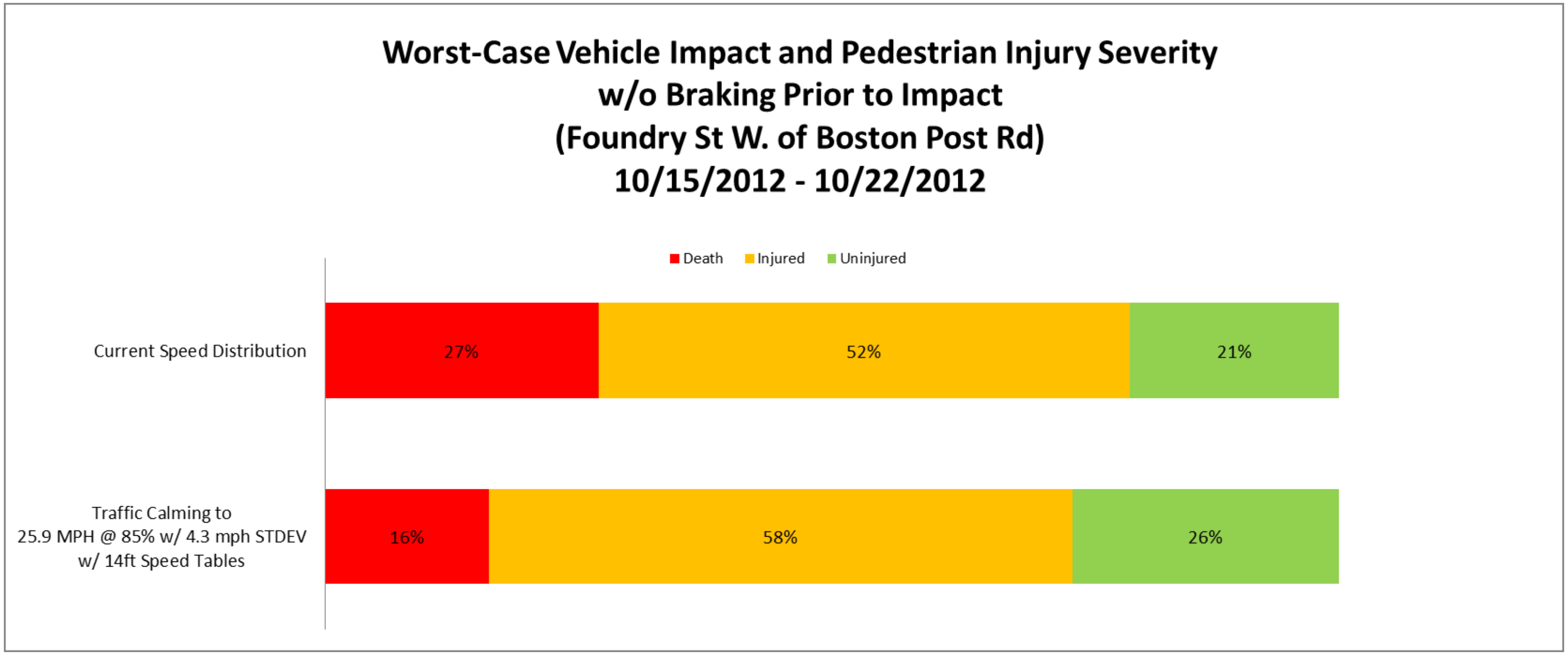
- 85% cumulative speed of 26.6 mph
- 10 mph pace of 17 mph - 26 mph containing 59.2% of the observed traffic
- Mean of 20.7 mph with a median of 20.9 mph (only slightly skewed)
- Standard Deviation of 6.4 mph

85% Cumulative Speed vs. Time of Day



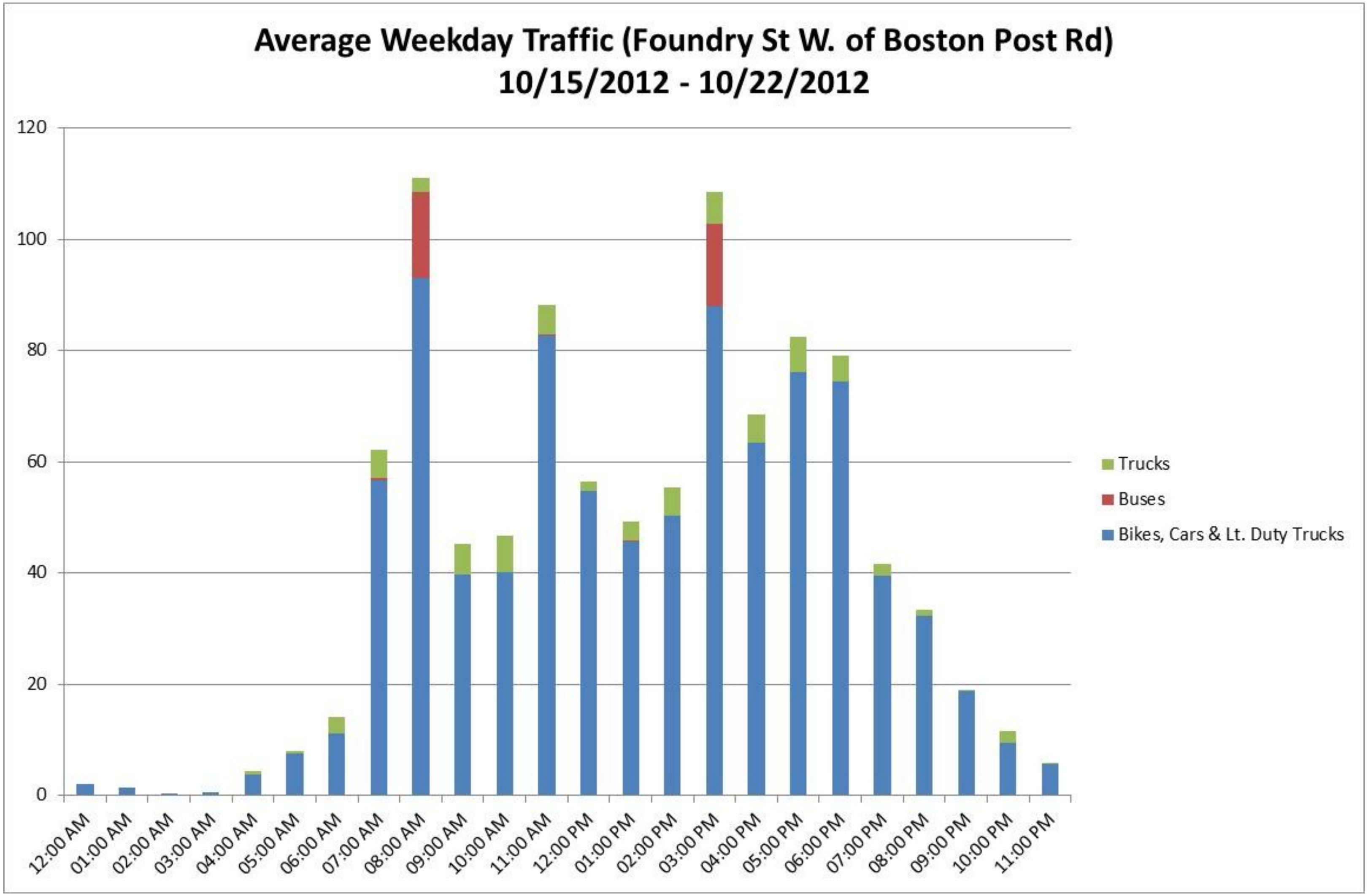
- Highest 85% speeds seen on off hours
  - Particularly very early in the morning but confidence interval is large due to small number of observations
- Lowest 85% speeds seen during 8am, 11 am, and 3 pm school hours
  - Again changes are likely due to congestion rather than changes in collective judgment

