Effectiveness of portable speed warning signs

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Abstract

Speeding is a continual issue for road authorities to manage, especially on local streets and around schools. Speeding increases the required stopping distance of vehicles to avoid an accident. This in turn, results in increased occurrences of accidents and their associated severity. Speeding may be due to poor driver behaviours such as hooning, distracted drivers, or technical issues such as vehicle defects or not knowing basic road rules, for example, 50km/hr on local roads in South East Queensland.

Brisbane City Council is taking a proactive approach by installing 26 portable speed warning signs on streets and roads to reduce speeding and help increase safety. The portable speed warning signs have been operational since November 2013 and in the 17 months up to the end of the March 2015, have subsequently captured 25.1Million motorists and advised them to slow down if driving over the posted speed limit.

During the 17 months, the 26 signs have been moved around Brisbane 175 times. The data from each of these sites has shown a marked decrease in the number of motorists travelling over the speed limit as a consequence of being advised of their travelling speed.

Background to portable speed warning signs program

The Portable Speed Warning Signs Program is part of Lord Mayor Graham Quirk's commitment to making Brisbane's suburban streets safer. The program aims to increase motorists' awareness of their travelling speed and to achieve better adherence to the speed limit in locations with identified or suspected speed issues. To date the program has shown a marked decrease in the travelling speed for motorists travelling over the speed limit with average speed reduction of 9.5km/hr after passing the signs.

The main phases of the project detailed within this report are as follows:

- Site Assessment and Resident Consultation
- Sign Installation
- How the Signs Function
- Analysis of Results

Site Assessment and Resident Consultation

Each of the 26 local wards within Brisbane City Council has a list of requested streets for the portable speed warning signs. These streets are largely based on requests from resident's and council officers' recommendations from traffic investigations. From each local councillor's ranked order of their sites, a desktop site assessment is undertaken to see if a proposed location/s can be found. This is because the signs are not suitable for all locations within the road network due to two main requirements:

1. longitudinal placement along the streets so that the sign can detect approaching vehicles,
2. sufficient sunlight as the signs are solar powered.

The factors for the longitudinal placement include:

- sufficient forward visibility free from presence of obstructions such as trees, other road signs, and conflicts and decision points to ensure drivers have sufficient time to read the messages posted. This is generally 3 seconds on local streets with a minimum of 50m.
- sufficient separation after the portable speed warning sign to other road signs, conflict and decision points. This is generally 2 seconds on local streets with a minimum of 30m.
- constant longitudinal grade and limited vertical curvature on approach to the sign. This is generally 3 seconds on local streets with a minimum of 50m.

From the proposed location/s, a site visit is undertaken to complete a detailed site assessment to determine if an appropriate location can be found in the ***physical*** environment by assessing the following;

- ensuring the solar panels receive adequate sunlight
- ensuring separation between other traffic signs to ensure drivers have sufficient time to read the messages posted,
- visual impact on adjacent residents,
- clearance from conflicts such as driveways and power poles,
- clearance from low hanging power lines and television cables, and
- clearance to underground services by dial-before-you-dig enquiry.

Once a ***physical*** location has been confirmed, the directly affected property owner/s are engaged via letter to seek their comments on the installation of the portable speed warning sign on the road verge in front of their property.

Portable Speed Warning Sign Installation

Installation of the portable speed warning signs involves the construction of a small concrete foundation below the ground on Council owned footpath/verge or sometimes median as shown in Figure 3.1.

Figure 3.1 – Portable Speed Warning Sign Footing Installed on Council Footpath/Verge

Once the concrete has cured, the sign is installed on a slip based pole and the solar panel connected as shown in Figure 3.2. The electrical technicians configure the sign to the speed environment which includes if it is within a school zone or non-school zone.

Figure 3.2 – Portable Speed Warning Sign Installed on Council Footpath/Verge

Once the speed sign is removed, the lid will remain and sits flush with ground level as shown in Figure 3.3. This means that the site can be used again if speeding at this location becomes an issue.

Figure 3.3 – Portable Speed Warning Sign Removed

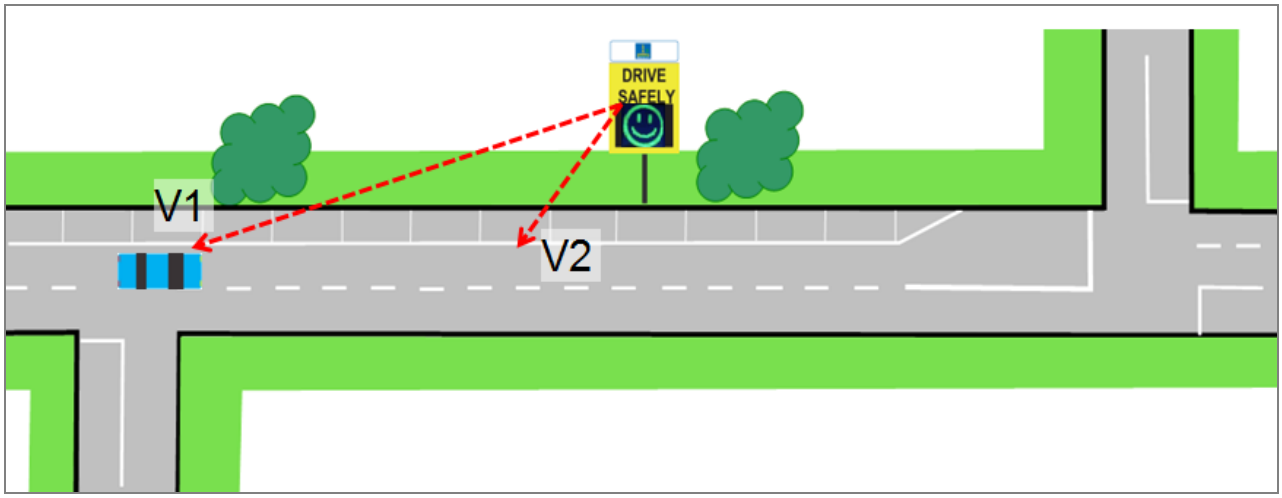
How the Portable Speed Warning Signs Function

