MILDURA RURAL CITY COUNCIL

Low Cost Implanted Compact Roundabout Evaluation

SAFE SYSTEM SOLUTIONS

ROAD SAFETY · AUDITING · ENGINEERING · PROJECT DEVELOPMENT

Mildura Rural City Council

FOR FURTHER INFORMATION
contact us at **info@SafeSystemSolutions.com.au**

Table of CONTENTS

SAFE SYSTEM SOLUTIONS
ROAD SAFETY · AUDITING · ENGINEERING · PROJECT DEVELOPMENT

List of TABLES

List of FIGURES

Information Page

DATE:	18/11/2020
CLIENT:	Mildura Rural City Council
REPORT NUMBER:	S20200280-REP-01

QUALITY RECORD:

Issue	Date	Description	Prepared By	Reviewed By	Approved By
4	18/11/2020	Evaluation Report	Fahim Zafar	Kenn Beer	

Safe System Solutions Pty Ltd
Brunswick I Camberwell I Hamilton I Sydney
Lidköping (Sweden) I Benalla I Bendigo I Launceston

info@SafeSystemSolutions.com.au
Office G2, 10-14 Hope Street, Brunswick, Vic, 3121
+61 3 9381 2222

www.SafeSystemSolutions.com.au

ACN:
164 341 084

ABN:
98 164 341 084

Industry Code:
99994

Professional Indemnity Insurance
Policy Number:
201908-0659 R1 BIA

Public Liability Insurance
Policy Number:
15T2402729

Victorian WorkCover Policy Number:
14074213

EXECUTIVE SUMMARY

This report is an evaluation of the speed outcomes associated with the Low Cost Implanted Compact Roundabout (LCIC roundabout) installed at the intersection of Eighth Street and Pine Avenue in Mildura.

The evaluation used two data control points and four additional data collection points to chart the pre-construction and post-construction vehicles speeds through the intersection.

A significant decrease in vehicles speeds was noted due to the installation of the LCIC roundabout, indicating that the intended benefits of the treatment were achieved.

Furthermore, the outcomes were compared to likely speeds at standard roundabouts. It was noted that although the impact angle at standard roundabouts vary based on the design of the entry curve, the potential crash outcomes from an LCIC roundabout are likely to match or outperform standard roundabouts with regard to safety, based on the lateral force applied to the impacted vehicle.

At the data collection point closest to the entry of the LCIC roundabout, an 85th percentile speed of 19.26km/h was noted, and a 99.9th percentile speed of 26.99km/h was calculated.

A number of assumptions relating to the outcomes of this evaluation are noted in this report.

The findings of this evaluation conclude that the data indicates excellent speed performance by the LCIC roundabout with regard to safety, however, further research such as evaluation of new LCIC roundabout sites is recommended to provide a greater sample size and validate the findings of this evaluation.

BACKGROUND

Mildura City Council has implemented a Low Cost Implanted Compact Roundabout (LCIC roundabout) at the intersection of Eighth Street and Pine Avenue in Mildura. This roundabout used a non-standard alignment by not realigning lanes to include reverse curves or entry curves. It also used non-standard traffic calming features (speed cushions) for roundabout locations, and a non-standard approach to construction to provide the final product at a significantly more cost-effective investment than typical roundabout installations (about one tenth of the price of a standard roundabout). This roundabout deviates from typical roundabout design and re-evaluates roundabout design from first principles. This approach was taken to identify how the safety benefits of a roundabout can be achieved with a retrofitted roundabout with minimal investment to obtain the desired speed outcomes.

Figure 1: Low Cost Implanted Compact Roundabout

Prior to the implementation of the LCIC roundabout, two other crashes were recorded at the intersection. Following the implementation of the LCIC roundabout, no crashes have been recorded. Communications with adjacent retailers indicate no unreported property damage crashes at the intersection either. The construction of this roundabout used spike-down kerbing and a concrete infill to create splitter islands, and precision excavation and an in-situ, poured concrete, fully mountable central island to reduce costs. The project was delivered for approximately one tenth of the price of a standard roundabout ($37,500) and solved the crash issue at the intersection. This project has been awarded the 2020 3M-ACRS Diamond Road Safety Award for its innovation and cost-effective approach to crash mitigation.

This report will focus on evaluating whether the desired speeds outcomes were achieved by comparing the theoretical and practical speeds for the LCIC roundabout.

To evaluate the speed outcomes of this project, before and after traffic counts and speed surveys were undertaken to assess motorist behaviour at the roundabout.

Safe System Solutions Pty Ltd was engaged by Mildura City Council to review information obtained from the speed surveys and to use this information to assess the consistency between the theoretical approach and practical outcomes. Furthermore, variation between the speeds at this LCIC roundabout and the expected speeds at a standard roundabout were also assessed. The theoretical speeds, data collection and outcomes are presented in this evaluation report.

Figure 2: Give Way controlled intersection (before conditions)

THEORY

Three key principles to roundabout design were identified that are intended to improve the crash outcome of motorists. **These are:**

- Entry speed
- Impact angle and
- Priority

These principles were re-evaluated for the design of LCIC roundabout to assess whether they could be achieved at a lower cost that is achieved at typical roundabouts. These principles are discussed below.

2.1 Entry Speed

The likely speed at which vehicles traverse the conflict point when entering the roundabout determine the speed at which crashes are likely to occur. The Safe System tolerance for side impact crashes with vehicles is 50km/h. At typical T-intersections and cross intersections where the speed may be greater, motorists along the main road continue through the intersection unimpeded at high operating speeds. Motorists that enter the traffic stream from the side-road therefore maybe impacted at speeds above the Safe System tolerance. It should be noted that within the Safe System tolerable speeds, lower operating speeds continue to reduce the likely severity of injuries sustained in crashes.

Typically, entry speed is controlled by modifying the approach alignment of roundabouts to include reverse curves and an entry curve. The radius of these curves compel motorists to reduce their speed, thus ensuring that entry speeds into the roundabout are slower than typical operating speeds along the road. The specific alignment of the reverse curves and entry curve can be controlled to modify the likely speeds at which motorists will navigate through them. The likely speed of conflict with vehicles from a side-road can therefore be reduced to a pre-determined amount. The typical entry speed at roundabouts is 40km/h, however, this may vary by location and design.

The retrofit of reverse curves can be challenging due to constrained road-side environments, and can often require land acquisition and a significant degree of civil works. The LCIC roundabout installed at the intersection of Eighth Street and Pine Avenue, Mildura therefore sought a different approach. Speed reduction approaching the roundabout was achieved using speed cushions rather than reverse curves.

Vertical deflections such as speed humps, cushions and platforms have been shown to effectively reduce operating speeds. The height and length of the treatment as well as the gradient of the ramp can be used to control the desired operating speeds. However, vertical deflections as a speed reduction measure are not typically used at roundabout approaches.

The speed cushions provided were designed for a travel speed of 20km/h and, following learning from a previous installation, were made sufficiently wider than the typical vehicle axile width in order to avoid wider vehicles experiencing a reduced effect. It was theorised that the use of speed cushions on all approaches would satisfactorily compensate for the speed reduction typically achieved using reverse curves.

Note that the Safe System speed tolerance for side impact crashes is 50km/h and the Safe System speed tolerance for crashes with pedestrians is 30km/h. It was theorised that use of speed cushions designed to be traversed at 20km/h would reduce speeds through the intersection sufficiently to cater for both pedestrian and motorist safety within the Safe System framework.

2.2 Impact angle

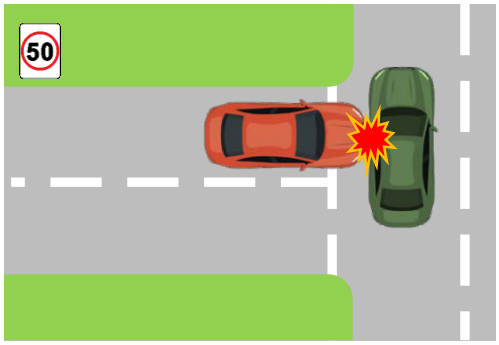
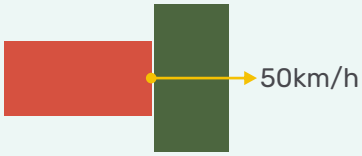
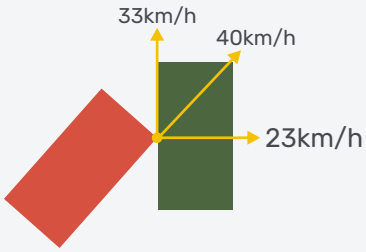
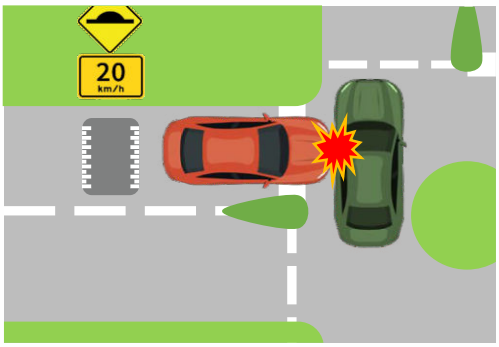
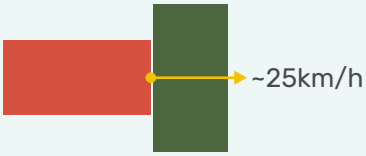
In a typical roundabout, the reverse curves lead into an entry curve which compels motorists to enter the circulating carriageway at a shallow angle in comparison to the circulating traffic rather than perpendicular to it. This modifies the distribution of forces in the event of a crash, resulting in lower lateral force of the impacted vehicle, and therefore, lower severity crashes. This assists in reducing crashes forces to speeds that are more survivable within the Safe System framework. Note that this idealisation assumes an impact through the centre of the impacted vehicle. Rotation applied to the impacted vehicle resulting from off-centre collisions have not been considered.

For the LCIC roundabout, no entry curve was provided. This means that the high impact angle of 90 degrees was retained, similar to the alignment of typical T-intersections and cross intersections. However due to the greater speed reduction created by the speed cushion at the entry to the intersection, the resulting crash forces are expected to still provide a similar crash outcome in comparison to a standard roundabout as shown in **Table 1**.

Note that the angle of the entry curve at standard roundabouts is variable and can therefore result in some variation to the conversion between the actual vehicle speeds and the lateral speed component. The force diagram presented in **Table 1** assumes an impact angle of 30 degrees. Although shallower angles can be applied, this angle was taken to conservatively represent the majority of roundabout entry configurations.
The angle of impact is calculated between the initial trajectory of the two vehicles.

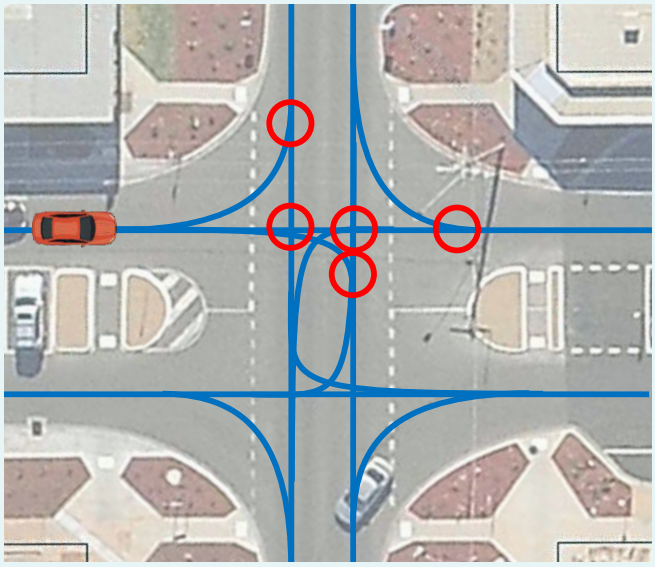
Table 1

Resultant Lateral Forces from Various Intersection Configurations

Intersection Type	Crash Diagram	Crash Force Diagram	Resultant Lateral Speed
Cross Intersection			50km/h
Standard Roundabout			23km/h
LCIC Roundabout			~25km/h

2.3 Priority

Roundabouts simplify decision-making by limiting potential conflict points to one location when looking for a gap in traffic, as opposed to a typical T-intersection or cross intersection where there may be multiple conflict locations to consider. By consolidating conflicts to one location, the cognitive load on motorists is reduced and decision making for gap selection is improved. Note that additional conflict points would exist for multi-lane roundabouts.



The reduction in conflict points is achieved by creating a one-way circulating carriageway within the roundabout and requiring all approaches to give-way. These elements are consistent between standard roundabouts and the LCIC roundabout No modifications to this arrangement were required for the LCIC roundabout to achieve the benefits associated with this principle.