Application of DoT HS Stats

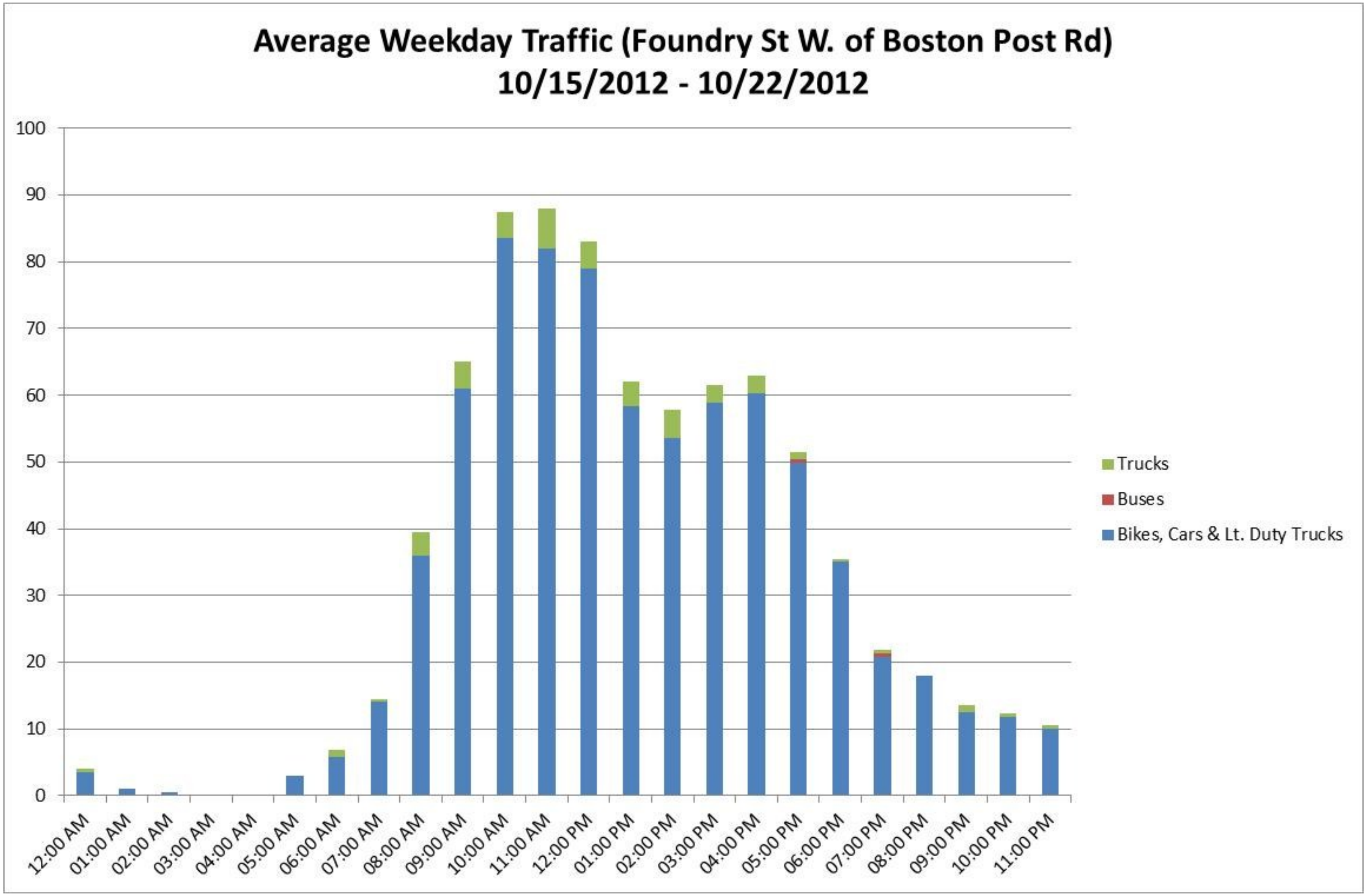


- **<u>Caution must be used</u>** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **<u>zero</u>** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **<u>example only</u>**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in there are some gains in safety to be found in the worst-case scenario through traffic calming measures
  - The success criteria may be higher than other roads due to the location of school on it

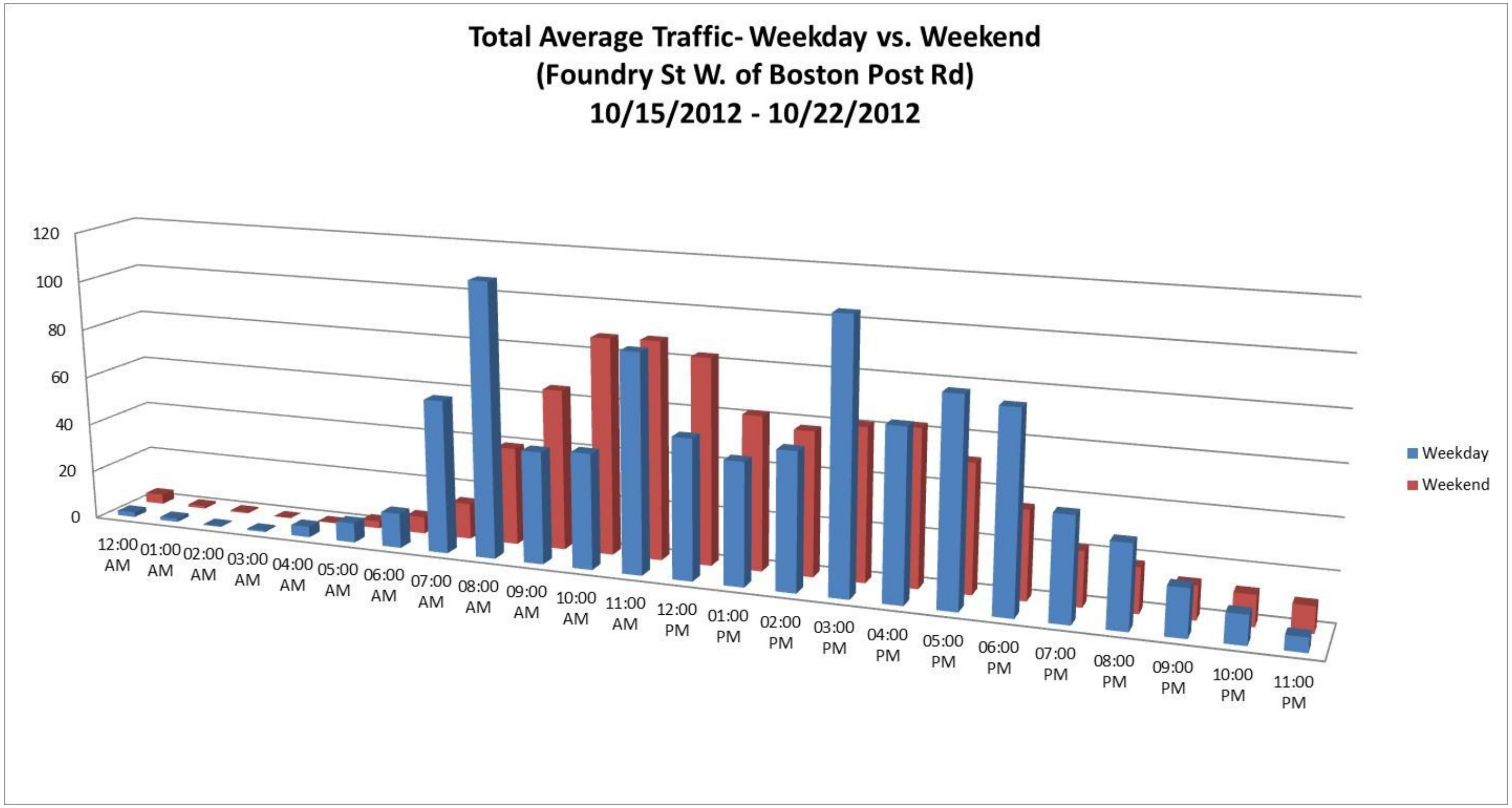
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Peak hours are the school hours during the week
- Generally volume below 100 vehicles/hour

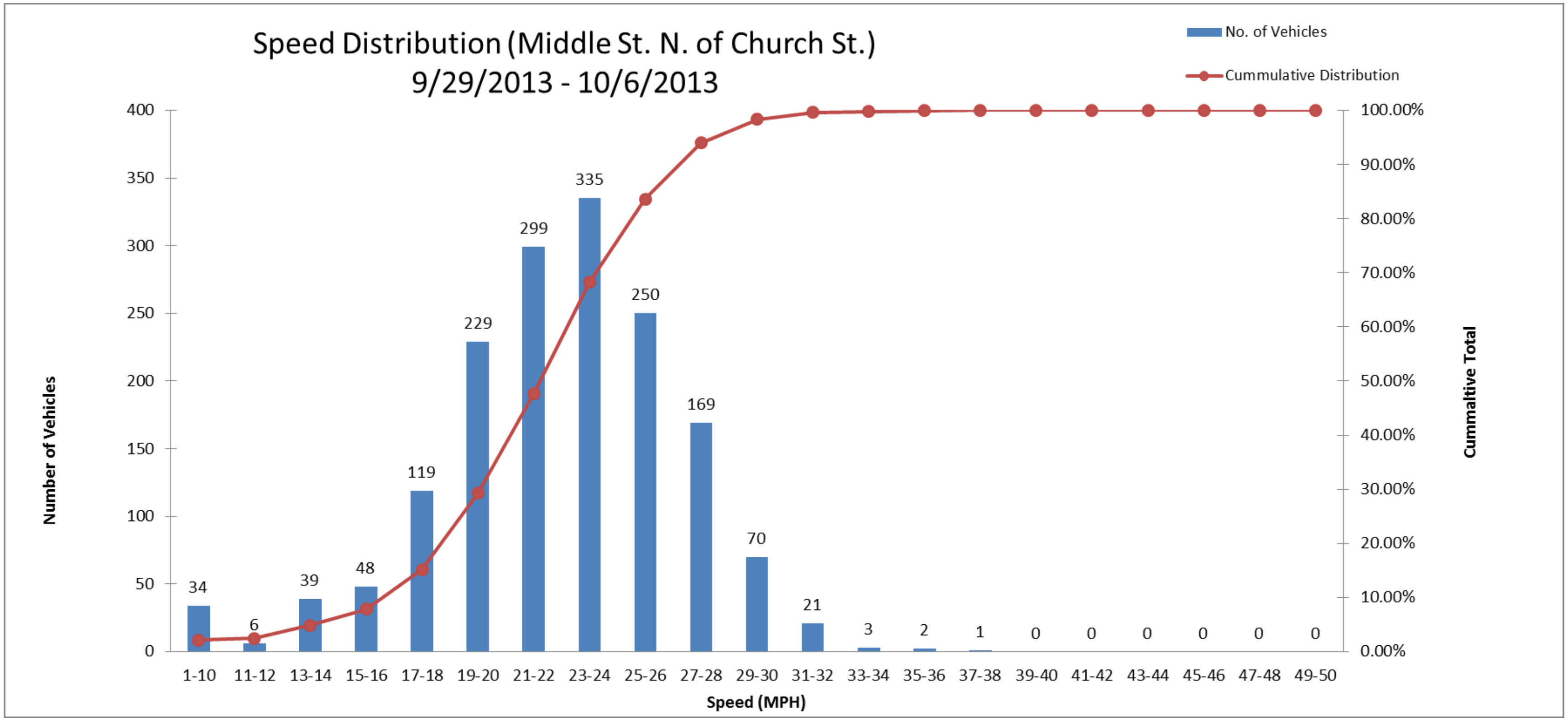
Preliminary Observations
Foundry St W. of Boston Post Rd.