The portable speed warning signs measure the speed of each motorist then displays a message dependent on their speed. The signs also record the initial entering speed and the final or exiting speed of each motorist.

The following naming convention for the speed records used within this report is as follows:

- V1 – initial speed of the vehicle entering the radar range of the sign
- V2 – final speed of the vehicle exiting the radar range of the sign

Figure 4.1 – How the Portable Speed Signs Function



The default setting for the sign is blank and as a motorist approaches the sign, the vehicle's speed is detected by the sign's radar and one of the following three messages displayed:

1. If the motorist is driving at or below the speed limit, a smiley face message is displayed as shown in Figure 4.2,
2. If the motorist is driving above the speed limit by up to 9km/h, the vehicle's speed is displayed below a 'YOUR SPEED' message as shown in Figure 4.3,
3. If the motorist is driving 10km/h or more above the speed limit, the sign is programmed to display a 'SLOW DOWN' message as shown in Figure 4.4.

Figure 4.2 – Message 1

Figure 4.3 – Message 2

Figure 4.4 – Message 3

Additionally, the message changes as the vehicle's speed changes whilst within the radar range of the sign.

There are several key aspects in relation to the messaging and operation of the portable speed warning signs in Council's program:

- the third message doesn't display excessive speeds so motorists don't try and display a high speed reading,
- the signs remain at each location for at least one month before being moved to a new location. This is to allow the speed warning signs to have a positive effect on motorists driving behaviour,
- the speed readings are not used for the issuing of any infringement notices as the purpose of the speed radar is only to enable feedback to motorists of driver speed. The signs also don't have a camera to photograph vehicles. If a site shows excessive and continual speeding, then we do however recommend to the local councillor that Queensland Police Services (QPS) assesses the location to their criteria and undertakes enforcement if considered appropriate.

Analysis of Result

As part of the successful tender's product, analysis software was also supplied. It provides a series of six graphs providing results on the V1 speed reading plus overall statics such as the number of records and percentage of vehicles travelling over the speed limit. It also provides the user several functions such as defining a time interval for the graphs and refining a subset of data It doesn't however provide detailed analysis of the V2 speed reading.

The analysis software does allow the raw data to be exported into a comma delimited space file (CSV) which includes the V1 and V2 speeds plus date and time stamp. From the raw data, the sites have been analysed by developing a series of graphs and statistical measures comparing each record's V1 and V2 speeds. The V1 and V2 speeds allows measurements and statistics not just by all vehicles passing the sign, but more importantly by the difference between the vehicle's V1 speed reading to the V2 speed reading and thus to be able to gauge the sign's effectiveness.

Results for Program Round by Round

The portable speed warning signs have been operational since November 2013, and as at the end of March 2015, the 26 signs have been moved around Brisbane 175 times. Four of these sites had no data due to a sign fault. The sites are spread across 106 suburbs within Brisbane City Council as shown in the figure included at Appendix A. Based on the 171 sites, Table 5.1 below provides a high level summary of result for the program round by round and as a total.

Table 5.1 – Program Results Round by Round

Statistic	Round							
	1	**2**	**3**	**4**	**5**	**6**	**7***	**Total**
Total number of vehicle trips (,000)	2,361.7	2,844.3	4,043.6	3,618.7	3,194.8	6,731.0	2,331.3	**25,125.4**
Reduction of average speed of all vehicles (km/hr)	5.7	4.5	4.8	5.7	4.6	5.2	6.5	**5.2**
Reduction of average speed of vehicles with V1 speeds > the speed limit (km/hr)	10.1	8.6	9.3	9.2	9.5	9.4	10.0	**9.5**
Percentage total vehicles with V1 speeds > the speed limit (%)	29.3	15.4	18.1	26.3	20.6	22.4	24.5	**22.1**
Percentage total vehicles with V2 speeds > the speed limit (%)	10.9	6.2	7.6	11.4	8.9	8.4	8.2	**8.7**

*Note: * Data from seventh round is for 16 of the 26 sites. 10 sites are still to be moved and analysed as at end of Mar 2015.*

Table 5.1 shows that the program has shown a marked decrease for vehicles travelling over the speed limit as a consequence of been advised of their entering speed from 22.1% of the 25.1Million to 8.7%. The program has delivered a reduction of average speed for vehicle travelling over the speed limit of 9.5km/hr across all sites since the program began.