Figure 3:
Conflict Points for Priority Controlled Intersections (left); Roundabouts (right)

2.4 Other Considerations

In addition to the principles presented earlier in this Section , a number of other factors were considered to ensure that the deviation from typical roundabout design did not negatively impact safety outcomes. Although these factors are outside of the scope of this evaluation, a number of important notes regarding other aspects of the LCIC roundabout are presented below.

- The roundabout was constructed using the existing pavement widths available. The central island was made fully mountable to ensure that vehicle swept paths were not impeded. As a result, no signage could be placed on the central island of the LCIC roundabout. Concrete infill with a high contrast to the pavement colour (yellow) was used to help delineate the central island.
- In order to facilitate pedestrian safety, the speed cushions on the approaches were placed immediately upstream of the pedestrian crossing locations. As a result, vehicles speeds are slowest at the point at which pedestrians cross.
- The existing street lighting was retained with a modification to the lamp power to improve lighting at the site. Additional lighting was not provided for the speed cushions.

DATA COLLECTION

The key factor analysed for this project was traffic speeds for vehicles approaching and travelling through the LCIC roundabout. This was achieved by installing traffic counters at 6 locations along the approach and measuring traffic volumes and speeds at all locations.

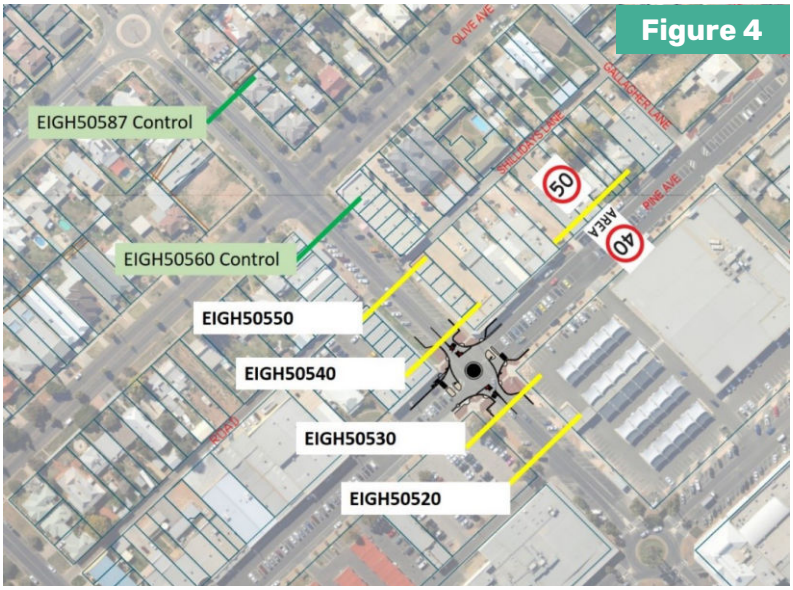


Figure 4

The configuration of the traffic counters is described in **Figure 4**. Note that two traffic counters were used as control points to isolate the effect of the LCIC roundabout from other factors. The control points were placed along Eighth Street, one at a midblock location (EIGH50587) and one on the approach / departure to a standard intersection (EIGH50560). Eighth Street is the priority road through these intersections and is generally expected to produce the highest speeds through the LCIC roundabout.

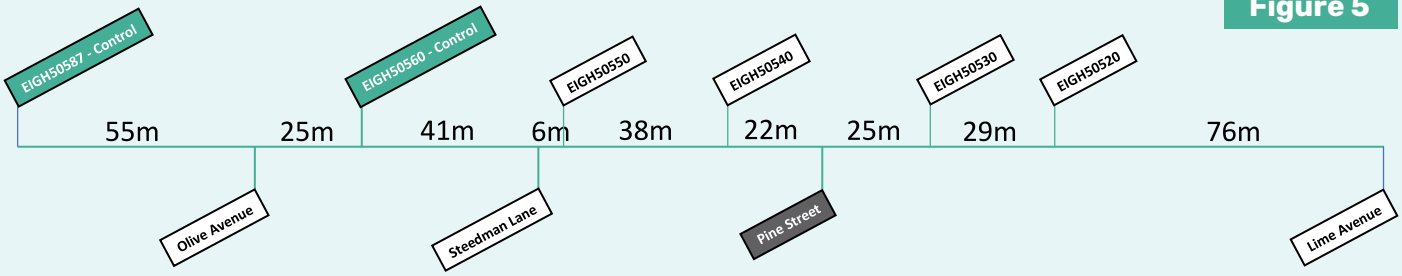


Figure 5

Figure 5 displays the approximated spacing between traffic counters and side street locations. Note that distances from side streets were measured from the centre of the intersection. The traffic counter EIGH50540 was placed 300mm upstream of the leading edge of the speed cushion. The location of the pedestrian crossing on all approaches is such that the speed cushions are set back from the hold line by approximately one passenger vehicle length. It is therefore anticipated that vehicles will dismount the speed cushion and begin entering the roundabout at approximately the same speed that is recorded at the speed counter.

During the processing of the obtained pre-construction data it was identified that a number of tube counters malfunctioned during data collection. A portion of the data collection was therefore filtered out to dismiss any faulty or inaccurate information. A consecutive 4-day period during the data collection was identified that contained no faults with any tube counters. The information from this period was used use for the assessment and Council is confident that all traffic counters were functioning appropriately across this period. For the post-construction data collection, a four-day period was selected that aligned with the days included in the pre-construction counts (Thursday to Sunday).

Due to budgetary constraints, the evaluation was conducted along one approach only. The selected approach was along the priority road which is likely to have greater operating speeds than the side road. The northwest (southeast-bound) approach was chosen for analysis to avoid interference in the speed data from the slow point created by the roundabout at the intersection of Eighth Street and Lime Avenue.

RESULTS

The results of the speed survey were processed by Mildura Rural City Council and provided for this evaluation. The speed survey results can be found in Appendix A.

Figure 6 demonstrates the median and 85th percentile speed of vehicles travelling through each data collection point. The Safe System speed tolerance for pedestrian crashes is also shown. The location of the Low-Cost Roundabout is shown by the yellow band. The values for the 85th percentile readings are provided on the graph.

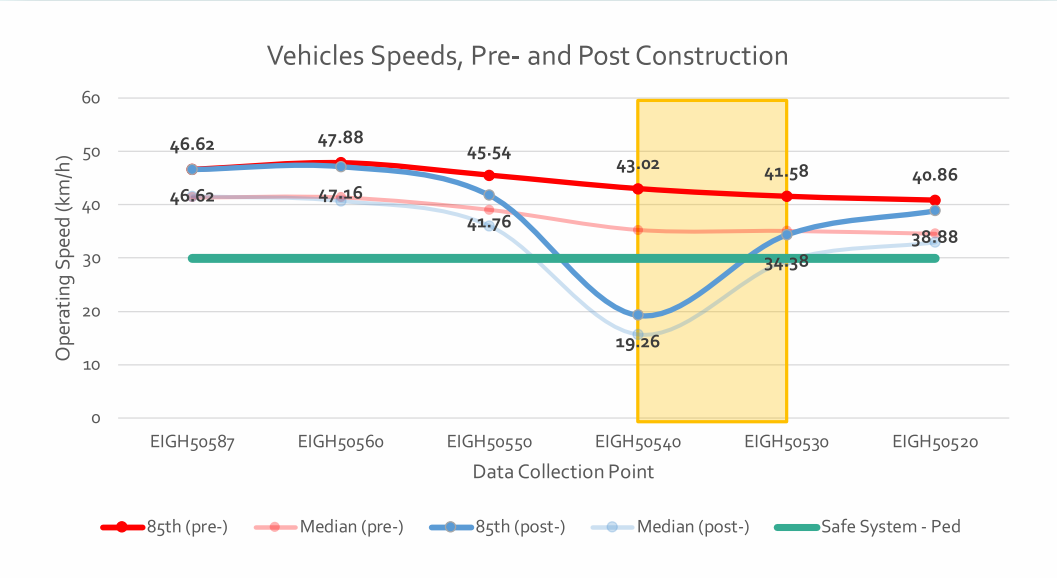


Figure 6: Pre-Construction and Post-Construction Vehicle Speeds, median and 85th percentile

Figure 6 demonstrates a significant reduction in speed introduced by the speed cushions as vehicles enter the roundabout. The location of the slowest point occurs at the data counter EIGH50540, where the 85th percentile speed is reduced by 23.76km/h to a speed of 19.26km/h. Note that speed information displayed on the graph assumes a smooth interpolation between data collection points. It is expected that the actual slowest point occurs 300mm downstream of the data counter EIGH50540, at the leading edge of the speed cushion. Any further speed reduction or fluctuation that occurs within the roundabout is not captured by the data collectors. For this evaluation, it has been assumed that the recorded speeds at the data counters are the representative of the lowest speeds when traversing the intersection along this approach.

The recorded 85th percentile speed at the data counter EIGH50540 is significantly lower than the expected speed of ~25km/h from **Table 1**, indicating that the safety outcomes in the practical application appear to outperform the theory in terms of safety outcome.

Figure 6 also shows that the operating speeds at locations away from the roundabout location are not significantly different in the before and after counts. This suggests that the speed reduction is achieved by the implemented treatments rather than due to other compounding factors such as weather conditions during the traffic count.

A horizontal line on **Figure 6** marks the Safe System speed tolerance for crashes with pedestrians. The graph demonstrates that at the approach to, and within the LCIC roundabout, 85th percentile vehicle speeds were within these speed tolerances. The speed increased above the Safe System speed tolerance at the exit to the roundabout.

Following the data collection, the extent to which speeds had been reduced to within Safe System tolerances was further explored.

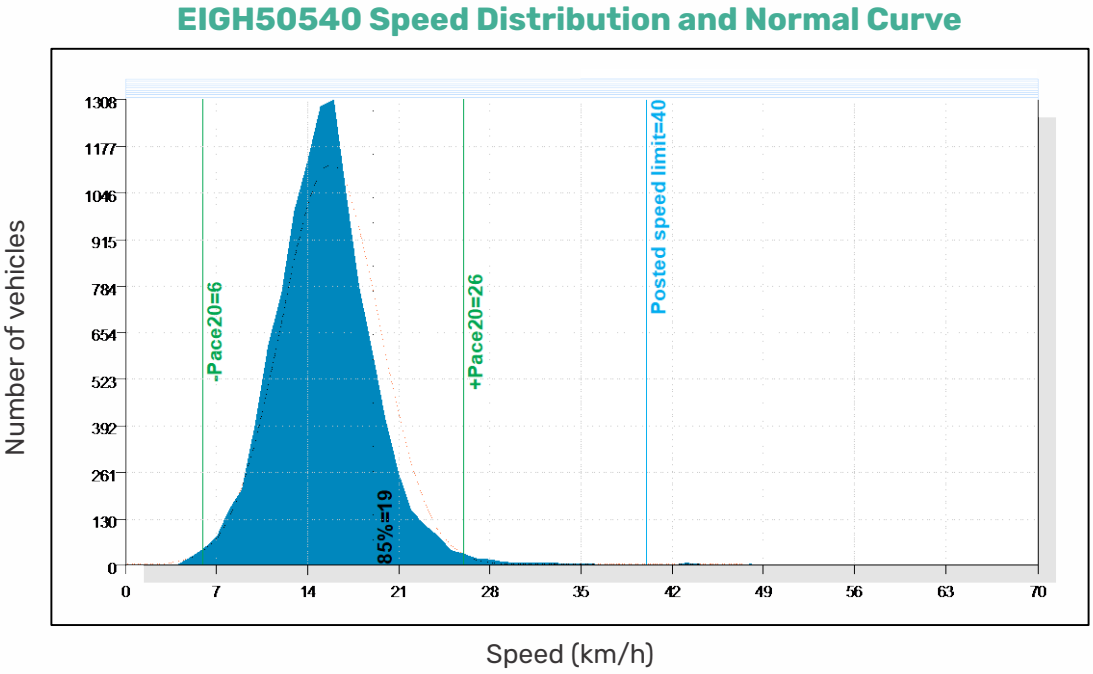


Figure 7: Speed Distribution at Counter EIGH50540

Figure 7 is an extract from Appendix A and demonstrates the typical distribution of speeds recorded at data collection points. The data used for this demonstration is from the counter EIGH50540. It can be seen that the data is approximately normal in its distribution. A normal curve was produced from this data which is shown on the graph with a dashed line. Information such as the mean, standard deviation, and spread of the normal graphs were recorded and are provided in Appendix A.

Noting that a pedestrian crossing point is immediately downstream of the counter EIGH50540, the data from this counter was used as a proxy for vehicle speeds across the pedestrian crossing point and when entering the intersection. The mean speeds as well as the upper limit for each standard deviation were graphed and compared to the Safe System speed tolerance for crashes with pedestrians.