- Effective Speed Limit: 30 mph
- Posted Speed Limit: 25 mph
- Eastbound and Westbound Speed Differential: -2.6 mph
  - for 85% cumulative speed
  - Descending hill prior to entering village area may be contributing factor
  - A speed differential greater than 0.4 mph is statistically significant with a 95% confidence
- Best conformance seen during three school hours where again congestion is likely the major factor in improved conformance
- Highest speeds seen late in the evening and very early morning hours

Middle St. N. of Church St. Data Set

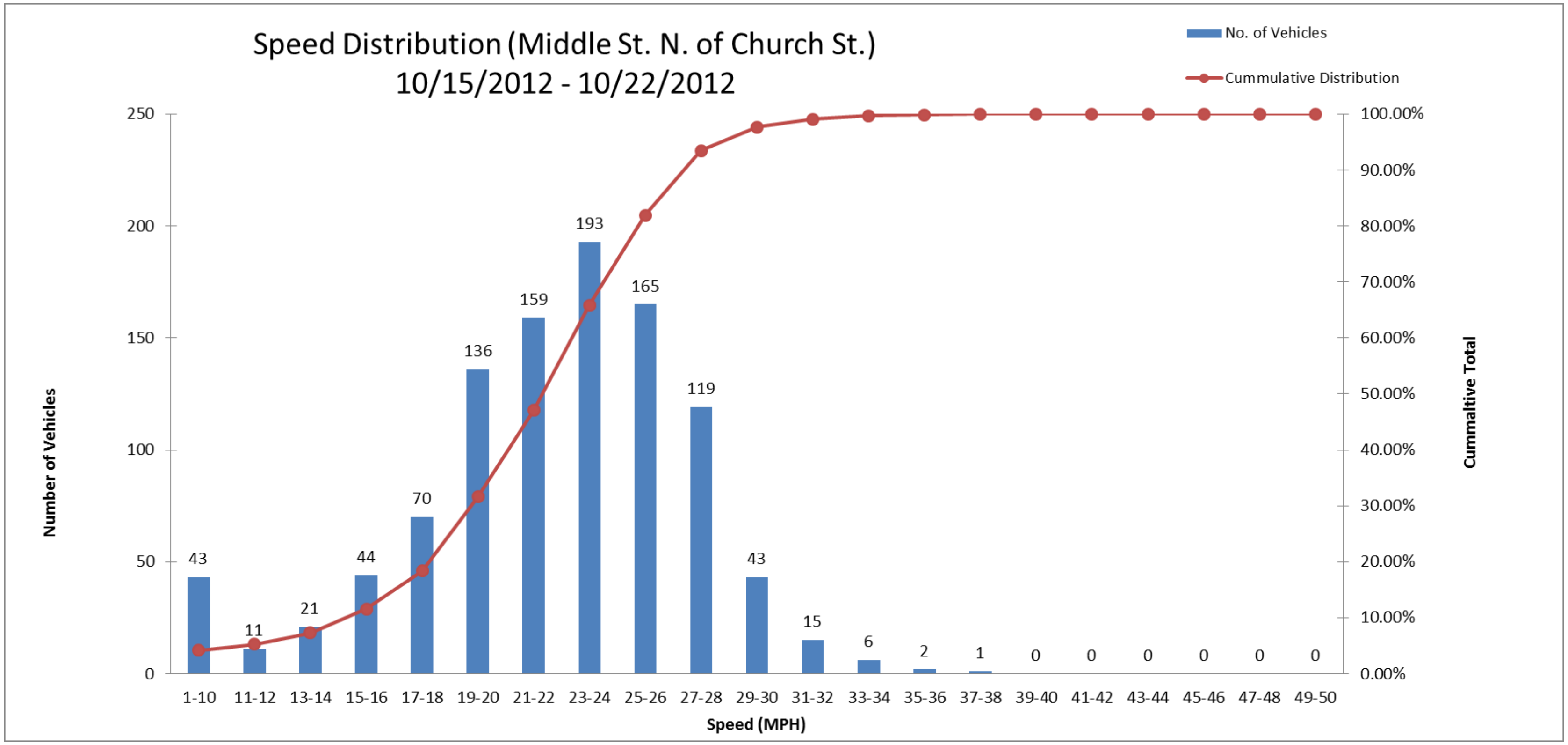
- Data Set Summary:
  - Site Code: 13539
  - 1:00pm on Monday 9/29/2013 thru 8:00am on Monday 10/6/2013
  - 2,576 speed and vehicle type observations (including northbound and southbound)

Northbound Stats



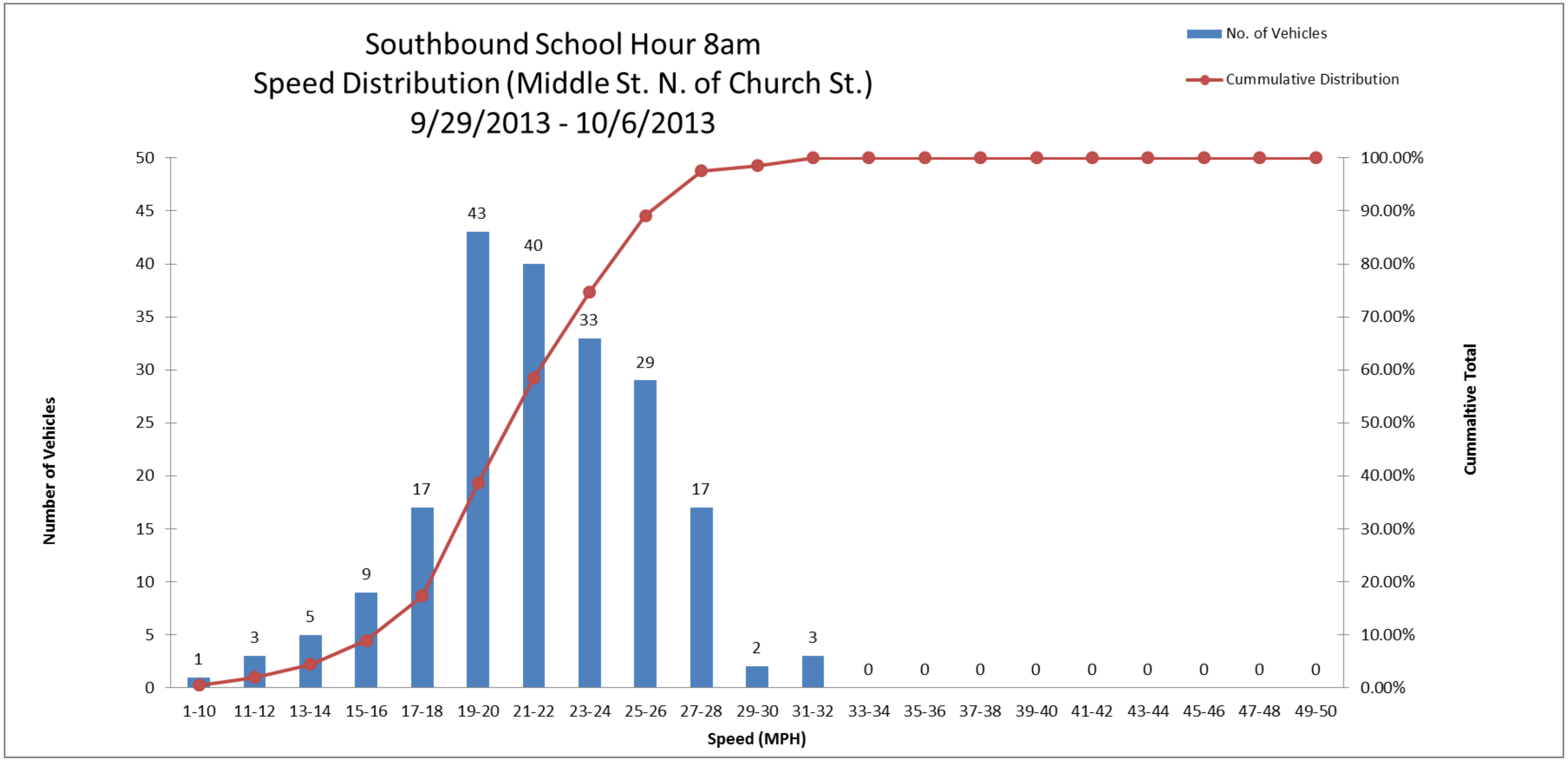
- 85% cumulative speed of 26.3 mph
- 10 mph pace of 19 mph - 28 mph containing 78.9% of the observed traffic
- Mean of 22.4 mph with a median of 22.2 mph (essentially normal)
- Standard Deviation of 4.9 mph

Southbound Stats



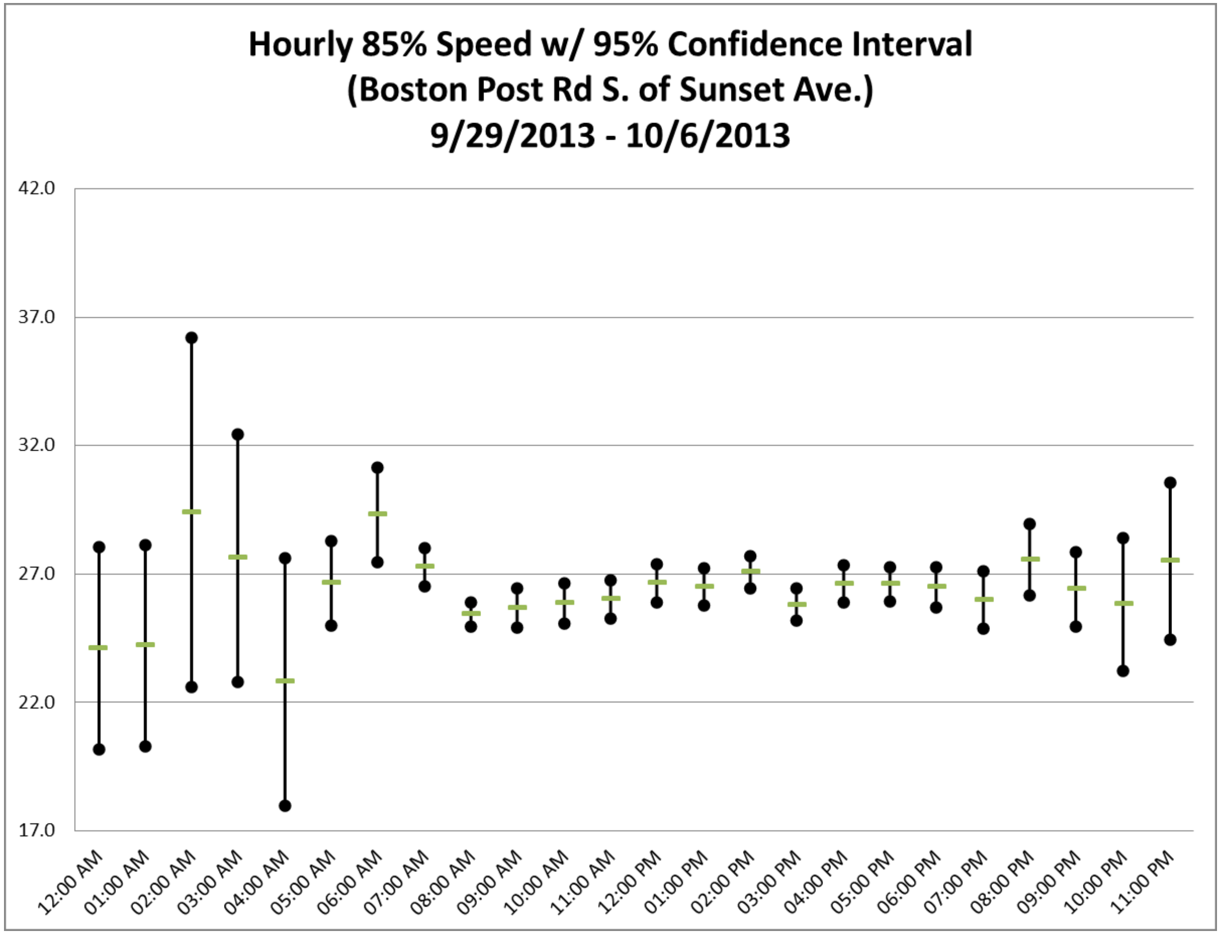
- 85% cumulative speed of 26.5 mph
- 10 mph pace of 19 mph - 28 mph containing 75.1% of the observed traffic
- Mean of 22.1 mph with a median of 22.3 mph (essentially normal)
- Standard Deviation of 5.4 mph