Summary of Sites within the Program

A breakdown of the number of sites and vehicles by road hierarchy and speed limit is shown in Table 5.2. *Table 5.2 – Number of Sites and Vehicles by Road Hierarchy and Speed Limit*

Road Hierarchy	Speed Zone					
		40km/hr	**50km/hr**	**60km/hr**	**70km/hr**	**Total**
Arterial	Number of Sites	0	0	8	1	**9**
	Number of Vehicles (,000)	0.0	0.0	1,951.5	214.8	**2,166.3**
Suburban	Number of Sites	2	4	34	1	**41**
	Number of Vehicles (,000)	430.1	768.2	7,298.0	204.9	**8,701.2**
District	Number of Sites	6	42	27	1	**76**
	Number of Vehicles (,000)	599.1	5,849.8	4,493.0	120.5	**11,062.4**
Neighbourhood	Number of Sites	4	40	1	0	**45**
	Number of Vehicles (,000)	438.4	2,684.3	72.8	0.0	**3,195.4**
Total	**Number of Sites**	**12**	**86**	**70**	**3**	**171**
	Number of Vehicles (,000)	**1,467.6**	**9,302.3**	**13,815.3**	**540.3**	**25,125.4**

Table 5.2 show that the program has a diverse range of sites with the four main site type's account for 143 sites (83.6%) of the 171 sites with 20.3Million vehicles (80.8%) as follows:

- District at 50km/hr – 42 sites (24.6%) with 5,849,800 vehicles (23.3%),

- Neighbourhood at 50km/hr – 40 sites (23.4%) with 2,684,300 vehicles (10.7%),
- Suburban at 60km/hr – 34 sites (19.9%) with 7,298,000 vehicles (29.0%),
- District at 60km/hr – 27 sites (15.8%) with 4,493,000 vehicles (17.9%).

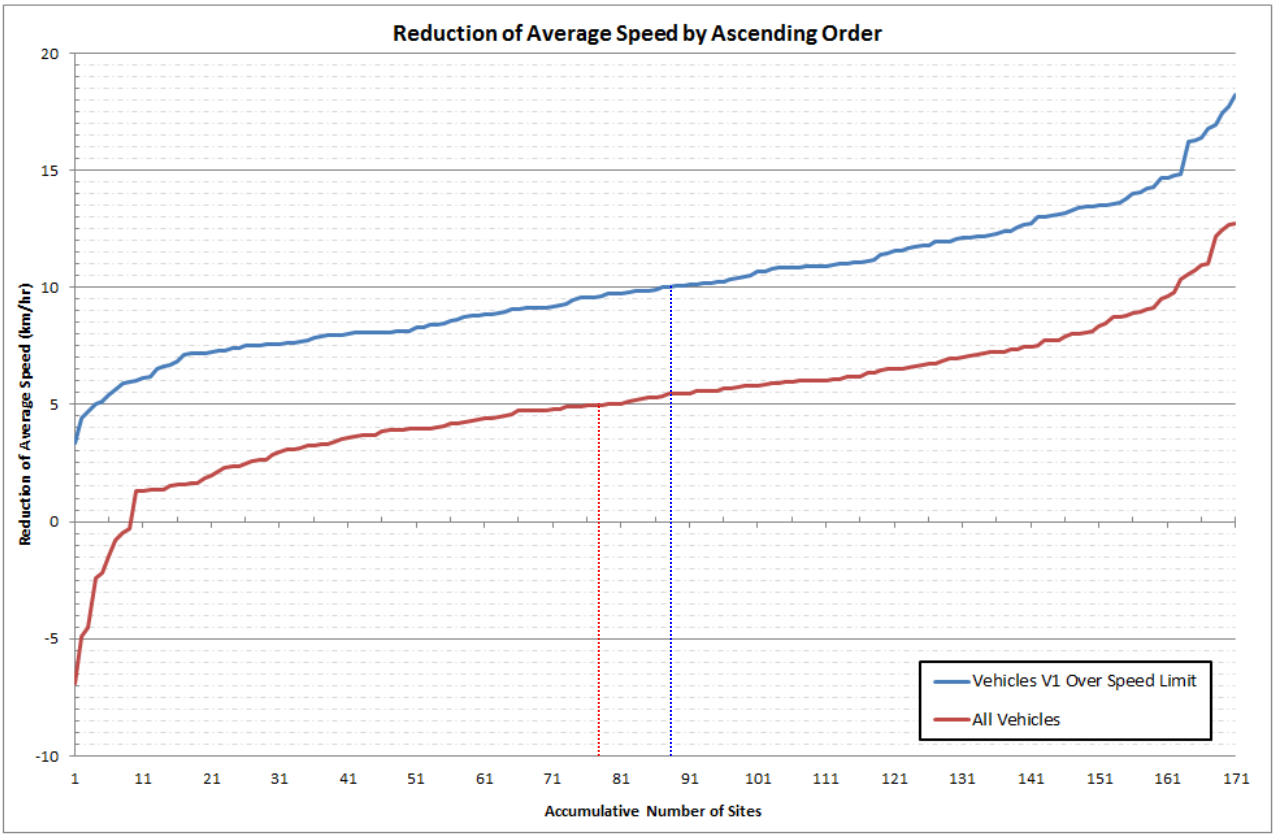
Results for Reduction of Average Speed

The reduction of average speeds for all vehicles and vehicles entering the sign radar range over the speed limit are shown in Figure 5.5 in ascending order.

Figure 5.5 results show all sites are effective at reducing speeds for vehicles with V1 over the speed limit with a range of 3.4km/hr to 18.2km/hr. 50% of the sites show a reduction of the average speed of 10km/hr or greater. 45% of the sites show a reduction of the average speed of 5km/hr or greater.

A few sites had a negative value as these sites had the large majority vehicles still accelerating as they approached the sign. This was as the sign was either too close to the start of the street or just after a side street with a high volume turning to the sign.