Figure 8 and **Figure 9** were developed to summarise mean vehicles speeds before and after the LCIC roundabout was installed. **Figure 8** shows the before and after mean speed, and **Figure 9** depicts the post-construction speeds at the mean, and at one, two, and three standard deviations above the mean. It can be seen that vehicle speeds fell within and upper limit of 23.26km/h at 2 standard deviations (~97.2% of all traffic), and within 26.99km/h at three standard deviations (~99.9% of all traffic). This information is based on the normalised curve created from the data obtained from the EIGH50540 data counter.

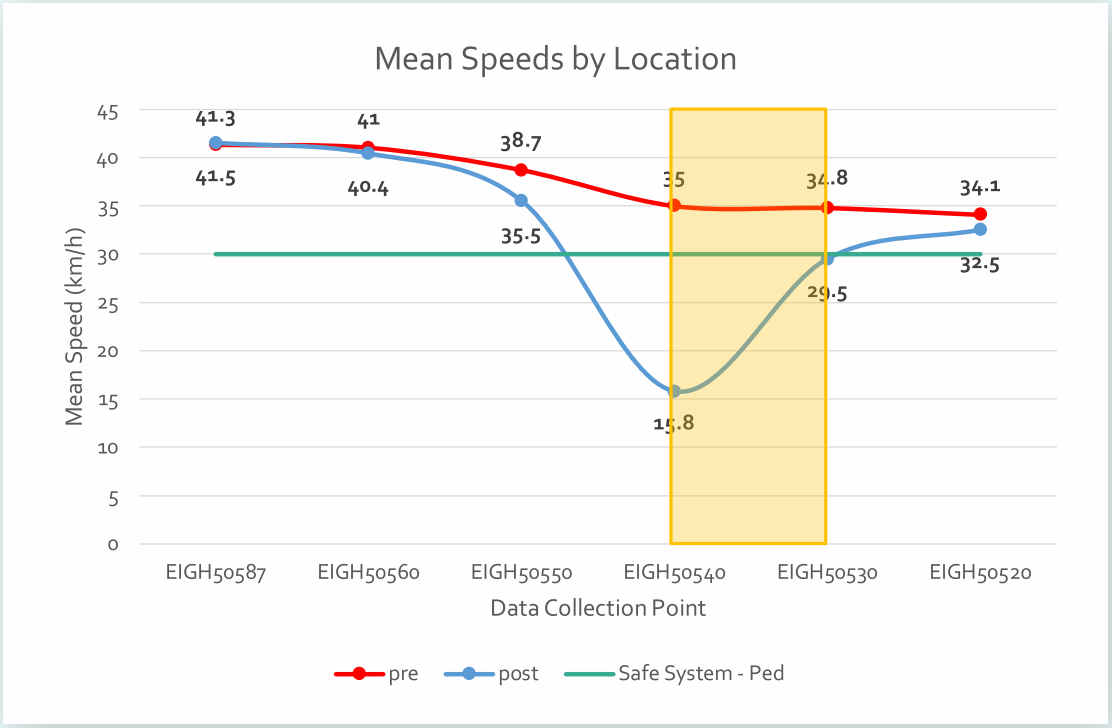


Figure 8: Pre-Construction and Post-Construction Mean Speeds by Location

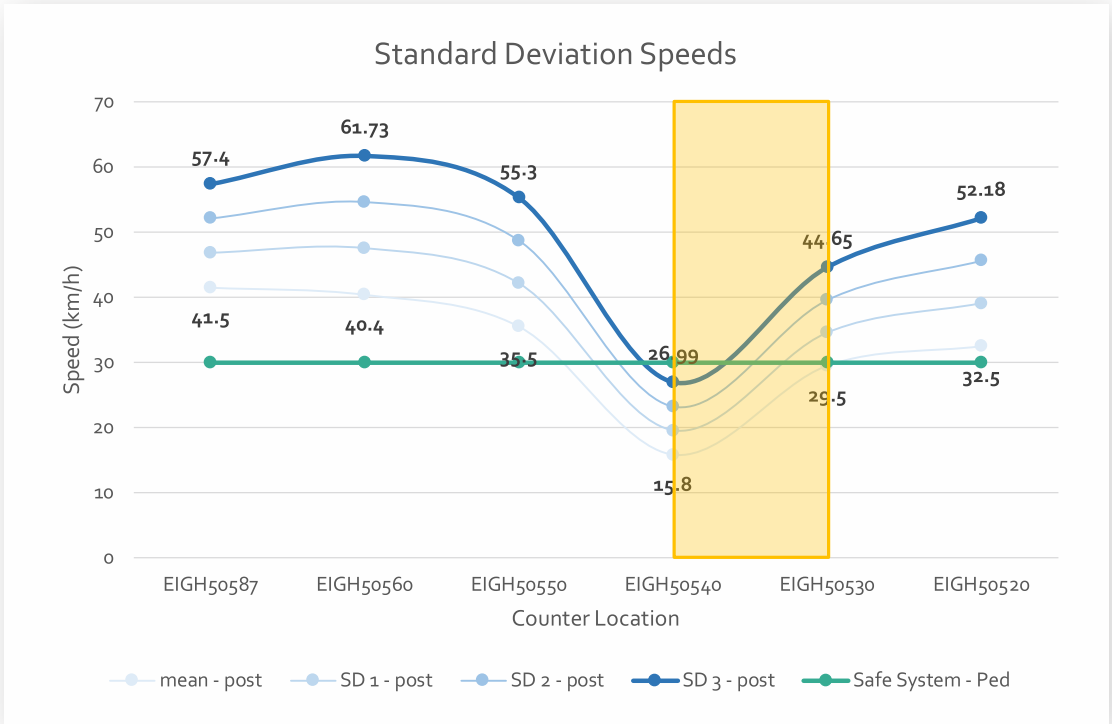
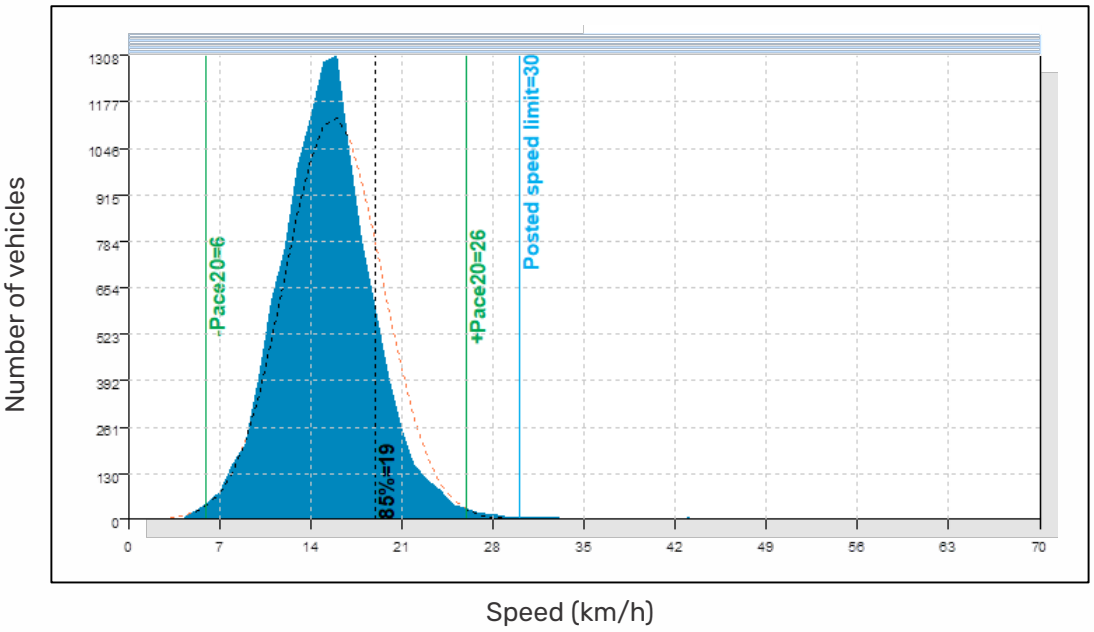


Figure 9: Post-Construction Upper Limits of Standard Deviation of Speeds

EIGH50540 Speed Distribution Under 30km/h



Posted speed limit = 30 km/h
Exceeding = 31 (0.293%)

Figure 7: Raw Data Speed Distribution under

As presented in **Figure 9**, the actual data count found 99.707% of vehicles traveling within an operating speed of 30km/h. This discrepancy may be caused by variability in the data (which may not occur in a repeat experiment), or by a non-normal distribution of the data, however, based on both outcomes, the minimum level of compliance with the Safe System speed tolerance is 99.707%.

At the counter EIGH50530 where vehicles have exited the roundabout, it can be seen that the mean speeds are still at the safe system tolerances for pedestrian crashes, and 95% of vehicle speeds are within 40km/h. Referring back to **Figure 6**, the 85th percentile speed at the data collection point EIGH50530 was 34.38km/h.

ASSUMPTIONS

A number of assumptions that underpin this evaluation were identified. The re-evaluation of these assumptions are likely to impact the results to various degrees. The assumptions have been divided into three categories for Theory, Data Collection, and Results.

The assumptions identified for this evaluation are presented below.

5.1 Theory

Roundabout entry/collision speeds

Table 1 has been included in **Section 2.2** of this report to demonstrate the theoretical comparison of crash forces between standard roundabouts and the LCIC roundabout. This diagram assumes an impact angle at standard roundabouts of 30 degrees. The actual impact angle at standard roundabouts are more variable and may not align exactly with the diagram. Furthermore, the diagram limits the consideration of the crash forces to the cross-traffic component of the force applied to the impacted vehicle. Although this is a core component of the likely crash outcome when comparing intersection crashes, other factors such as total force, the increased likelihood of secondary impacts for crashes at higher operating speeds, or the variability of outcomes during off-centre collisions have not been considered. Some of these factors (such as likelihood of secondary impacts) are likely to further favour the LCIC roundabout (as it has demonstrated a lower likely collision speed). Other factors (such as off-centre impacts) are likely to favour standard roundabouts (due to the limitation of rotational force applied). The overall variation between the simplified theory and practical outcomes is not known.

5.2 Data Collection

External Influences

It has been assumed that the observed speed reduction has been caused entirely by the implemented LCIC roundabout treatment, and that no other factors have contributed to the results.

It is possible that external factors not considered in the study may have contributed to the speed reduction. An example of an external factor could be unfavourable weather conditions causing motorists to drive slower. However, area-wide impacts such as whether are unlikely to have contributed as demonstrated by the similar speeds at the control data collection points EIGH50587 and EIGH50560. Location-specific factors could include changes to land use patterns adjacent to the intersection, or the accidental retention of a temporary works sign, however, no such factors were identified.

Data accuracy and reliability

Tube counters were used to collect data at all data collection points including the number, classification, and speed of vehicles. These counters rely on automated processes to classify the data and may misclassify data under rare conditions. Furthermore, the devices can malfunction rendering the results meaningless. External influences such as tampering with tubes or data collection unit may also impact the results. Finally, motorists that notice the devices may react to their presence such as by slowing down, impacting the integrity of the data.

In order to limit the impact of any inaccuracies, the outputs from the data collection units were reviewed. A number of faulty results were identified, rendering a period of data collection as unreliable. The available data was cut to the longest continuous period of uninterrupted data collection without faults. This was used for the evaluation.

Data Collection Duration

Following the review of the data accuracy and reliability, the data ultimately used for the evaluation consisted of four days of traffic counts beginning at 00:00 hours on Thursday and ending at 00:00 hours on Monday for both preconstruction and post construction counts.

It was assumed that the data collection period was sufficient to reflect weekday and weekend vehicle speed patterns. Increasing the duration of data collection, and therefore having a larger set of data to analyse would further increase confidence in the results produced.

5.1 Results

Normalisation of Data

The speed data obtained at all locations were normalised. The equations of these normalised graphs were used to extrapolate information such as the 95th and 99.9th percentile speeds. Some degree of variability is expected in the data collected such that gathering similar data again would produce results that are similar but not identical. The normal distribution would therefore be different, resulting in variation to the mean and standard deviations noted in this evaluation. A large level of inaccuracy is not expected.

Extrapolation of Results

The data collected and evaluated was specific to the eastbound approach to the intersection. It was assumed that this approach would represent the highest speeds based on road priority and both intentional and incidental traffic calming measures upstream of the intersection on other approaches. It was therefore taken that results from this approach could be conservatively applied to other approaches to gain a representation of all intersection approach speeds. The idea that the results obtained from the dataset can be extrapolated to other approaches is an assumption.

The idea that the selected approach would generate the highest approach speeds appears to be a fair assumption based on activity and alignment upstream, however, confidence in this evaluation could be increased by conducting speed analysis on other approaches to the LCIC roundabout.

It has also been assumed that the results of this project can be extrapolated to other sites, provided that there are similarities at a high level such as land use and speed limits. A range of other factors such as local attitudes towards driving and risk tolerance may impact the level of speed reduction achieved with LCIC roundabouts.