Stats Southbound 8am School Hour



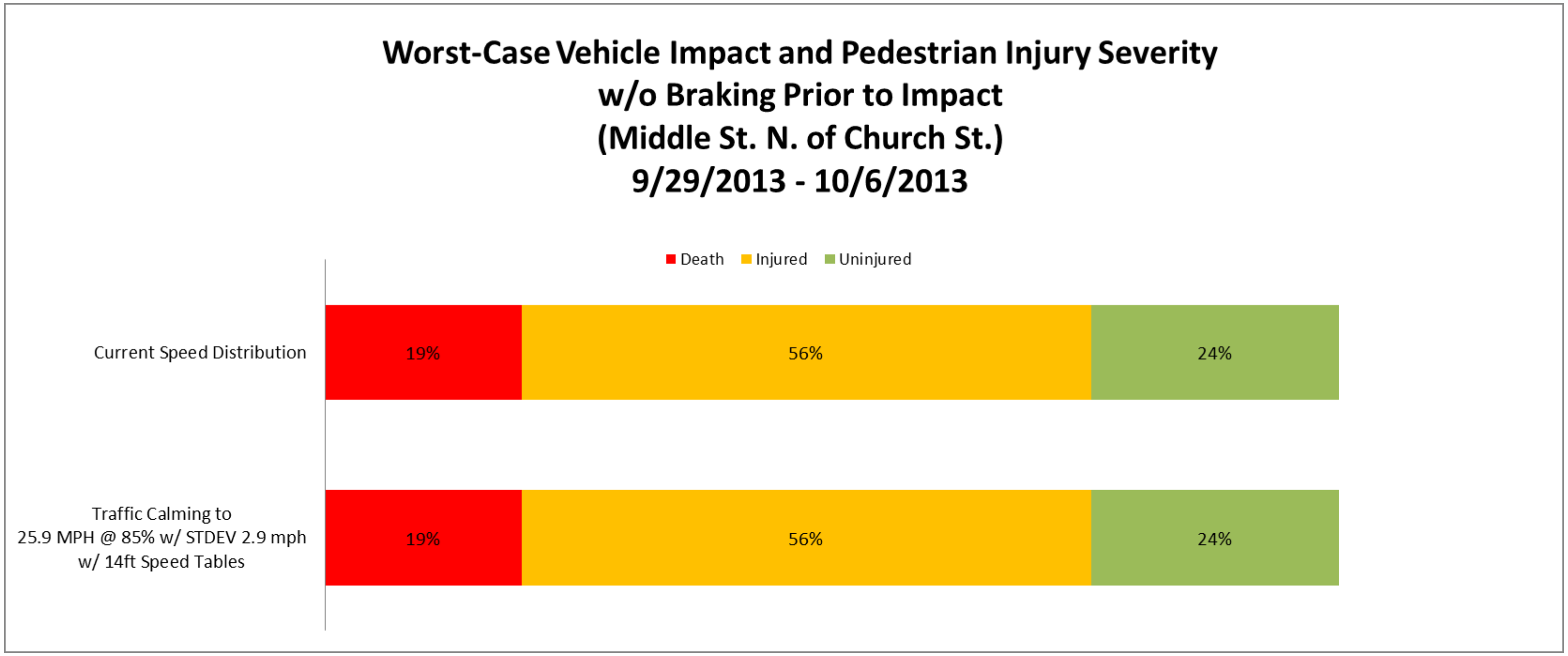
- 85% cumulative speed of 25.4 mph
- 10 mph pace of 19 mph - 28 mph containing 80.2% of the observed traffic
- Mean of 21.7 mph with a median of 21.2 mph
- Standard Deviation of 4.0 mph

85% Cumulative Speed vs. Time of Day



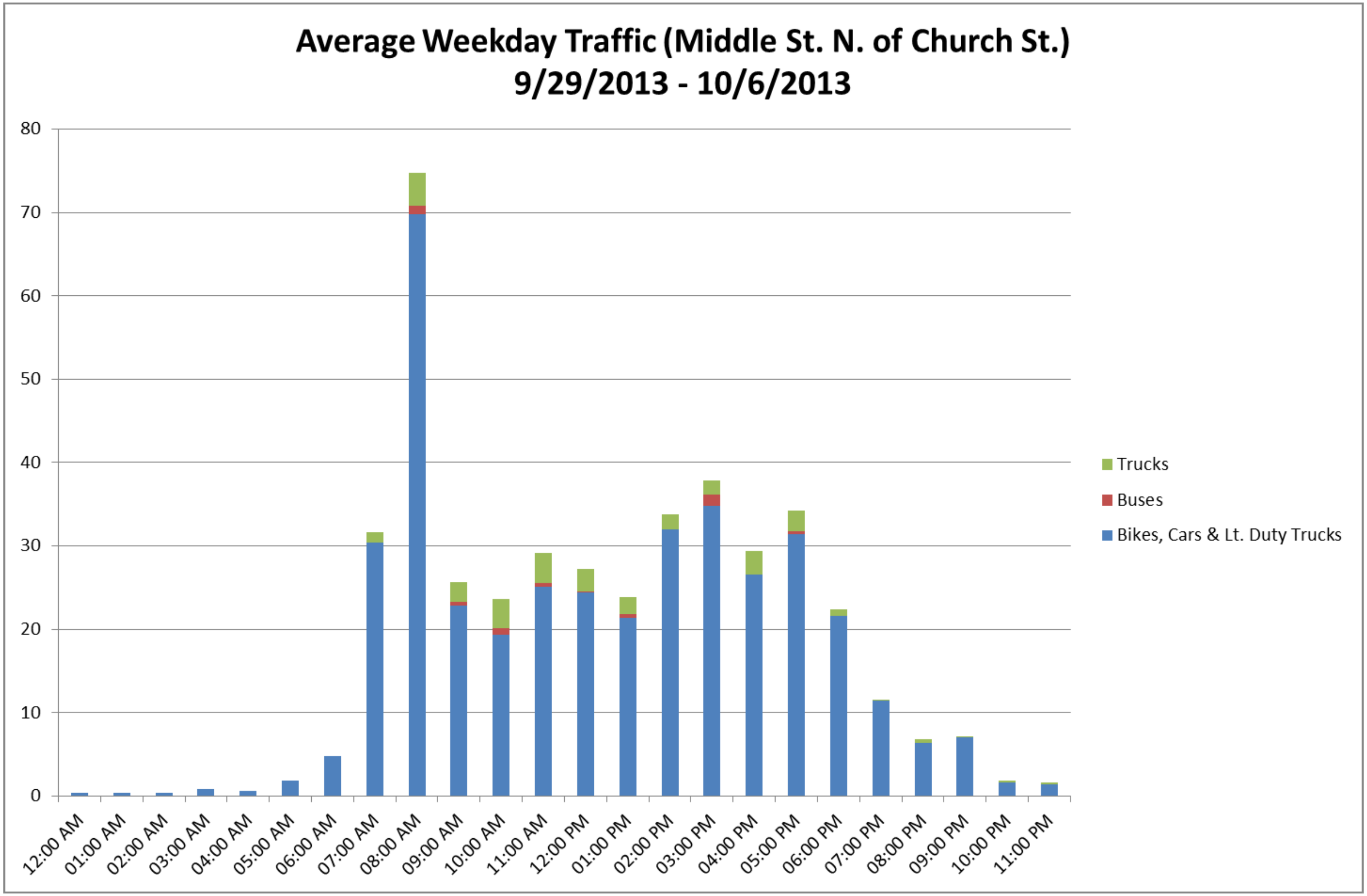
- 85% speeds fairly consistent
- Highest 85% speeds seen in the morning hours just prior to the commute