Figure 5.5 – Reduction of Average Speed by Ascending Order



Further figures with results of reduction of average speeds by various characteristics are included at Appendix B to determine if any sites are more the effective than others. These figures shows results only for vehicles entering the sign radar range over the speed limit. From these figures the following observations can be concluded:

- by volume the signs shows a spread of results, but they provide slightly better reduction of average speeds for sites with lower volume of vehicles (see Figure B.1),
- the sign are effective for all road hierarchies are effective at reducing speeds. Additionally, approximately half the sites for each road hierarchies have a reduction of average speed of 10km/hr or greater (see Figure B.2),
- the sign are effective for all speed limits at reducing speeds. Approximately half the sites for each speed limit have a reduction of average speed of 10km/hr or greater (Figure B.3).

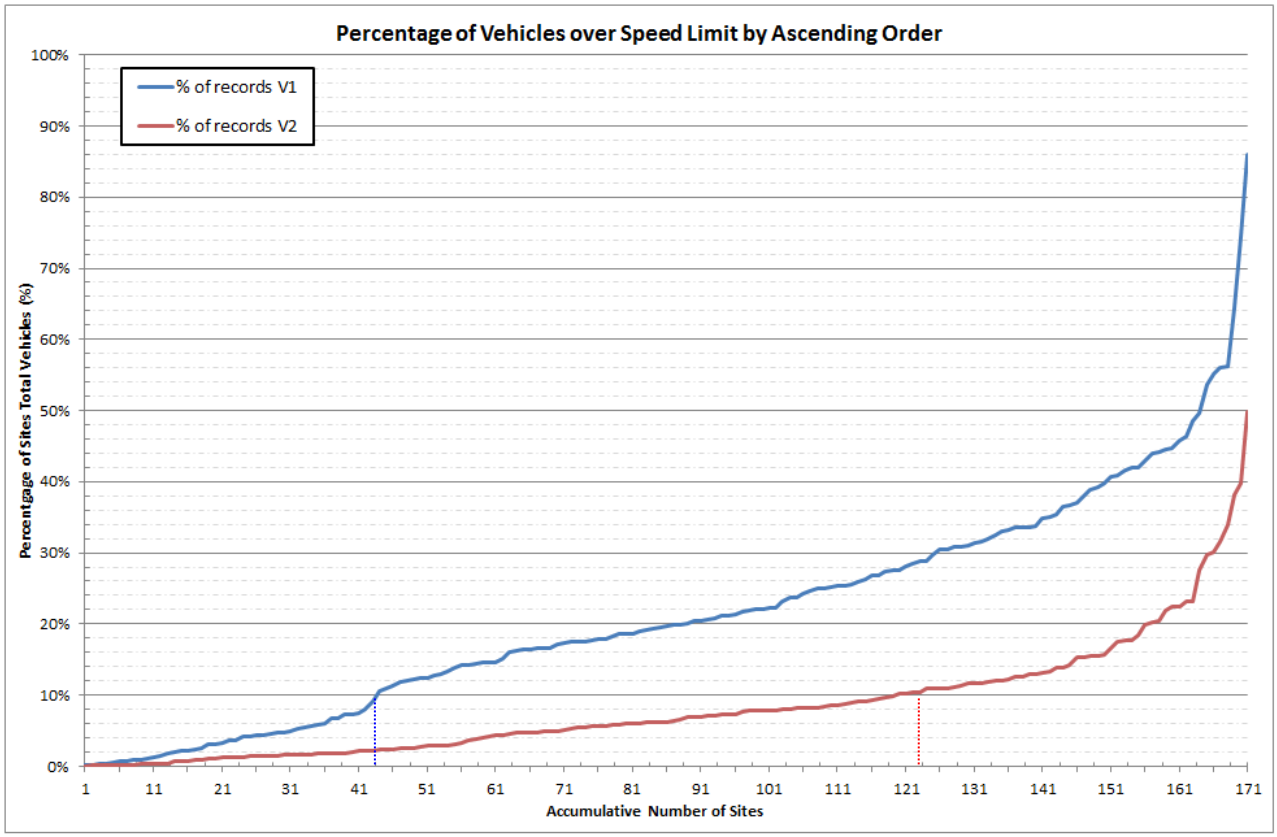
Results of Percentage Speeding

Whilst Section 5.3 results show the portable speed signs are effective in reducing the average speed, the other parameter that can be analysed is the percentage of vehicles over the speed limit at both V1 and V2.

The percentage of vehicles over the speed limit at V1 and V2 are shown in Figure 5.6 in ascending order.

Figure 5.6 shows 75% of sites have 10% or more of vehicles over speed limit at V1 and only 30% of sites at V2. Therefore, the signs are not only effective at reducing speeds but also increasing the number vehicles adhering to the speed limit.

Figure 5.6 – Percentage of Vehicles Over Speed Limit by Ascending Order



Further figures with results of percentage speeding by various characteristics are included at Appendix C to determine if any sites are more the effective than others. From these figures the following observations can be concluded:

- by volume the signs shows a spread of results for both the V1 and V2 records, but both linear trend lines for provide an indication of slightly lower percentage of vehicles speeding for sites with lower volumes (see Figure C.1),
- the sign are effective for all road hierarchies at reducing the percentage of vehicles over the speed limit. Approximately 65% to 75% of sites for each road hierarchy have only 10% of vehicles V2 records over the speed limit (see Figure C.2),
- the sign are effective for all speed limits at reducing the percentage of vehicles over the speed limit. Approximately 50% to 70% of sites with 40 to 60 speed limits have only 10% of vehicles V2 over the speed limit. The 70km/hr sites (3) all had less than 10% of vehicles V2 records over the speed limit (see Figure C.3).