CONCLUSION

This evaluation found the practical outcomes of speeds reduction achieved by the LCIC roundabout to validate the theory and provide the intended outcomes. The main outcomes of the evaluation note that the 85th percentile speed at the entry to the roundabout was 19.26km/h. This is significantly below the intended outcome of 25km/h and, dependant on the entry angle of a standard roundabout, is likely to outperform standard roundabouts in terms of lateral force applied to an impacted vehicle.

A list of outcomes from this evaluation are noted below:

- The 85th percentile speed of vehicles entering the roundabout was 19.26km/h, which falls within the Safe System tolerable speeds for side-impacts with vehicles within the (50km/h) and the Safe System tolerable speeds for impacts with pedestrians (30km/h).
- The 99.9th percentile speed of vehicles entering the roundabout was 26.99km/h, which falls within the Safe System tolerable speeds for side-impacts with vehicles within the (50km/h) and the Safe System tolerable speeds for impacts with pedestrians.
- Following the implementation of the LCIC roundabout, motorists reduced their entry speeds into the roundabout by an average of 19.2km/h.

Additional benefits of the LCIC roundabout that have not been evaluated in this report include the significant capital cost savings, and fast implementation. It is also noted that following the implementation of the LCIC roundabout, no crashes have occurred at the intersection. This includes minor non-injury crashes based on reports from surrounding retailers.

A number of assumptions have been identified that may impact the findings presented in this evaluation.

It is recommended that further evaluation be conducted at future installations of LCIC roundabouts to further validate this evaluation.

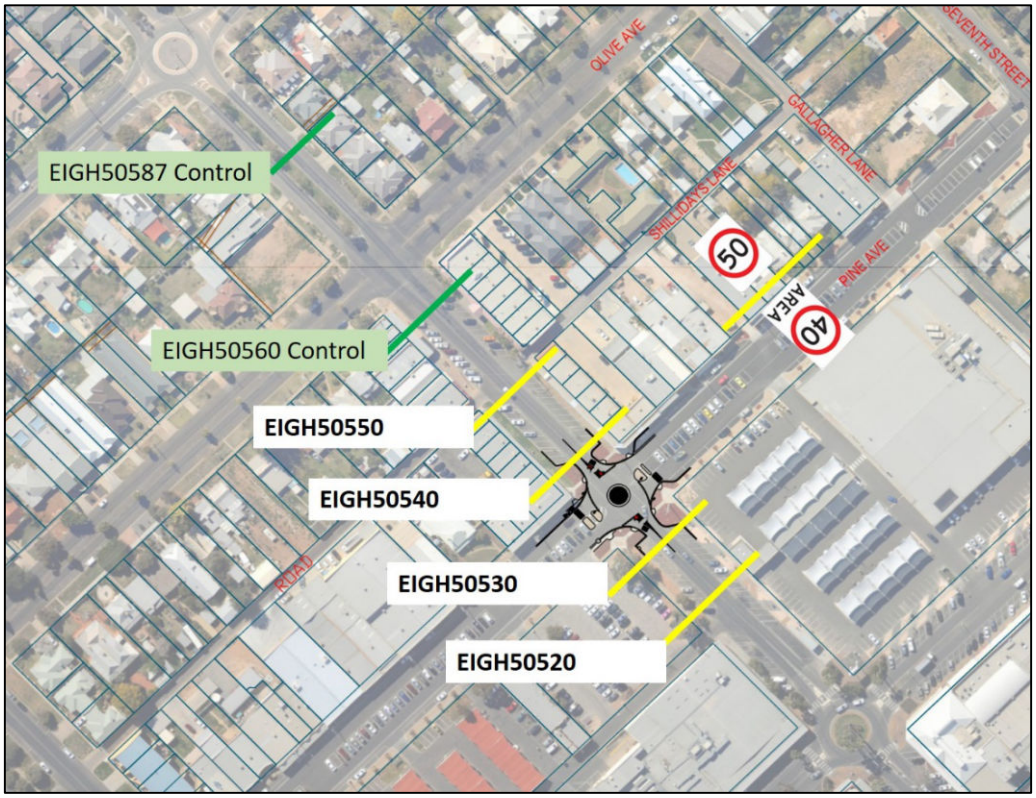
Appendix A:

Speed Survey Results

Metro Count Tube Locations

East travel direction is from EIGH50587 → EIGH50520

EIGHT50540 is placed 300mm from the face of the speed cushion approaching the intersection.



EIGH50520 Pre-Construction

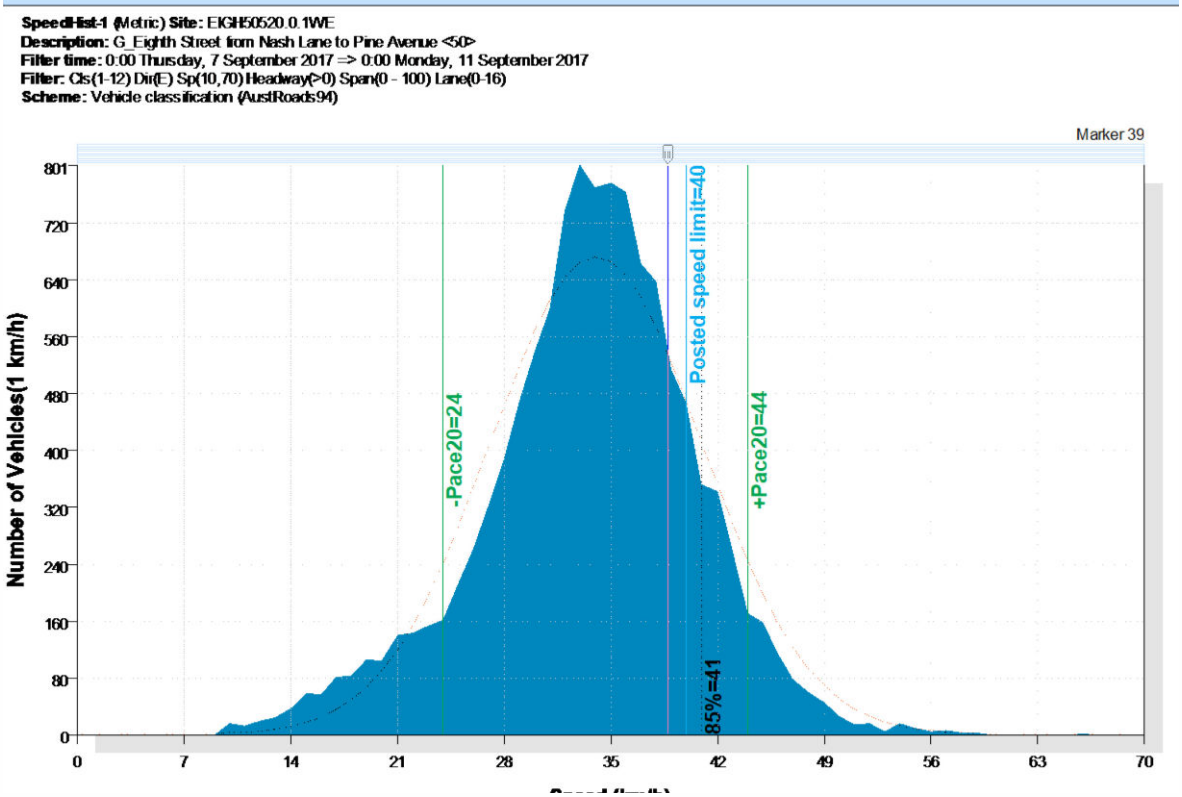
Site: **[EIGH50520] G_Eighth Street from Nash Lane to Pine Avenue <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 11769 / 101413 (11.61%)

Speed Statistics

Direction: East
Vehicles = 11769
Posted speed limit = 40 km/h, Exceeding = 2135 (18.14%), Mean Exceeding = 43.57 km/h
Maximum = 66.8 km/h, **Minimum** = 10.1 km/h, **Mean** = 34.1 km/h
85% Speed = 40.86 km/h, **95% Speed** = 44.82 km/h, **Median** = 34.56 km/h
20 km/h Pace = 24 - 44, **Number in Pace** = 10046 (85.36%)
Variance = 49.01, **Standard Deviation** = 7.00 km/h

Speed Histogram



EIGH50520 Post Construction

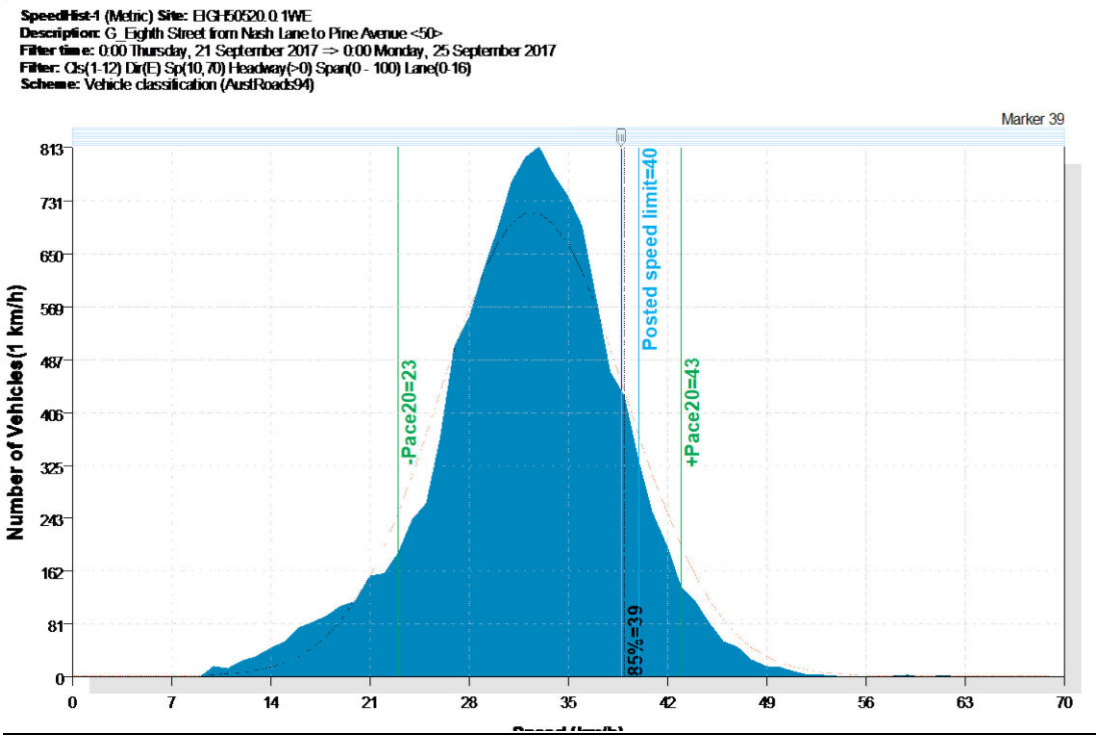
Site: **[EIGH50520] G_Eighth Street from Nash Lane to Pine Avenue <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 11740 / 101413 (11.58%)

Speed Statistics

Direction: EW
Vehicles = 11740
Posted speed limit = 40 km/h, Exceeding = 1295 (11.03%), Mean Exceeding = 43.08 km/h
Maximum = 69.9 km/h, **Minimum** = 10.2 km/h, **Mean** = 32.5 km/h
85% Speed = 38.88 km/h, **95% Speed** = 42.66 km/h, **Median** = 32.94 km/h
20 km/h Pace = 23 - 43, **Number in Pace** = 10266 (87.44%)
Variance = 43.10, **Standard Deviation** = 6.56 km/h