Application of DoT HS Stats

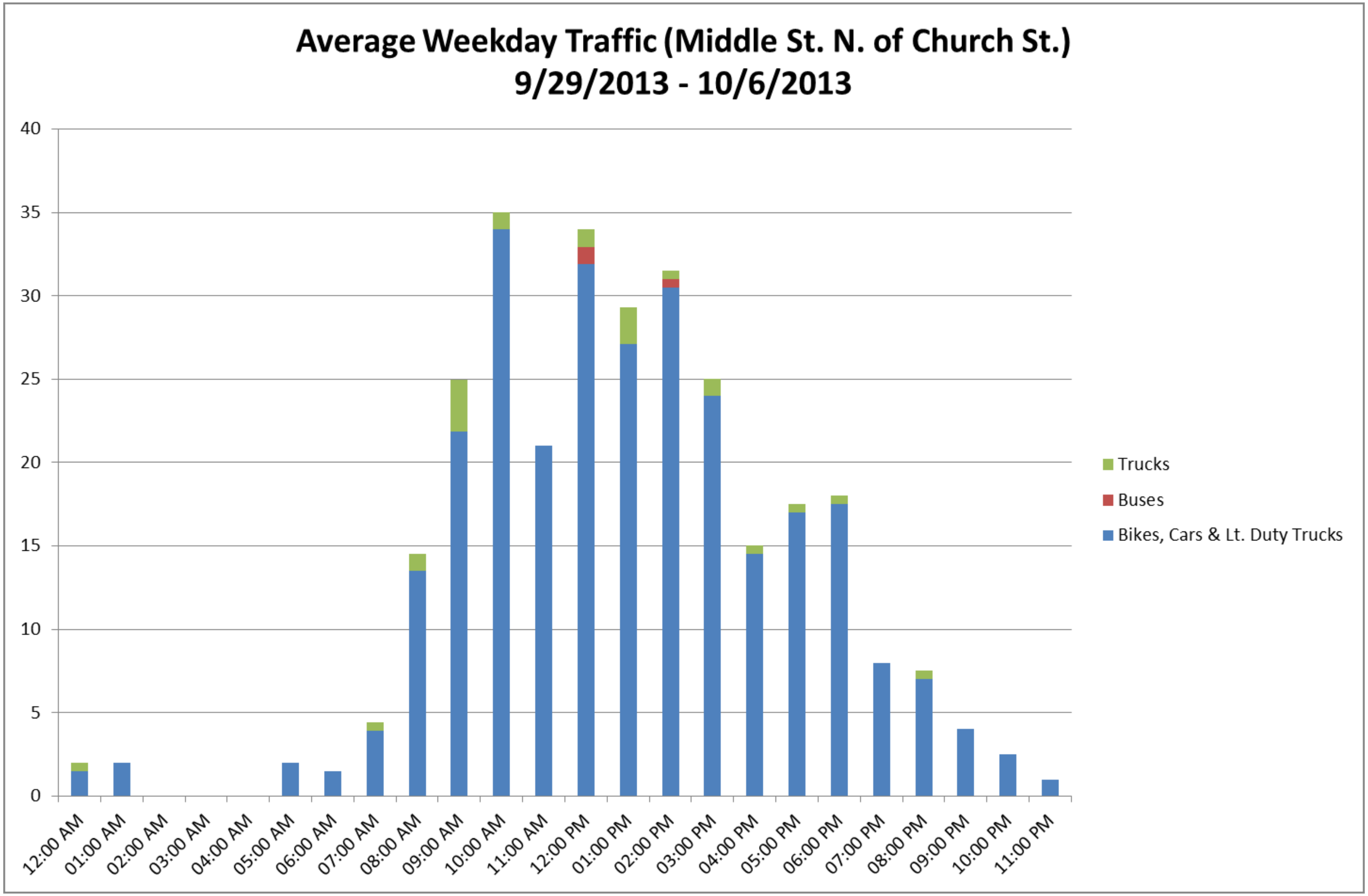


- **<u>Caution must be used</u>** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **<u>zero</u>** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **<u>example only</u>**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in depicting possible gains in safety to be found in the worst-case scenario through traffic calming measures
  - Here you can see there is negligible gains in safety

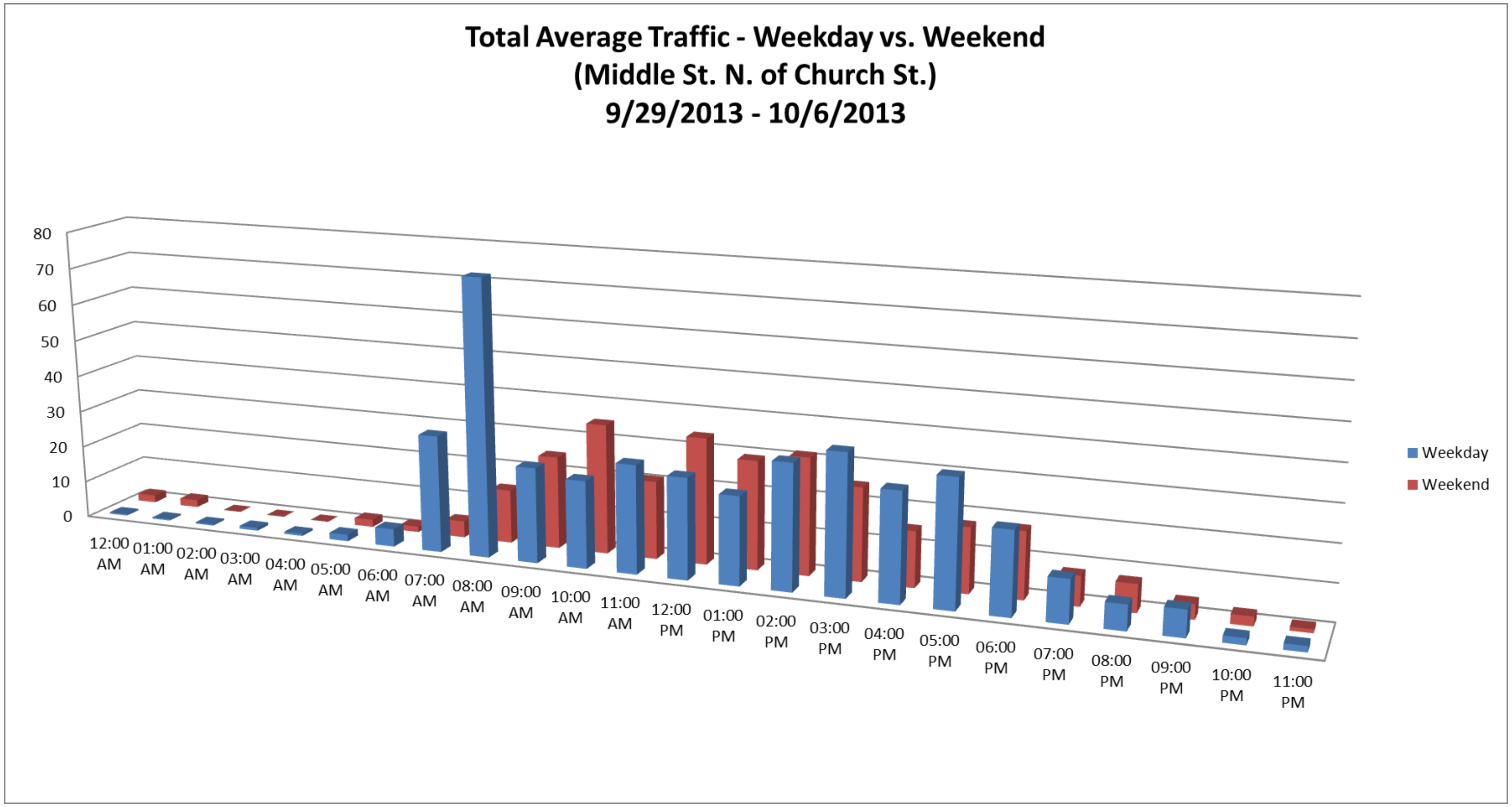
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Peak hour is the morning school where the volume effectively double
- Generally volume below 35 vehicles/hour

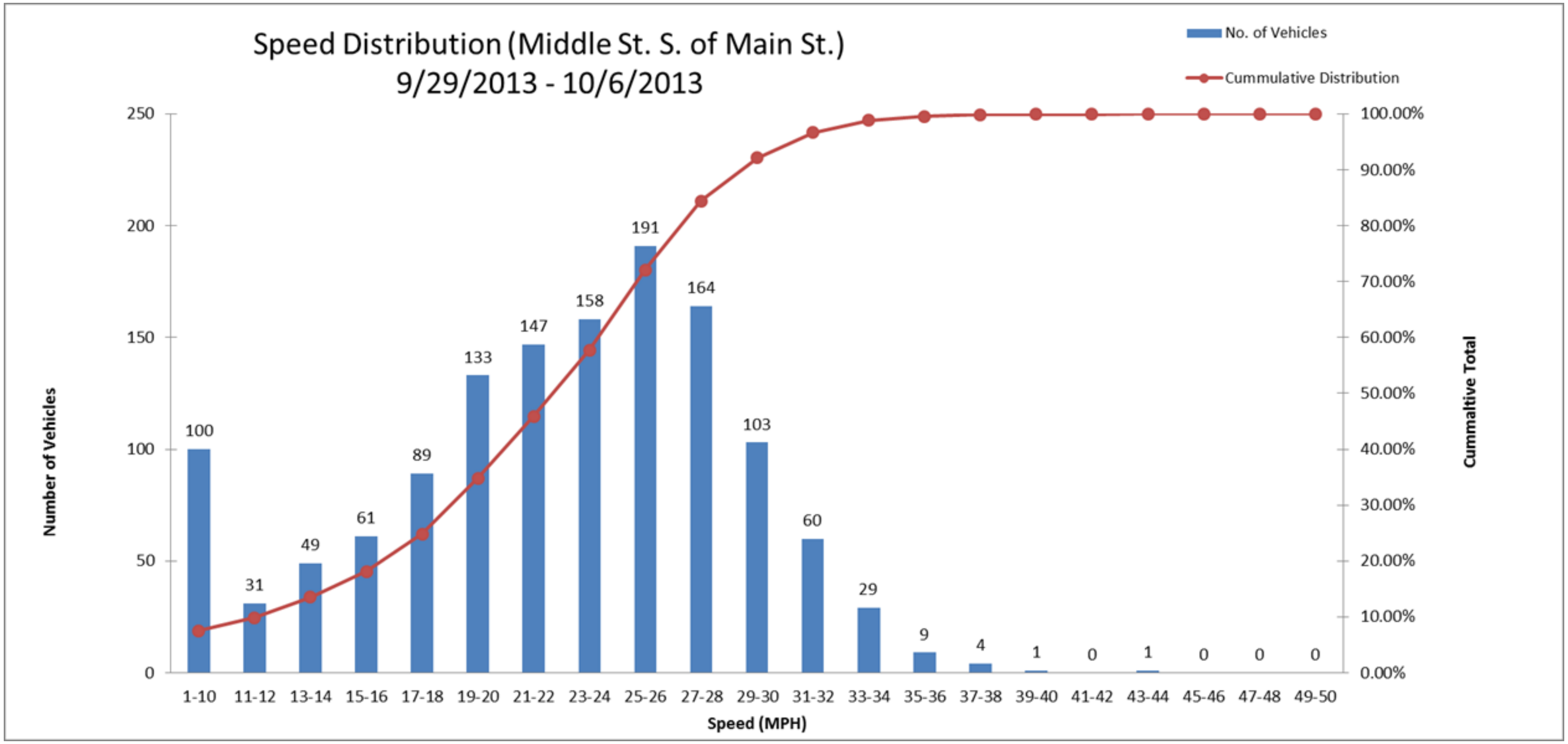
Preliminary Observations
Middle St. N. of Church St.