Results for School Zones Sites

Of the 171 sites, 15 sites are within a school zone. Table 5.3 below provides a high level summary of result for records at school times. Note all sites had school zone times of 7-9am and 2-4pm.

Table 5.3 – Program Results for School Zones at School Times

Static	Total
Total number of vehicle trips	**390,014**
Reduction of average speed of all vehicles (km/hr)	**4.6**
Percentage total vehicles with entering speed over the speed limit (%)	**32.0**
Percentage total vehicles with final speed over the speed limit (%)	**16.5**
Reduction of average speed of vehicles with entering speed over the speed limit (km/hr)	**8.6**

A breakdown of the number of sites and vehicles by road hierarchy and speed limit for the 15 sites within School Zones is provided in Table 5.4.

Table 5.4 – Number of Sites and Vehicles by Road Hierarchy and Speed Limit within School Zones

Road Hierarchy		Speed Zone				
		40km/hr	50km/hr	60km/hr	70km/hr	Total
Arterial	Number of Sites	0	0	3	0	**3**
	Number of Vehicles	0	0	303,010	0	**303,010**
Suburban	Number of Sites	0	0	3	0	**3**
	Number of Vehicles	0	0	508,296	0	**508,296**
District	Number of Sites	1	4	4	0	**9**
	Number of Vehicles	120,568	468,737	850,636	0	**1,439,941**
Neighbourhood	Number of Sites	0	0	0	0	**0**
	Number of Vehicles	0	0	0	0	**0**
Total	**Number of Sites**	**1**	**4**	**10**	**0**	**15**
	Number of Vehicles	**120,568**	**468,737**	**1,661,942**	**0**	**2,251,247**

The results for school zone sites are similar to the sections above, that is, the portable speed warning signs are effective at reducing speeds and increasing the number of vehicles adhering to the speed limit for all road hierarchy, speed limits and number of vehicles per day. A series of figures for school zone sites are included at Appendix D.

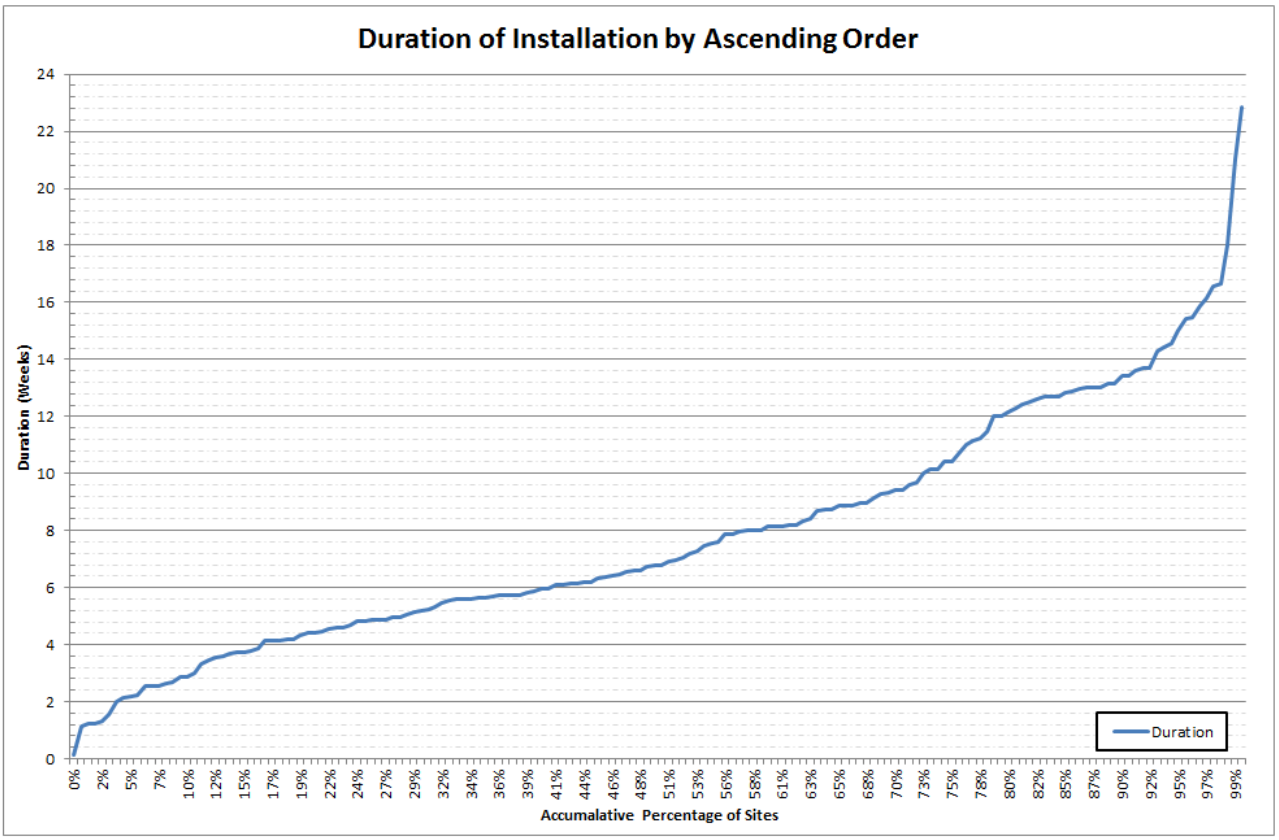
Results by Duration Installed

As part of the program development, research was undertaken which showed results of electronic speed signs in terms of speed reductions and compliance to the speed limit improved over time. In fact, some studies showed locations with signs installed for several years with nearly all vehicles adhering to the speed limit. Despite the signs being warning signs and not enforceable, motorists observed the signs messaging over time.