Speed Histogram



EIGH50530 Pre-Construction

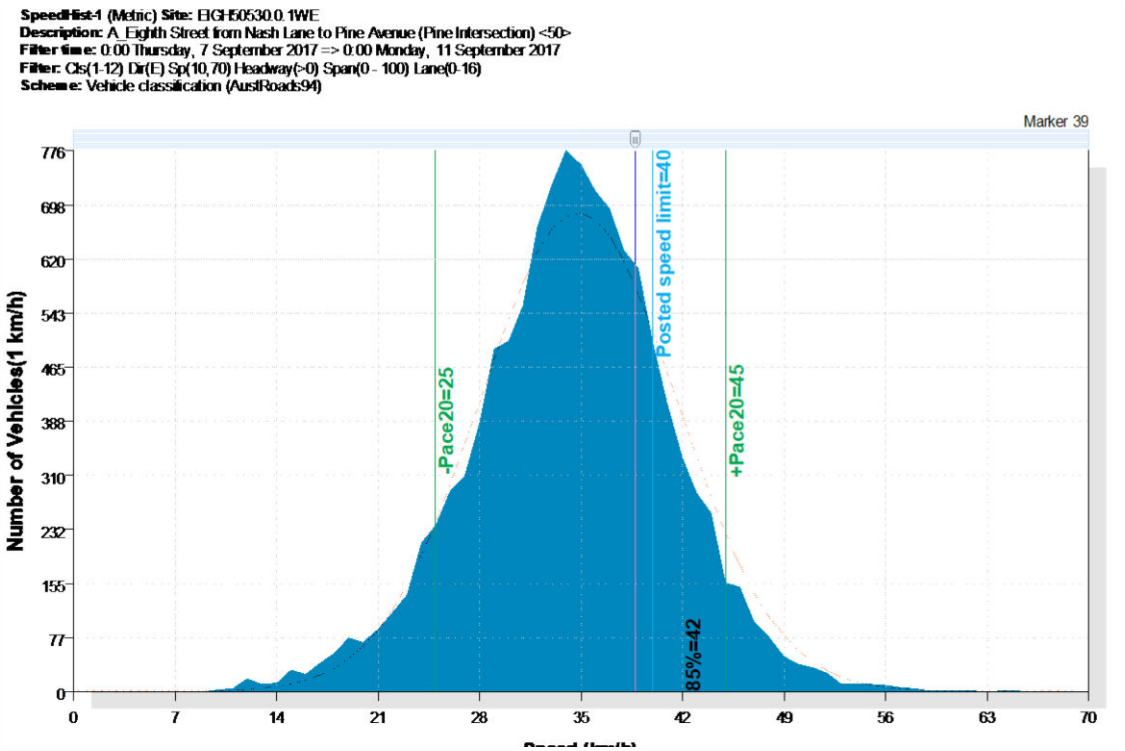
Site: **[EIGH50530] A_Eighth Street from Nash Lane to Pine Avenue (Pine Intersection) <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 11705 / 90748 (12.90%)

Speed Statistics

Direction: EW
Vehicles = 11705
Posted speed limit = 40 km/h, Exceeding = 2476 (21.15%), Mean Exceeding = 43.87 km/h
Maximum = 65.9 km/h, **Minimum** = 10.4 km/h, **Mean** = 34.8 km/h
85% Speed = 41.58 km/h, **95% Speed** = 45.54 km/h, **Median** = 35.10 km/h
20 km/h Pace = 25 - 45, **Number in Pace** = 10112 (86.39%)
Variance = 46.44, **Standard Deviation** = 6.81 km/h

Speed Histogram



EIGH50530 Post Construction

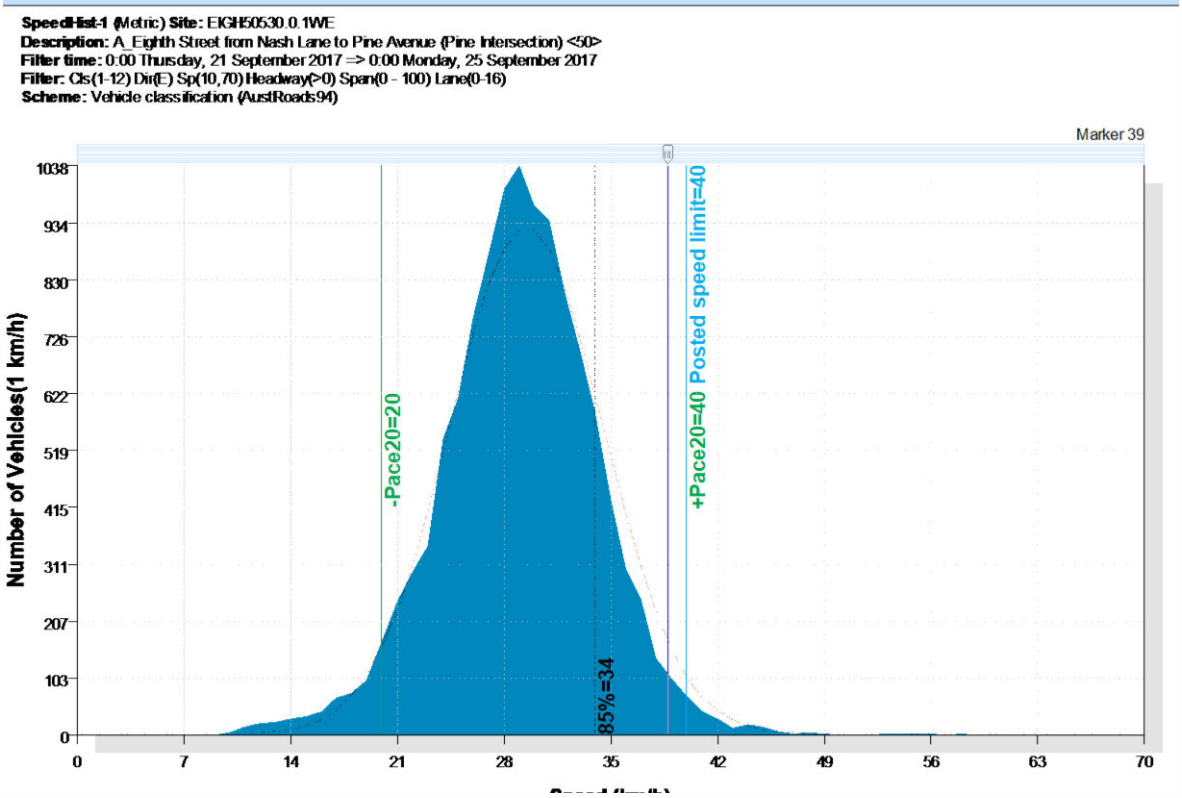
Site: **[EIGH50530] A_Eighth Street from Nash Lane to Pine Avenue (Pine Intersection) <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 11690 / 90748 (12.88%)

Speed Statistics

Direction: EW
Vehicles = 11690
Posted speed limit = 40 km/h, Exceeding = 203 (1.737%), Mean Exceeding = 42.67 km/h
Maximum = 58.5 km/h, **Minimum** = 10.1 km/h, **Mean** = 29.5 km/h
85% Speed = 34.38 km/h, **95% Speed** = 37.44 km/h, **Median** = 29.52 km/h
20 km/h Pace = 20 - 40, **Number in Pace** = 11095 (94.91%)
Variance = 25.53, **Standard Deviation** = 5.05 km/h

Speed Histogram



EIGH50540 Pre-Construction

Site: **[EIGH50540] CD_Eighth Street from Pine Avenue To Steedman Lane (Pine Intersection) <50>**

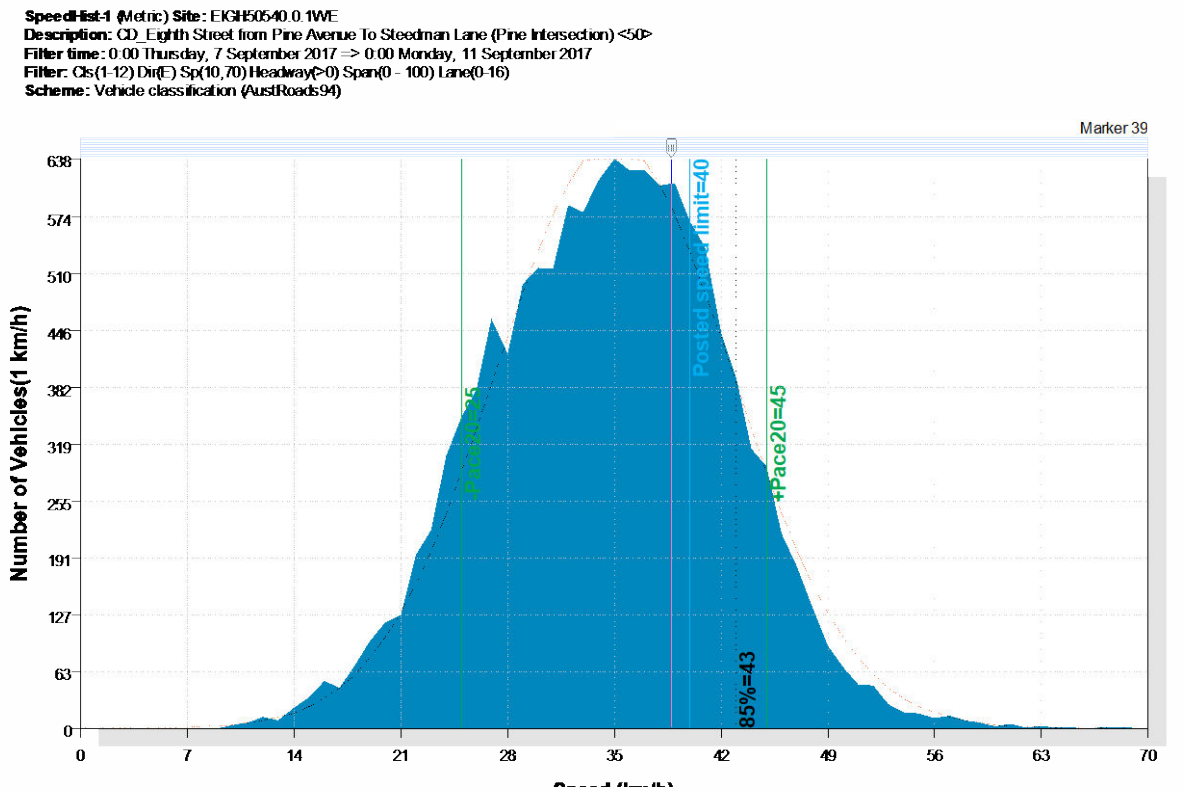
Profile:

Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12771 / 138701 (9.21%)

Speed Statistics

Direction: EW
Vehicles = 12771
Posted speed limit = 40 km/h, Exceeding = 3449 (27.01%), Mean Exceeding = 44.38 km/h
Maximum = 69.1 km/h, **Minimum** = 10.3 km/h, **Mean** = 35.0 km/h
85% Speed = 43.02 km/h, **95% Speed** = 47.23 km/h, **Median** = 35.28 km/h
20 km/h Pace = 25 - 45, **Number in Pace** = 10272 (80.43%)
Variance = 60.27, **Standard Deviation** = 7.76 km/h

Speed Histogram



EIGH50540 Post Construction

Datasets:
Site: **[EIGH50540] CD_Eighth Street from Pine Avenue To Steedman Lane (Pine Intersection) <50>**
Attribute: MILDURA

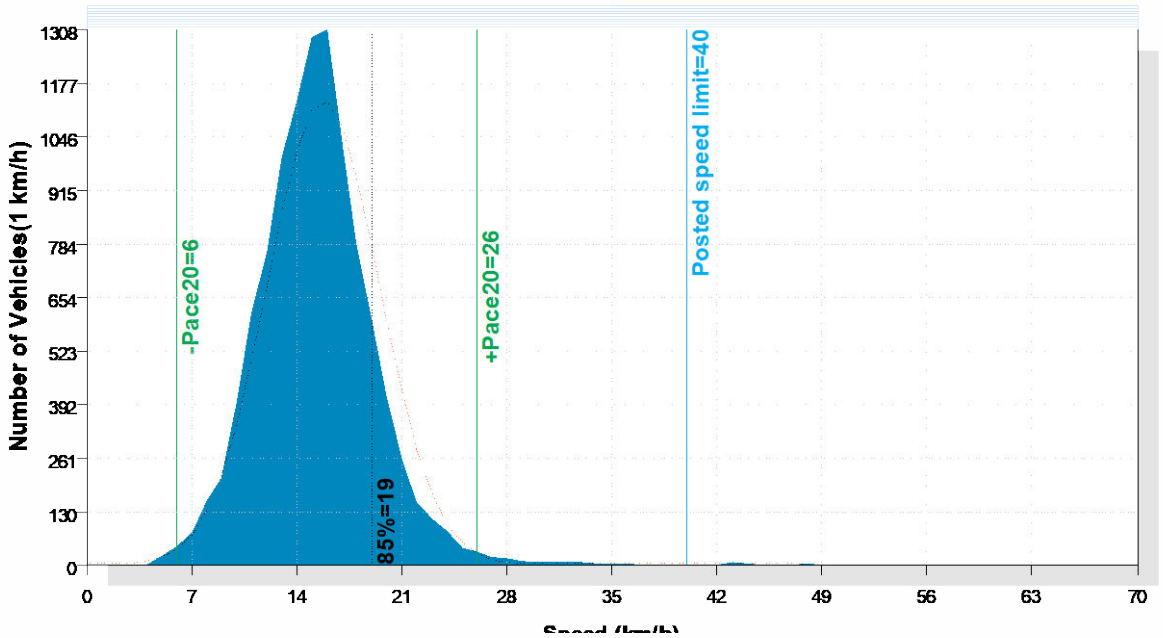
Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 5 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 4 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 10579 / 138701 (7.63%)

Speed Statistics

Direction: EW
Vehicles = 10579
Posted speed limit = 40 km/h, Exceeding = 8 (0.076%), Mean Exceeding = 44.19 km/h
Maximum = 48.2 km/h, **Minimum** = 5.0 km/h, **Mean** = 15.8 km/h
85% Speed = 19.26 km/h, **95% Speed** = 21.78 km/h, **Median** = 15.66 km/h
20 km/h Pace = 6 - 26, **Number in Pace** = 10457 (98.85%)
Variance = 13.88, **Standard Deviation** = 3.73 km/h