- Effective Speed Limit: 26.4 mph
- Posted Speed Limit: 25 mph
- Northbound and Southbound Speed Differential: -0.2 mph
  - for 85% cumulative speed
  - A speed differential greater than 0.5 mph is needed to be statistically significant with a 95% confidence
    - 85% cumulative speed essentially symmetric with any level of statistical confidence
- No corresponding spike in 85% cumulative speed seen with spike in southbound traffic during 8am school hour
- Highest speeds seen late in the couple of hours prior to the morning commute
  - Other off-hour 85% cumulative speeds indetermistic due to low sample size and large confidence interval

Middle St. S. of Main St. Data Set

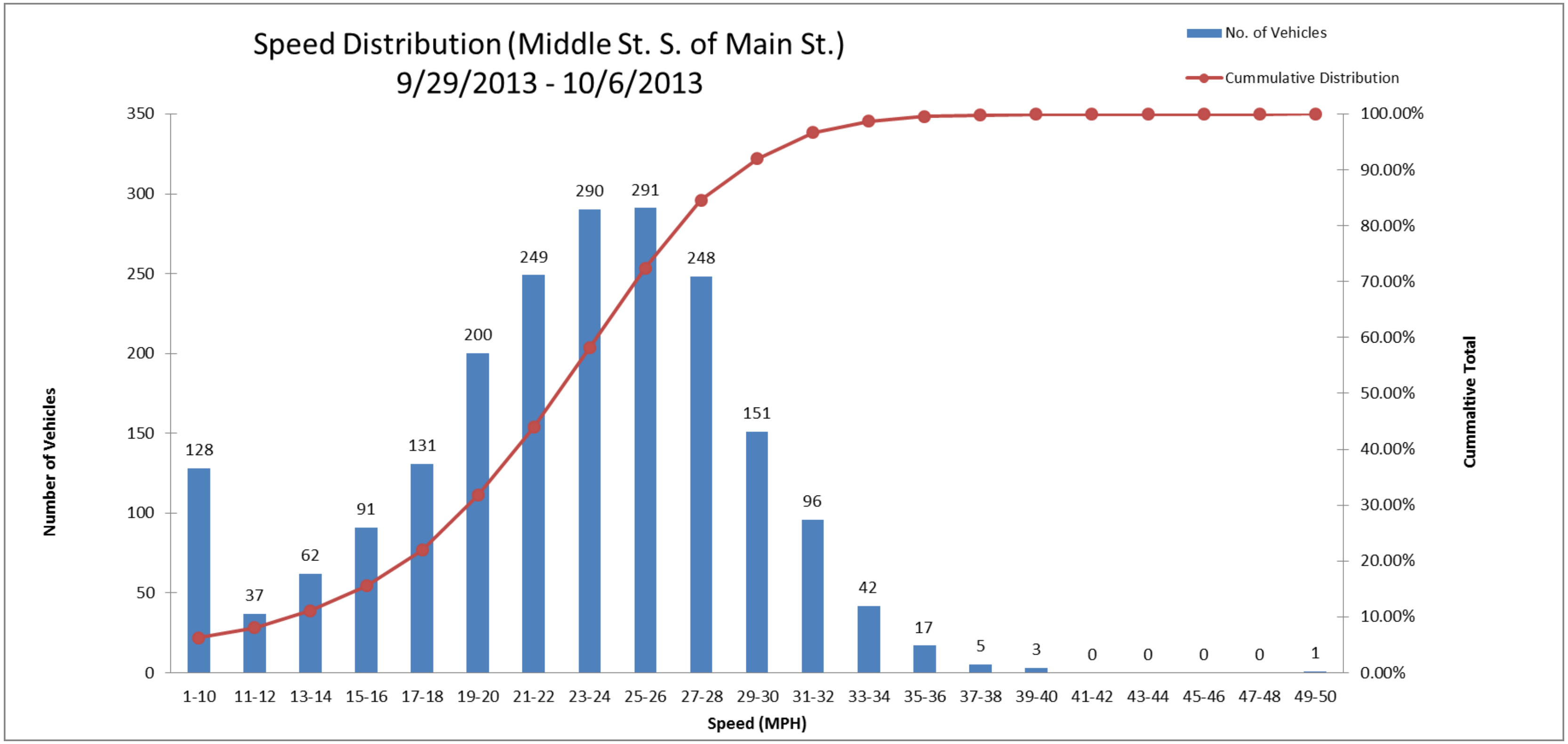
- Data Set Summary:
  - Site Code: 013542
  - 1:00pm on Monday 9/29/2013 thru 8:00am on Monday 10/6/2013
  - 2,576 speed and vehicle type observations (including northbound and southbound)

Northbound Stats



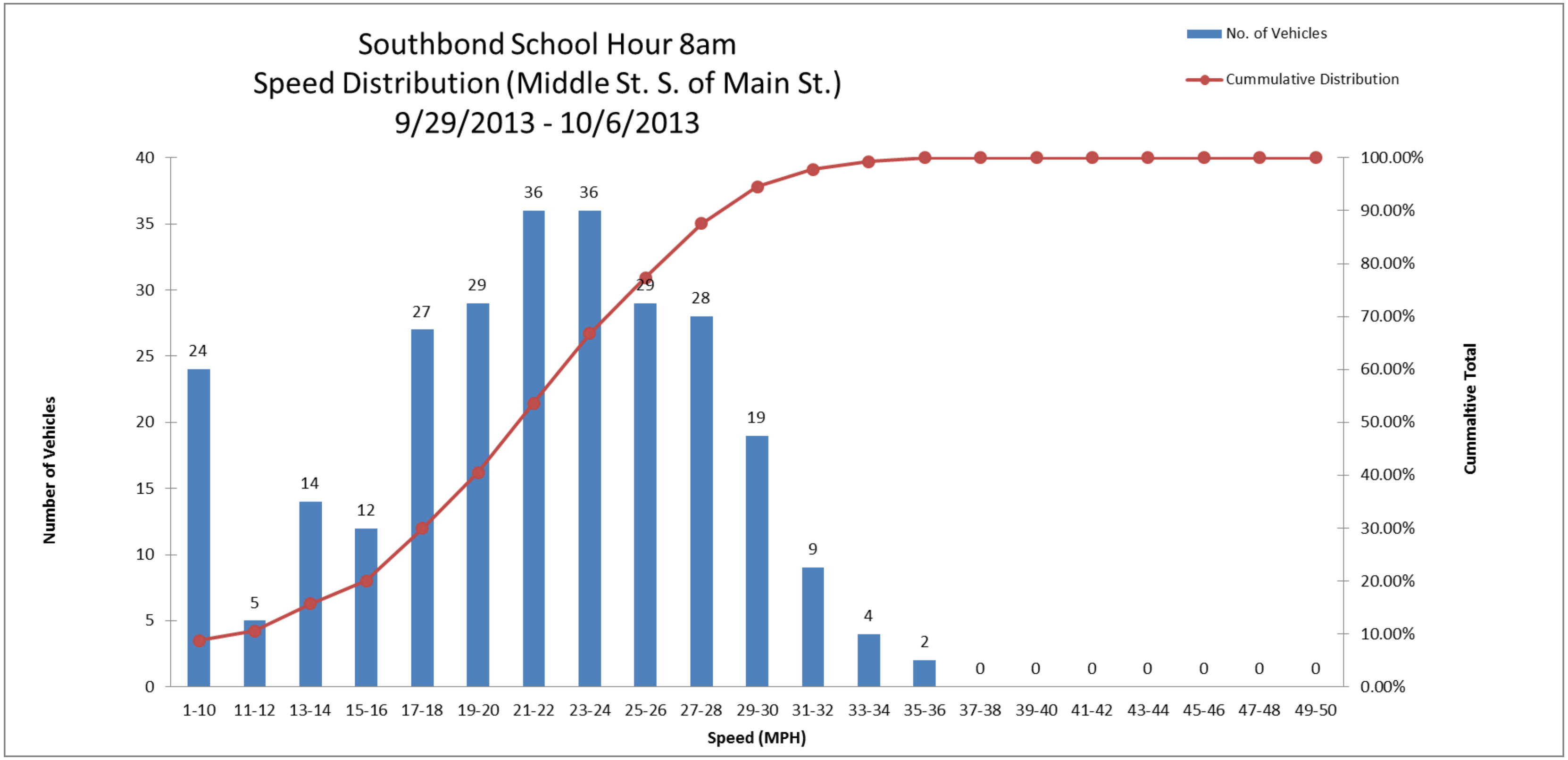
- 85% cumulative speed of 28.1 mph
- 10 mph pace of 19 mph - 28 mph containing 59.6% of the observed traffic
- Mean of 22.1 mph with a median of 22.7 mph (heavily skewed)
- Standard Deviation of 7.0 mph