As Council is installing the portable speed warning signs for a minimum of one month duration at sites, analysis is being completed assessing the results week by week. This is to understand what duration is required to allow the speed warning sign to have a positive effect on motorists. Additionally, what duration does the sign show a change in terms of driver behaviour not just a reaction to the sign.

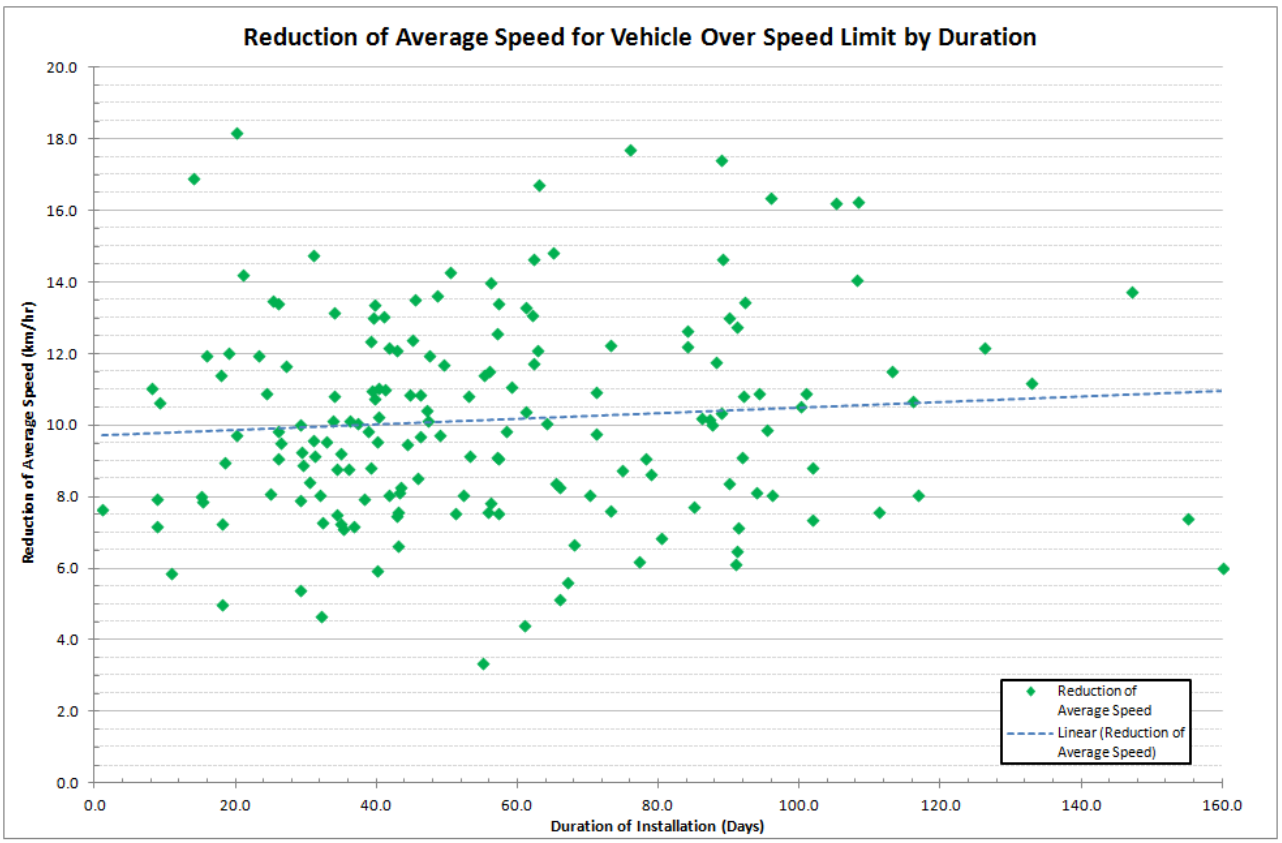
The duration of sign installation is shown in Figure 5.7 which shows an average duration of 8 weeks and maximum of 23 weeks.

Figure 5.7 – Duration of Installation by Ascending Order



The reduction of V1 to V2 average speeds by duration of sign installation is shown in Figure 5.8. Whilst Figure 5.8 shows a spread of results of reduction in average speeds, the linear trend line provides an indication of a slight increase in the reduction average speeds reducing over time.

Figure 5.8 – Reduction of Average Speed by Duration of Installation



The percentage of vehicles over the speed limit at both the V1 and V2 by duration of sign installation is shown in Figure 5.9.