Speed Histogram

SpeedHist-9 (Metric) Site: EIGH50540.0.1WE
Description: CD_Eighth Street from Pine Avenue To Steedman Lane (Pine Intersection) <50>
Filter time: 0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017
Filter: Cls(1-12) Dir(E) Sp(5,70) Headway(>4) Span(0 - 100) Lane(0-16)
Scheme: Vehicle classification (AustRoads94)



EIGH50540 Post Construction (SAFE SYSTEM SPEED 30KMH)

Site: **[EIGH50540] CD_Eighth Street from Pine Avenue To Steedman Lane (Pine Intersection) <50>**
Attribute: MILDURA

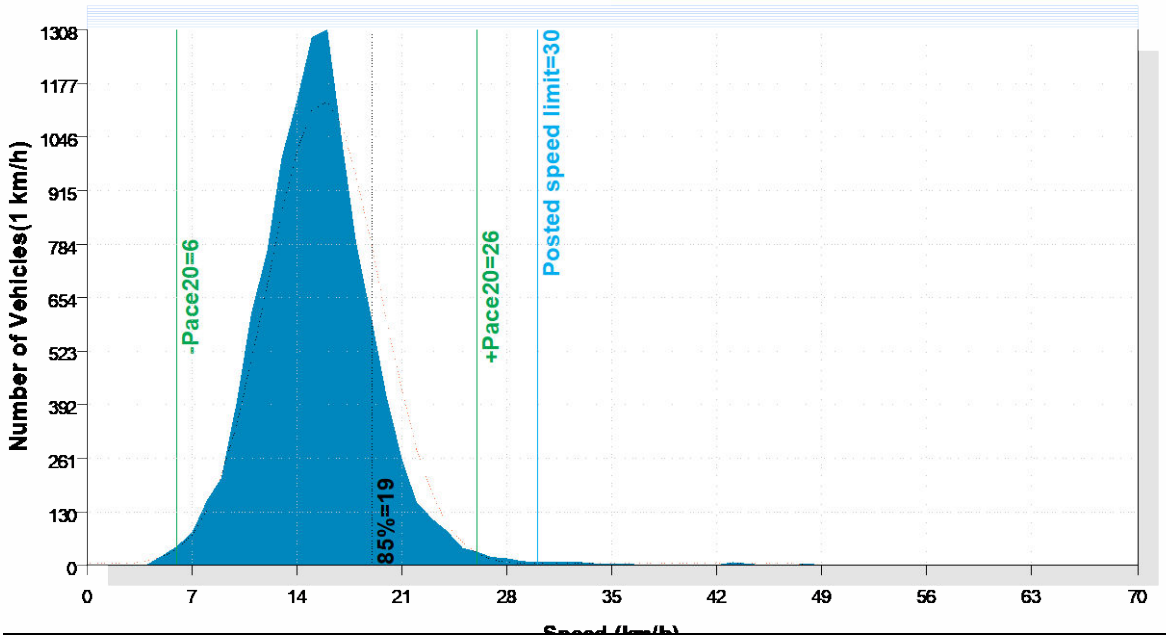
Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 5 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 4 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 10579 / 138701 (7.63%)

Speed Statistics

Direction: EW
Vehicles = 10579
Posted speed limit = 30 km/h, Exceeding = 31 (0.293%), Mean Exceeding = 35.66 km/h
Maximum = 48.2 km/h, **Minimum** = 5.0 km/h, **Mean** = 15.8 km/h
85% Speed = 19.26 km/h, **95% Speed** = 21.78 km/h, **Median** = 15.66 km/h
20 km/h Pace = 6 - 26, **Number in Pace** = 10457 (98.85%)
Variance = 13.88, **Standard Deviation** = 3.73 km/h

Speed Histogram

SpeedHist-9 (Metric) Site: EIGH50540.0.1WE
Description: CD_Eighth Street from Pine Avenue To Steedman Lane (Pine Intersection) <50>
Filter time: 0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017
Filter: Cls(1-12) Dir(E) Sp(5,70) Headway(>4) Span(0 - 100) Lane(0-16)
Scheme: Vehicle classification (AustRoads94)



EIGH50550 Pre-Construction

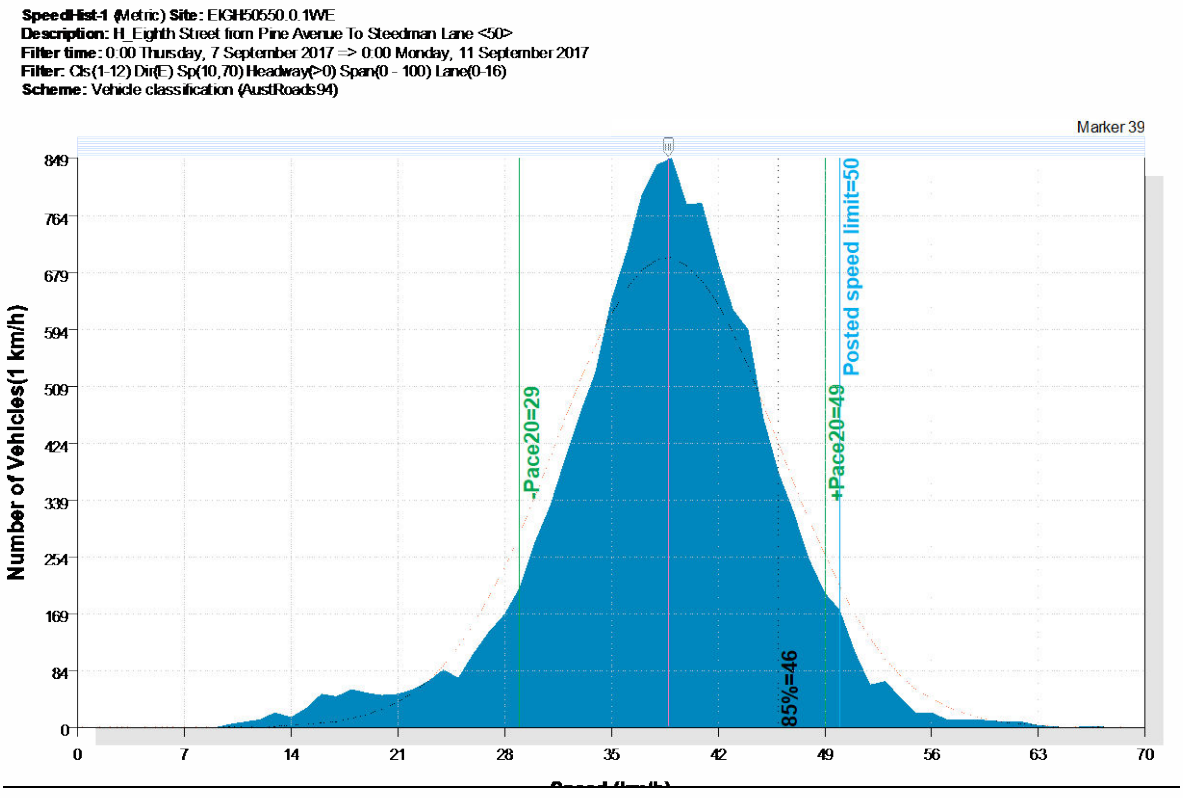
Site: **[EIGH50550] H_Eighth Street from Pine Avenue To Steedman Lane <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12766 / 108551 (11.76%)

Speed Statistics

Direction: EW
Vehicles = 12766
Posted speed limit = 50 km/h, Exceeding = 568 (4.449%), Mean Exceeding = 53.09 km/h
Maximum = 67.0 km/h, **Minimum** = 10.0 km/h, **Mean** = 38.7 km/h
85% Speed = 45.54 km/h, **95% Speed** = 49.62 km/h, **Median** = 39.06 km/h
20 km/h Pace = 29 - 49, **Number in Pace** = 10928 (85.60%)
Variance = 53.04, **Standard Deviation** = 7.28 km/h

Speed Histogram



EIGH50550 Post Construction

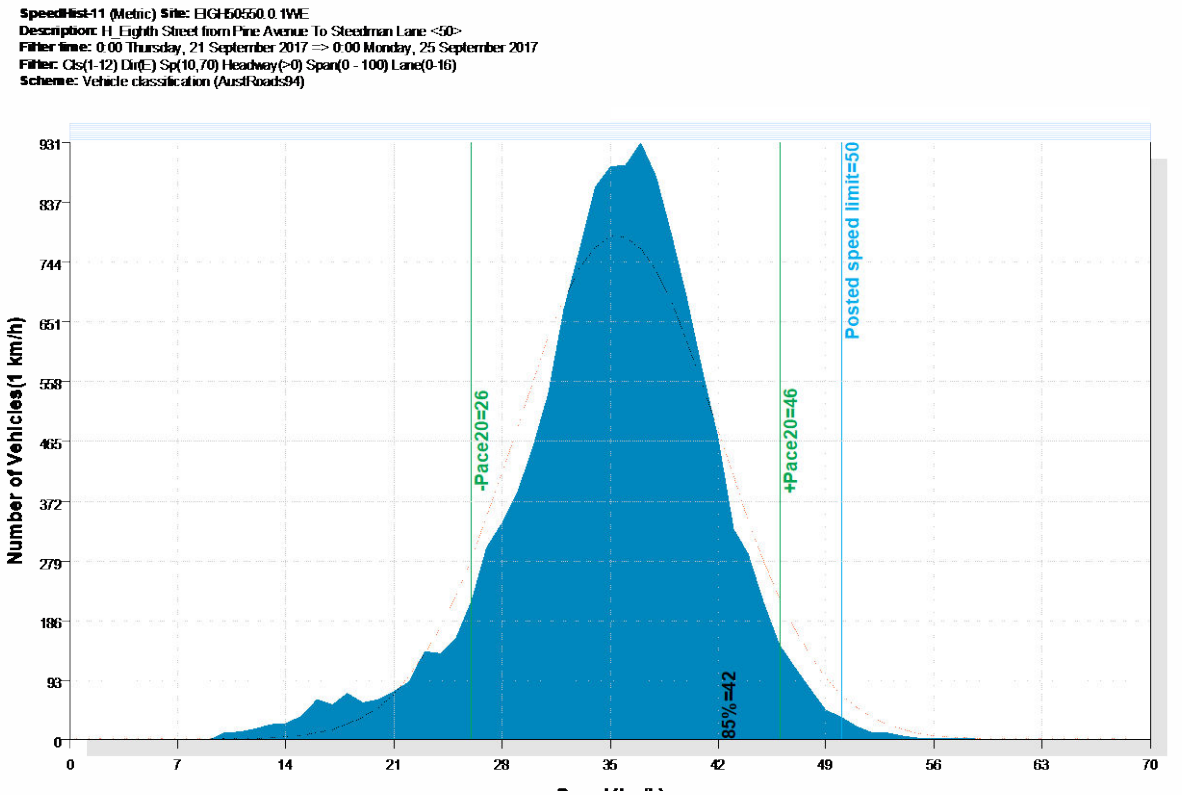
Site: **[EIGH50550] H_Eighth Street from Pine Avenue To Steedman Lane <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12989 / 108551 (11.97%)

Speed Statistics

Direction: EW
Vehicles = 12989
Posted speed limit = 50 km/h, Exceeding = 96 (0.739%), Mean Exceeding = 52.39 km/h
Maximum = 60.8 km/h, **Minimum** = 10.1 km/h, **Mean** = 35.5 km/h
85% Speed = 41.76 km/h, **95% Speed** = 45.18 km/h, **Median** = 36.00 km/h
20 km/h Pace = 26 - 46, **Number in Pace** = 11467 (88.28%)
Variance = 43.52, **Standard Deviation** = 6.60 km/h