Southbound Stats



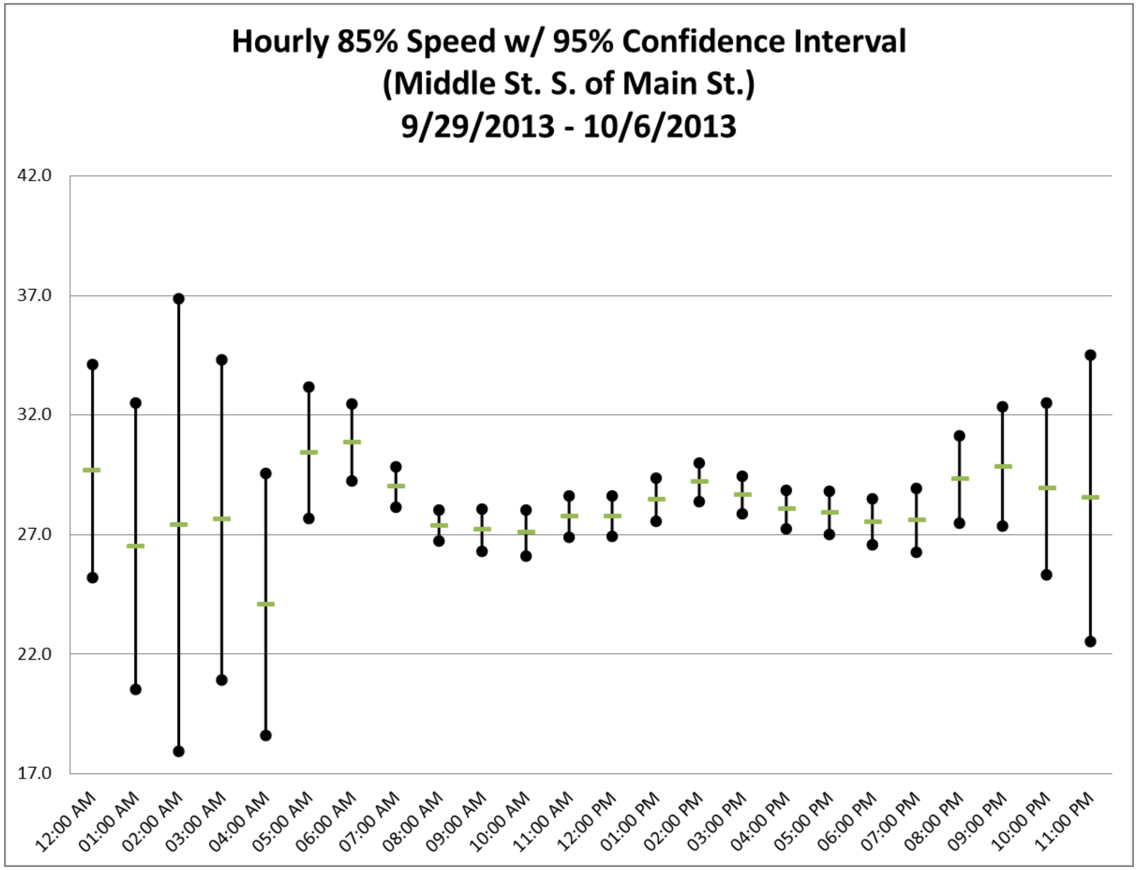
- 85% cumulative speed of 28.1 mph
- 10 mph pace of 19 mph - 28 mph containing 62.6% of the observed traffic
- Mean of 22.4 mph with a median of 22.8 mph (skewed)
- Standard Deviation of 6.7 mph

Stats Southbound 8am School Hour



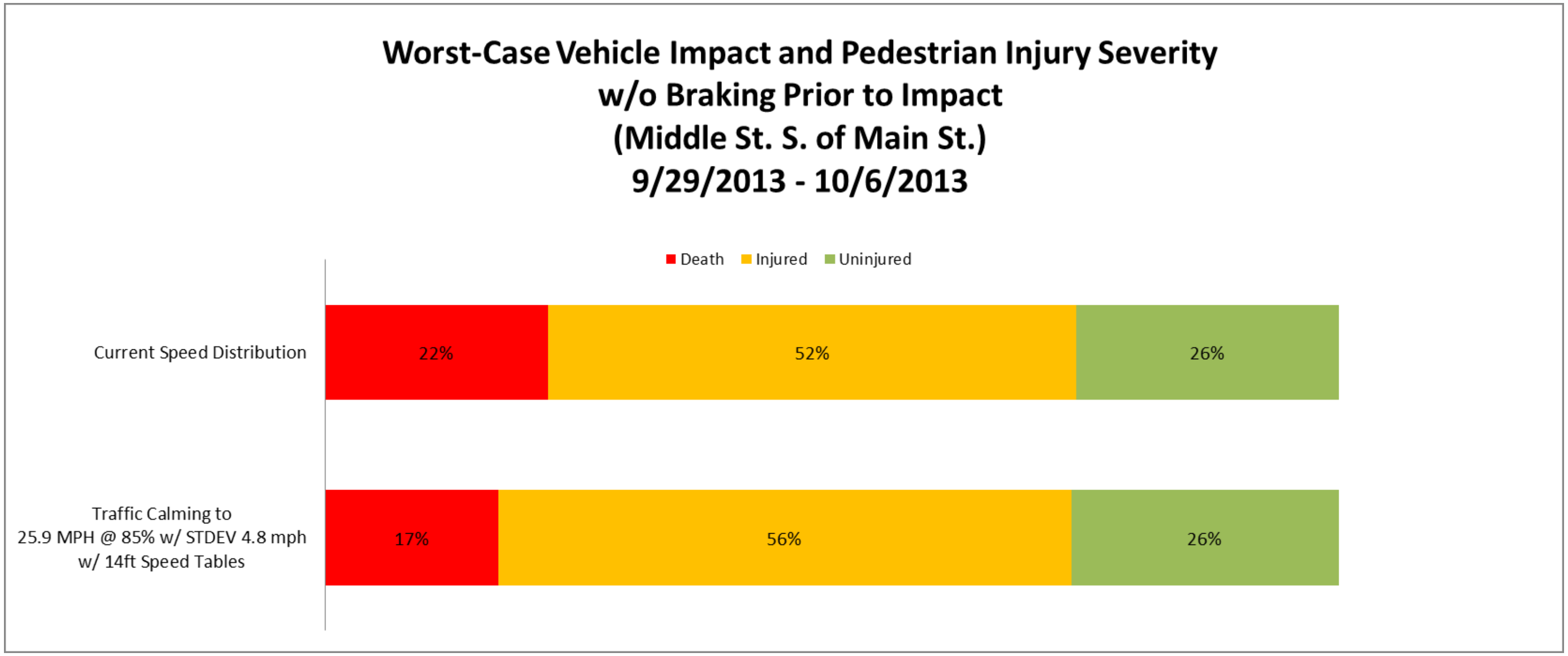
- 85% cumulative speed of 27.5 mph
- 10 mph pace of 19 mph - 28 mph containing 57.7% of the observed traffic
- Mean of 22.1 mph with a median of 22.4 mph
- Standard Deviation of 6.9 mph

85% Cumulative Speed vs. Time of Day



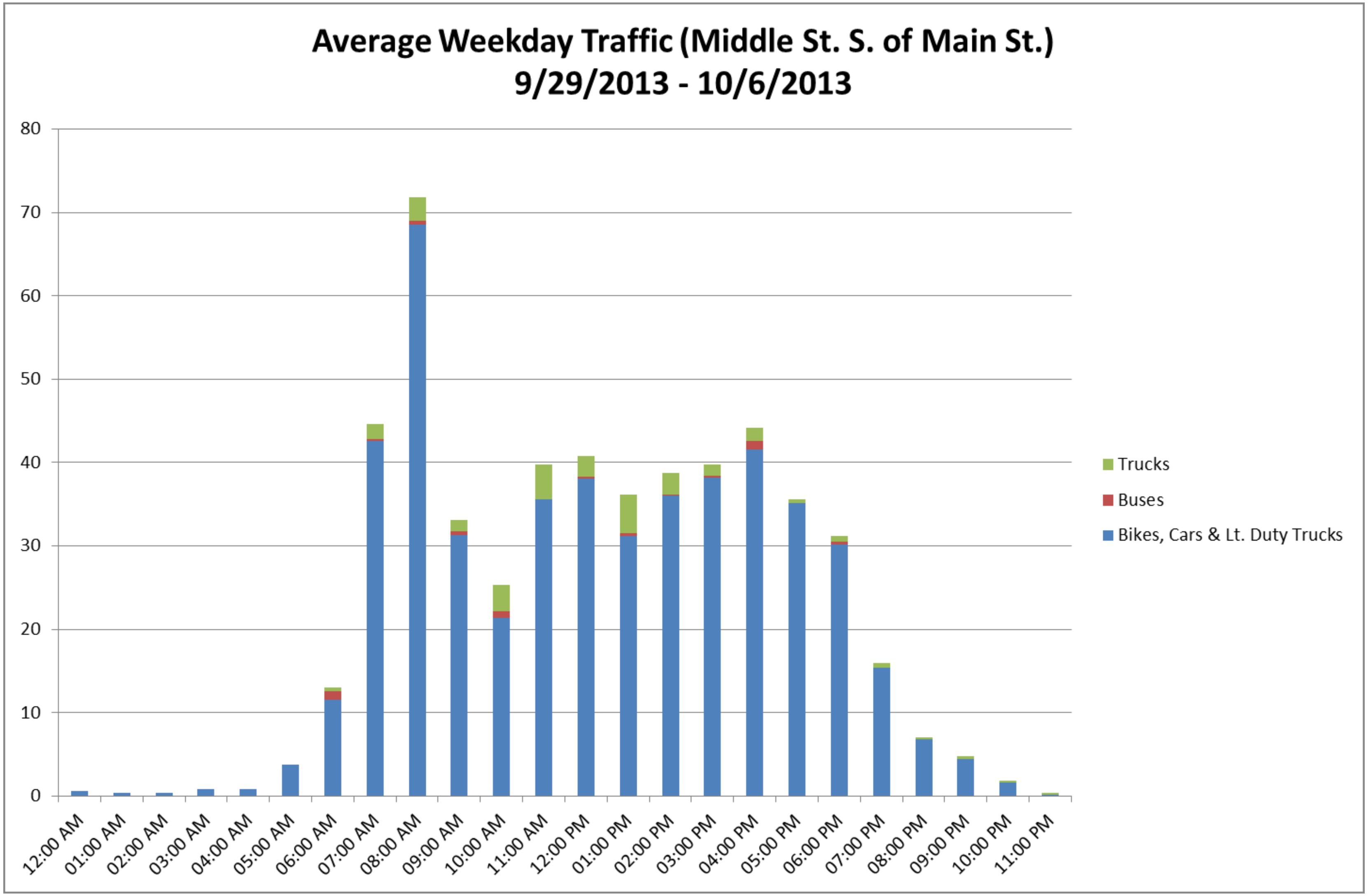
- Highest 85% speeds seen on off hours
  - Particularly the morning prior to the commute but confidence interval is larger due to small number of observations
- During the daytime hours the 85% speed if fairly consistent