Figure 5.9 – Percentage of Vehicles Speeding by Duration of Installation

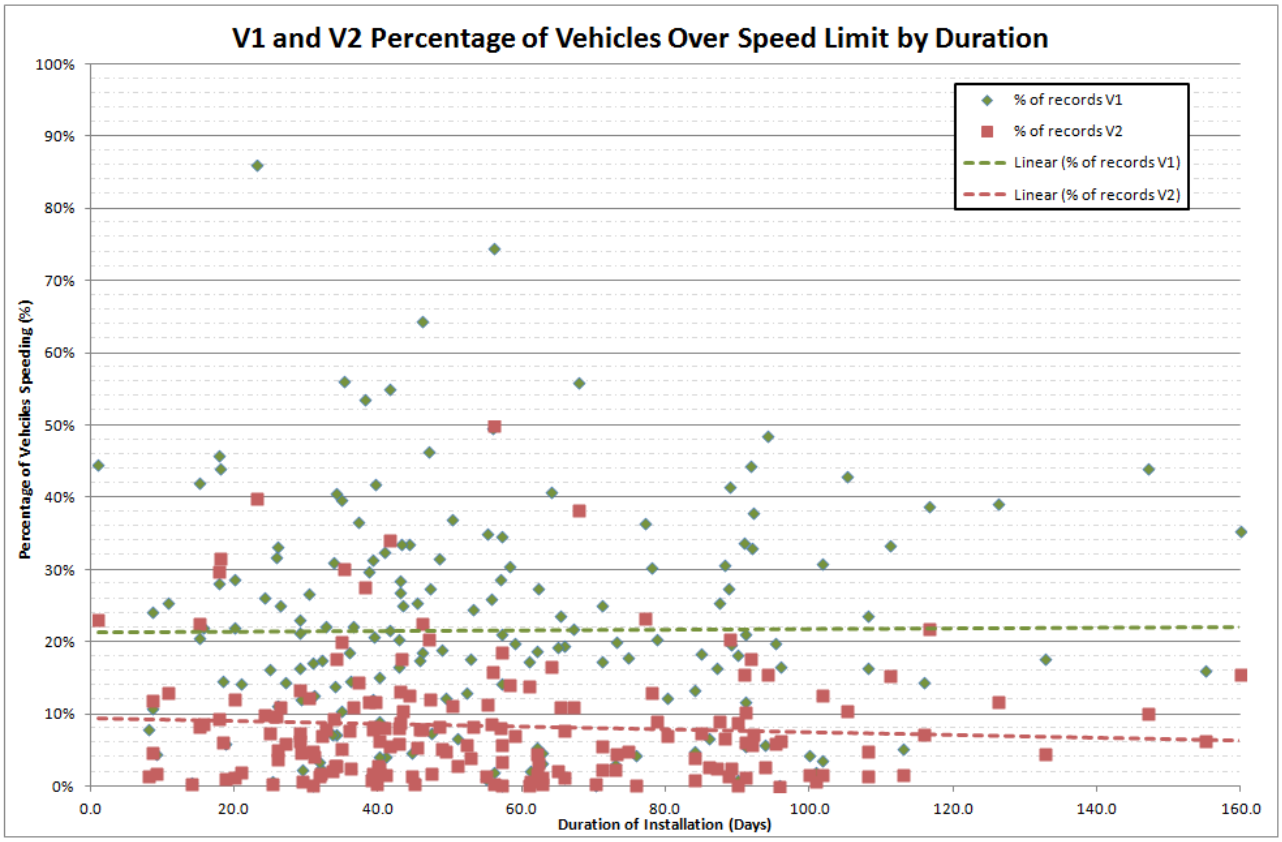
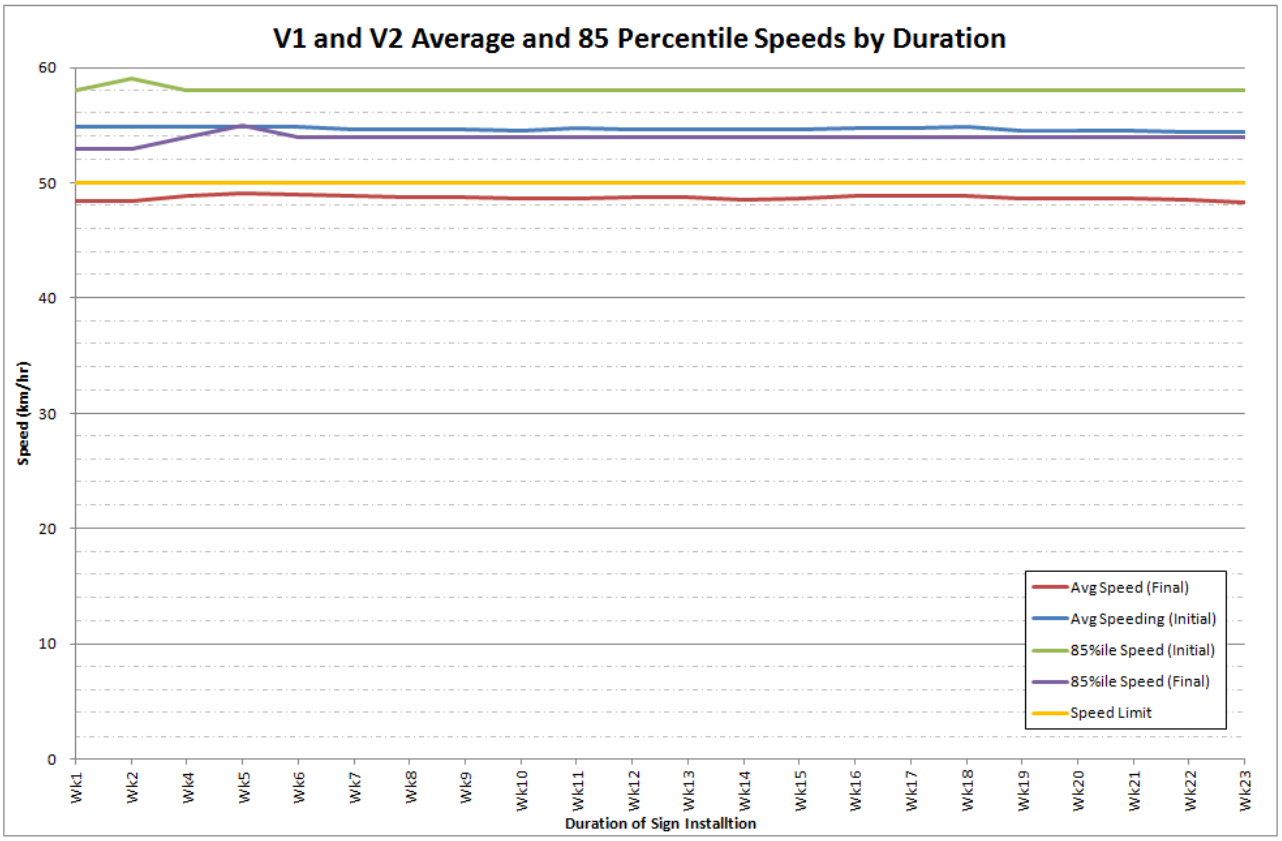