Speed Histogram



EIGH50560 Pre-Construction

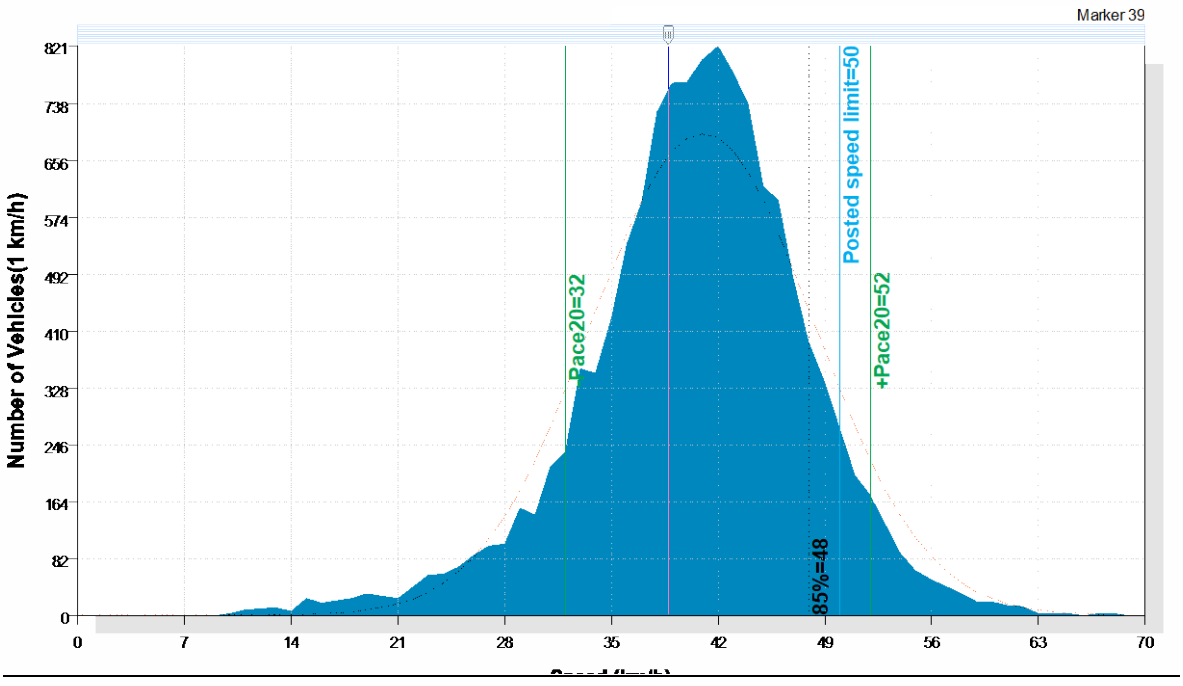
Site: **[EIGH50560] RM_Eighth Street from Steedman Lane to Olive Avenue <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12689 / 136567 (9.29%)

Speed Statistics

Direction: EW
Vehicles = 12689
Posted speed limit = 50 km/h, Exceeding = 1128 (8.890%), Mean Exceeding = 53.41 km/h
Maximum = 69.0 km/h, **Minimum** = 10.5 km/h, **Mean** = 41.0 km/h
85% Speed = 47.88 km/h, **95% Speed** = 52.20 km/h, **Median** = 41.40 km/h
20 km/h Pace = 32 - 52, **Number in Pace** = 10817 (85.25%)
Variance = 53.22, **Standard Deviation** = 7.30 km/h

Speed Histogram



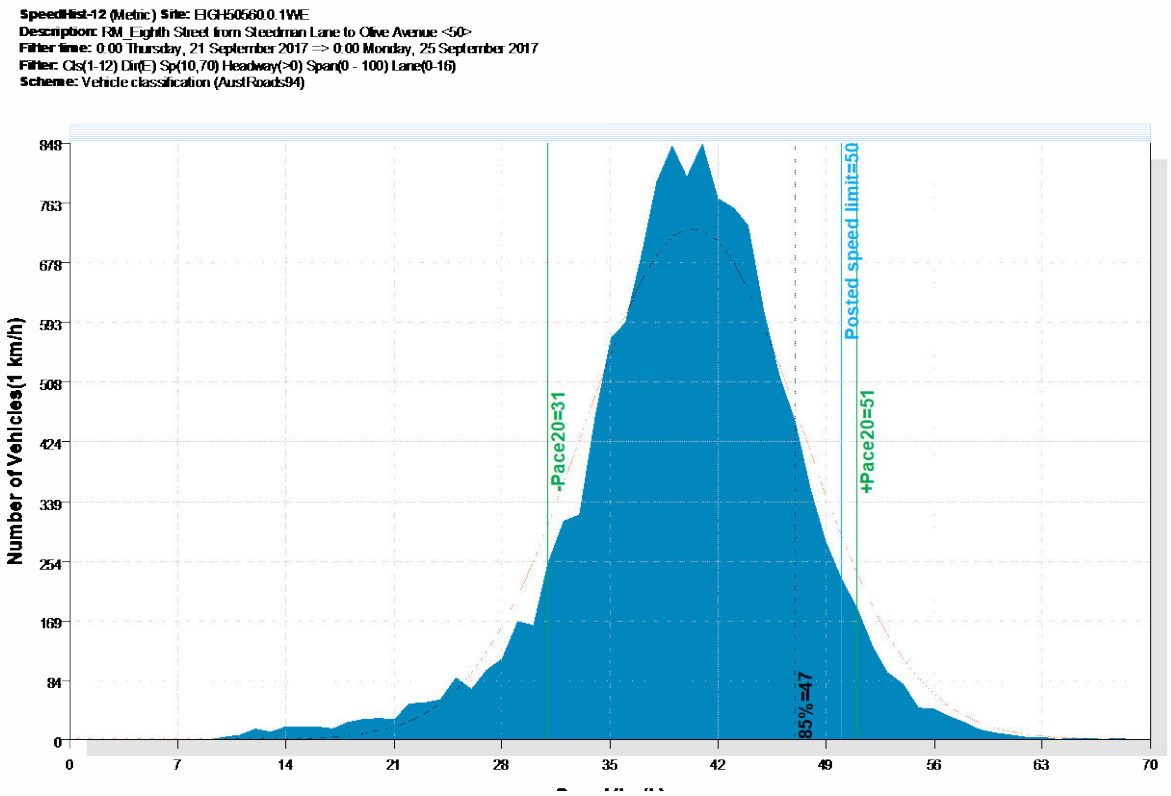
EIGH50560 Post Construction

Site: **[EIGH50560] RM_Eighth Street from Steedman Lane to Olive Avenue <50>**
Attribute: MILDURA

Speed Statistics

Direction: EW
Vehicles = 12937
Posted speed limit = 50 km/h, Exceeding = 914 (7.065%), Mean Exceeding = 53.19 km/h
Maximum = 68.9 km/h, **Minimum** = 10.0 km/h, **Mean** = 40.4 km/h
85% Speed = 47.16 km/h, **95% Speed** = 51.12 km/h, **Median** = 40.68 km/h
20 km/h Pace = 31 - 51, **Number in Pace** = 11165 (86.30%)
Variance = 50.48, **Standard Deviation** = 7.11 km/h

Speed Histogram



EIGH50587 Pre-Construction

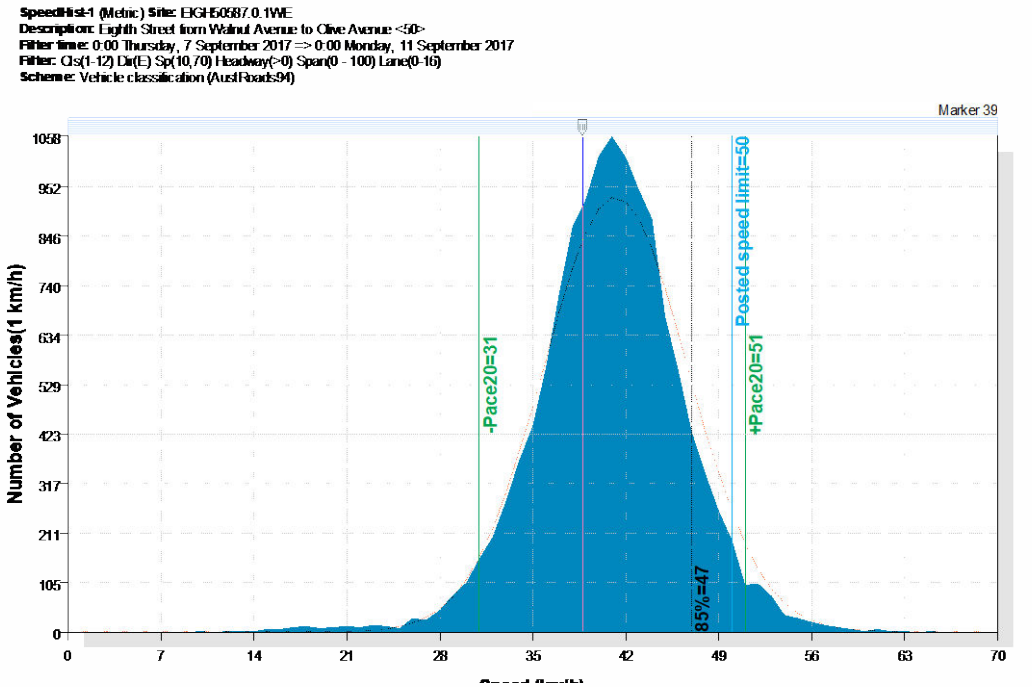
Site: **[EIGH50587] Eighth Street from Walnut Avenue to Olive Avenue <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 7 September 2017 => 0:00 Monday, 11 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Pre Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12664 / 81012 (15.63%)

Speed Statistics

Direction: EW
Vehicles = 12664
Posted speed limit = 50 km/h, Exceeding = 600 (4.738%), Mean Exceeding = 52.62 km/h
Maximum = 66.0 km/h, **Minimum** = 10.2 km/h, **Mean** = 41.3 km/h
85% Speed = 46.62 km/h, **95% Speed** = 49.86 km/h, **Median** = 41.40 km/h
20 km/h Pace = 31 - 51, **Number in Pace** = 11858 (93.64%)
Variance = 29.76, **Standard Deviation** = 5.46 km/h

Speed Histogram



EIGH50587 Post Construction

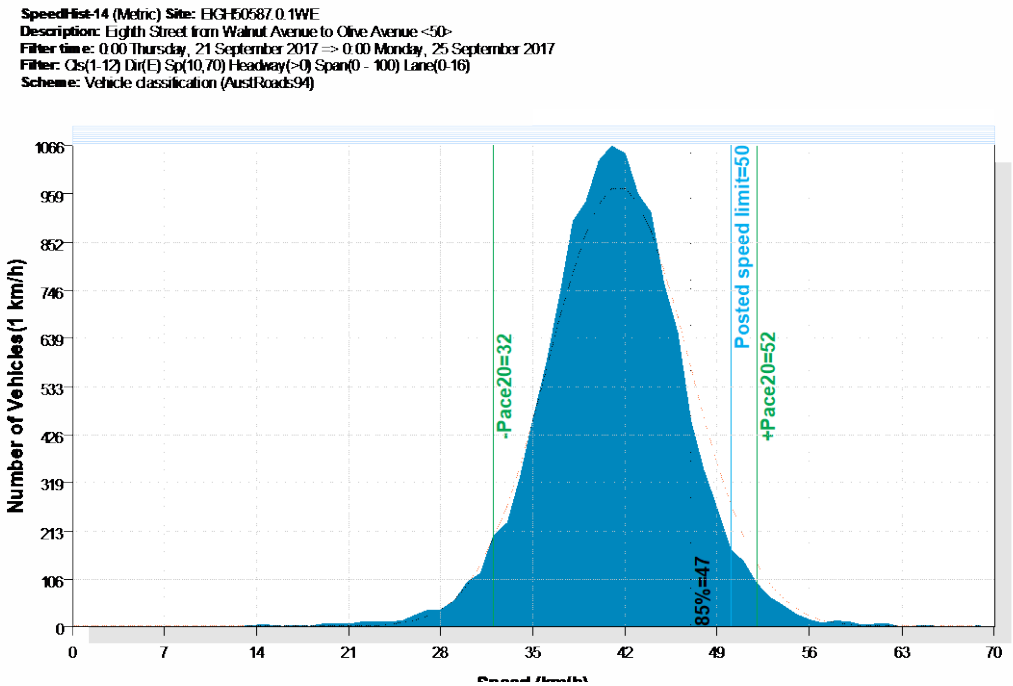
Site: **[EIGH50587] Eighth Street from Walnut Avenue to Olive Avenue <50>**
Attribute: MILDURA

Profile:
Filter time: **0:00 Thursday, 21 September 2017 => 0:00 Monday, 25 September 2017 (4)**
Included classes: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12
Speed range: 10 - 70 km/h.
Direction: East (bound), P = East, Lane = 0-16
Separation: Headway > 0 sec, Span 0 - 100 metre
Name: Post Construction
Scheme: Vehicle classification (AustRoads94)
Units: Metric (metre, kilometre, m/s, km/h, kg, tonne)
In profile: Vehicles = 12940 / 81012 (15.97%)