Application of DoT HS Stats

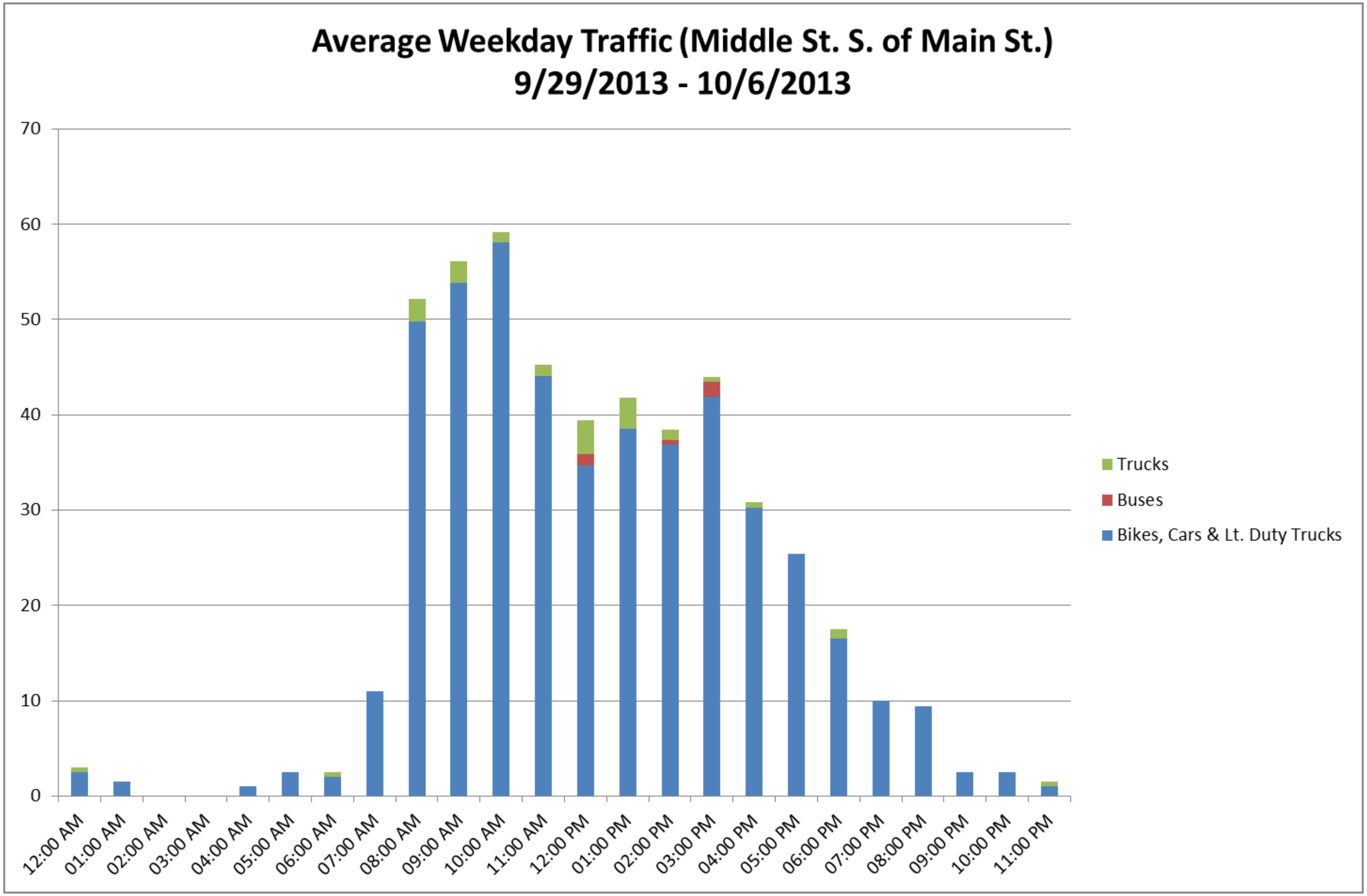


- **<u>Caution must be used</u>** when referencing the above graph as it represents absolute worse-case scenario
  - Assumes **<u>zero</u>** driver reaction/braking prior to impact
  - Traffic calmed pedestrian injury severity stats represent best case improvement localized near a traffic calming measure
  - Speed table used as an **<u>example only</u>**. The resultant speed distribution based on 2002 Minnesota DoT Investigative Report into effectiveness of traffic calming measures.
- It is however illustrative in depicting possible gains in safety to be found in the worst-case scenario through traffic calming measures
  - Here you can have some small gains in safety through traffic calming
  - Again amount of school aged pedestrian traffic may play a role in determining what is considered sufficient

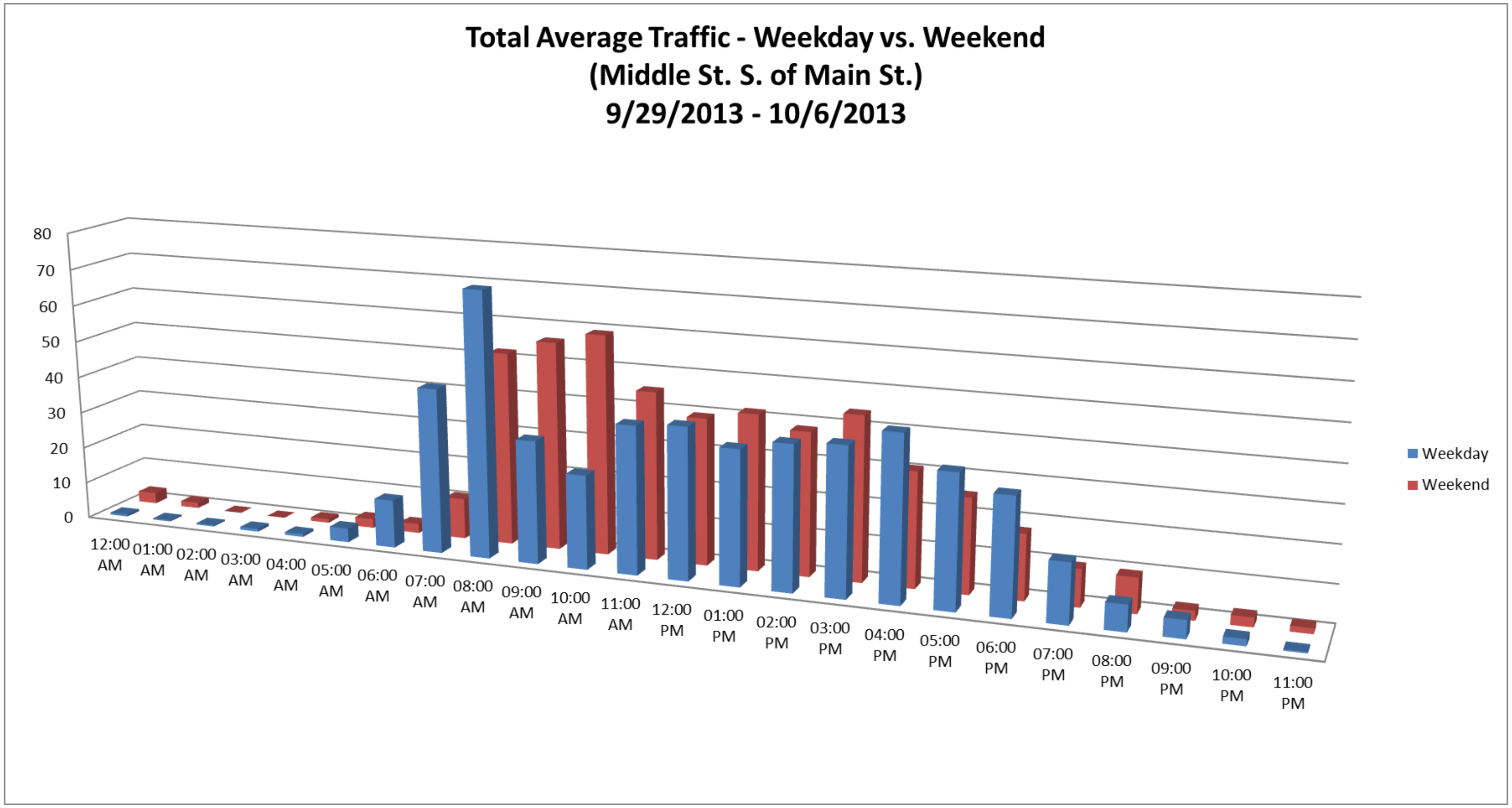
Weekday Traffic Volume



Weekend Traffic Volume



Weekday/Weekend Traffic Volume Comparison



- Peak hour is the morning school where the volume nearly doubles
  - Other pear hours seen between 8:00am – 11:00am during the weekend
- Generally volume below 40 vehicles/hour

Preliminary Observations
Middle St. S. of Main St.

- Effective Speed Limit: 28.1 mph
- Posted Speed Limit: 25 mph
- Northbound and Southbound Speed Differential: -0.0 mph
  - for 85% cumulative speed
  - 85% cumulative Northbound and Southbound speed essentially symmetric with any level of statistical confidence
- No corresponding spike in 85% cumulative speed seen with spike in southbound traffic during 8am school hour
  - From earlier data traffic originates from the intersection of Middle and Boston Post Rd by drivers trying to avoid the school hour congestion with school crossing
- Highest speeds seen late in the couple of hours prior to the morning commute
  - Other off-hour 85% cumulative speeds indetermistic due to low sample size and large confidence interval