Speed Statistics

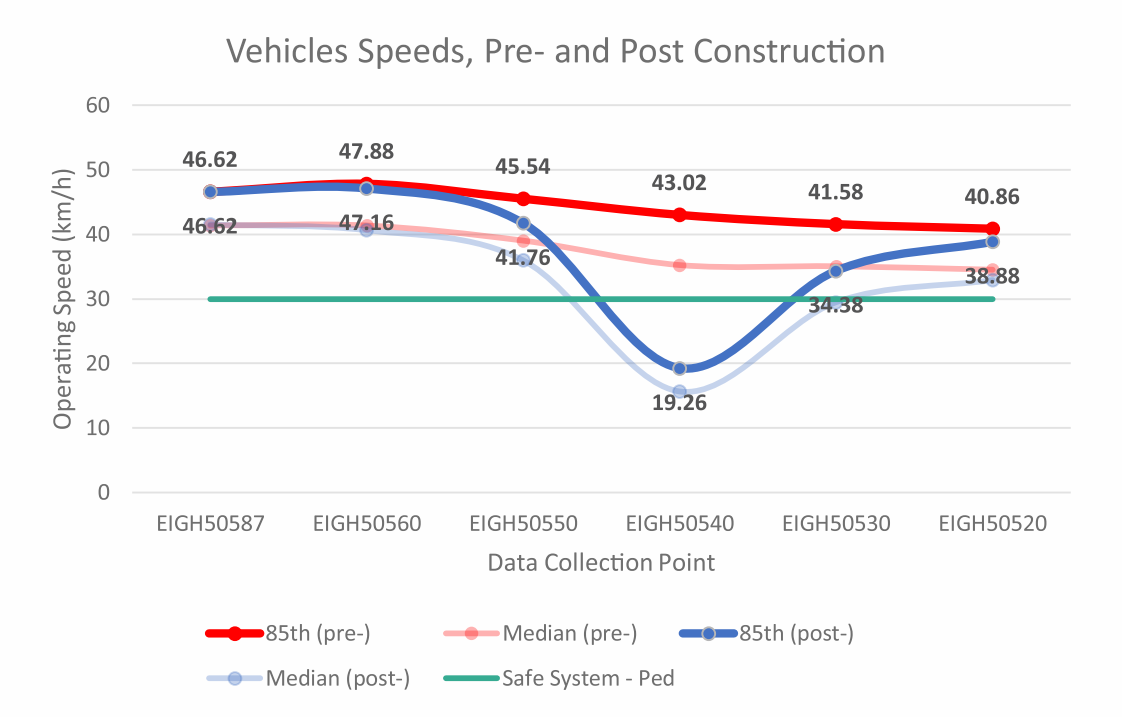
Direction: EW
Vehicles = 12940
Posted speed limit = 50 km/h, Exceeding = 620 (4.791%), Mean Exceeding = 52.88 km/h
Maximum = 69.5 km/h, **Minimum** = 10.3 km/h, **Mean** = 41.5 km/h
85% Speed = 46.62 km/h, **95% Speed** = 49.86 km/h, **Median** = 41.58 km/h
20 km/h Pace = 32 - 52, **Number in Pace** = 12189 (94.20%)
Variance = 28.11, **Standard Deviation** = 5.30 km/h

Speed Histogram



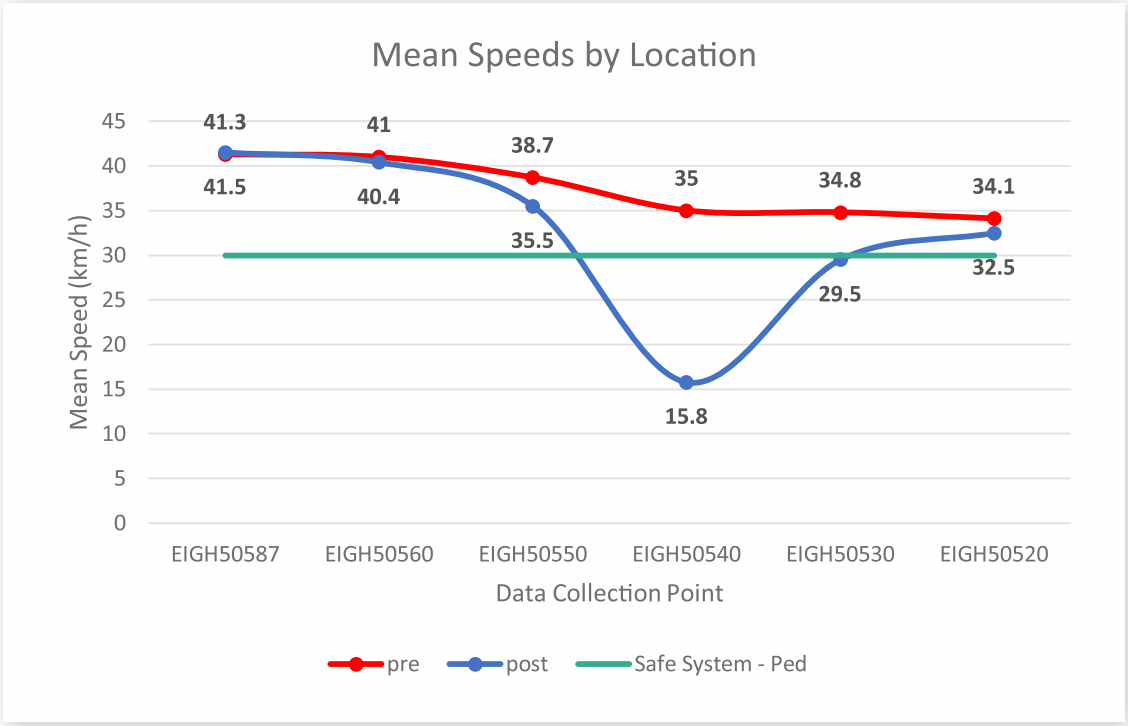
85th Percentile and Median Speeds

Vehicle Speeds, Pre- and Post Construction					
	Pre-Construction		Post Construction		
Location	85th (pre-)	Median (pre-)	85th (post-)	Median (post-)	Safe System - Ped
EIGH50587	46.62	41.4	46.62	41.58	30
EIGH50560	47.88	41.4	47.16	40.68	30
EIGH50550	45.54	39.06	41.76	36	30
EIGH50540	43.02	35.28	19.26	15.66	30
EIGH50530	41.58	35.1	34.38	29.52	30
EIGH50520	40.86	34.56	38.88	32.94	30



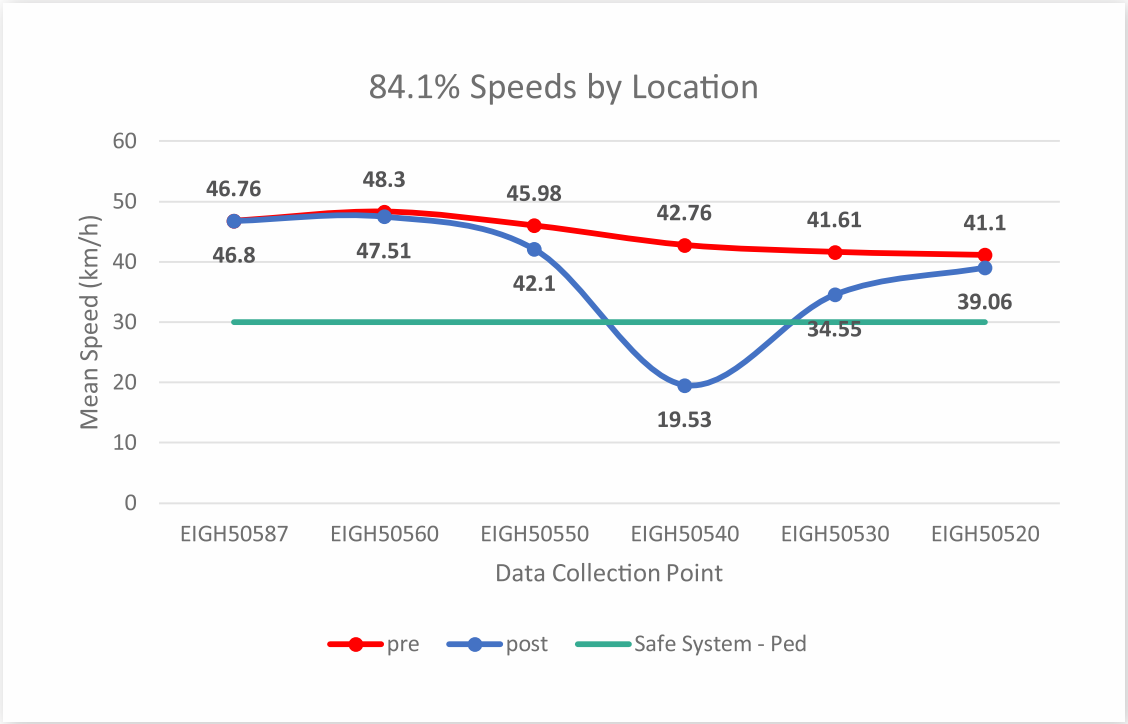
Mean Speeds and Standard Deviations

Mean speeds					
Location	pre	post	Safe System - Ped	SD pre	SD post
EIGH50587	41.3	41.5	30	5.46	5.3
EIGH50560	41	40.4	30	7.3	7.11
EIGH50550	38.7	35.5	30	7.28	6.6
EIGH50540	35	15.8	30	7.76	3.73
EIGH50530	34.8	29.5	30	6.81	5.05
EIGH50520	34.1	32.5	30	7	6.56



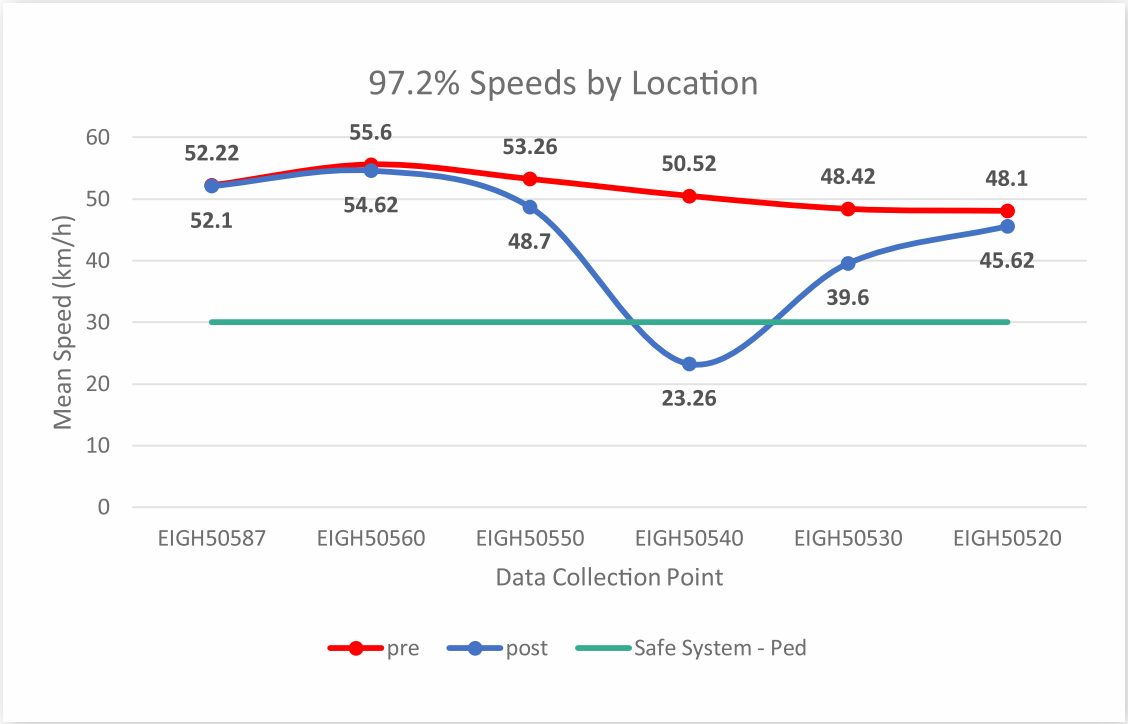
Mean speeds and Upper Limit Speeds at 1 Standard Deviation (84.1th percentile)

SD 1 speeds			
Location	pre	post	Safe System - Ped
EIGH50587	46.76	46.8	30
EIGH50560	48.3	47.51	30
EIGH50550	45.98	42.1	30
EIGH50540	42.76	19.53	30
EIGH50530	41.61	34.55	30
EIGH50520	41.1	39.06	30



Mean speeds and Upper Limit Speeds at 2 Standard Deviations (97.2th percentile)

SD 2 speeds			
Location	pre	post	Safe System - Ped
EIGH50587	52.22	52.1	30
EIGH50560	55.6	54.62	30
EIGH50550	53.26	48.7	30
EIGH50540	50.52	23.26	30
EIGH50530	48.42	39.6	30
EIGH50520	48.1	45.62	30



Mean speeds and Upper Limit Speeds at 3 Standard Deviation

SD 3 speeds			
Location	pre	post	Safe System - Ped
EIGH50587	57.68	57.4	30
EIGH50560	62.9	61.73	30
EIGH50550	60.54	55.3	30
EIGH50540	58.28	26.99	30
EIGH50530	55.23	44.65	30
EIGH50520	55.1	52.18	30