Figure 5.9 shows a spread of results for both the entering and exiting records. Whilst the linear trend line for the V1 records percentage of speeding shows a constant trend over duration of sign installation, the percentage of speeding for V2 records shows a slight decrease over duration of sign installation.

The two sites with the longest durations of installation have been assessed in more detail to further understand the results over longer durations of installation.

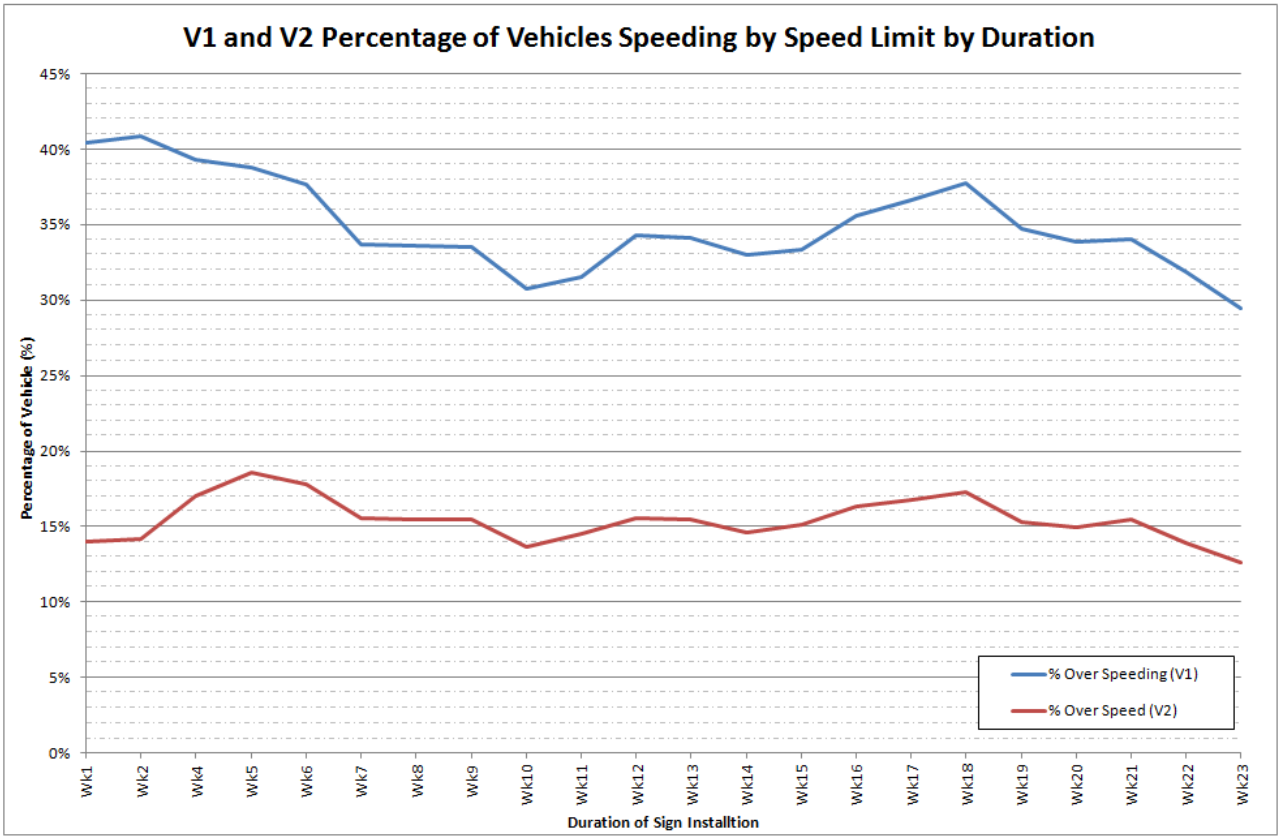
Site 1 is a street with a district hierarchy with a 50km/hr speed limit and non-school zone. It was installed for 160 days or 23 weeks and 6 days and had nearly 500,000 records pass it. Figure 5.10 shows average speed and 85th percentile speed for V1 and V2 week by week. The data shows fairly constant results week by week with both average speed and 85th percentile speed approximately 2km/hr less at week 23 compared to week 1.

Figure 5.10 – Site 1 Week by Week Vehicle Average and Percentile Speeds



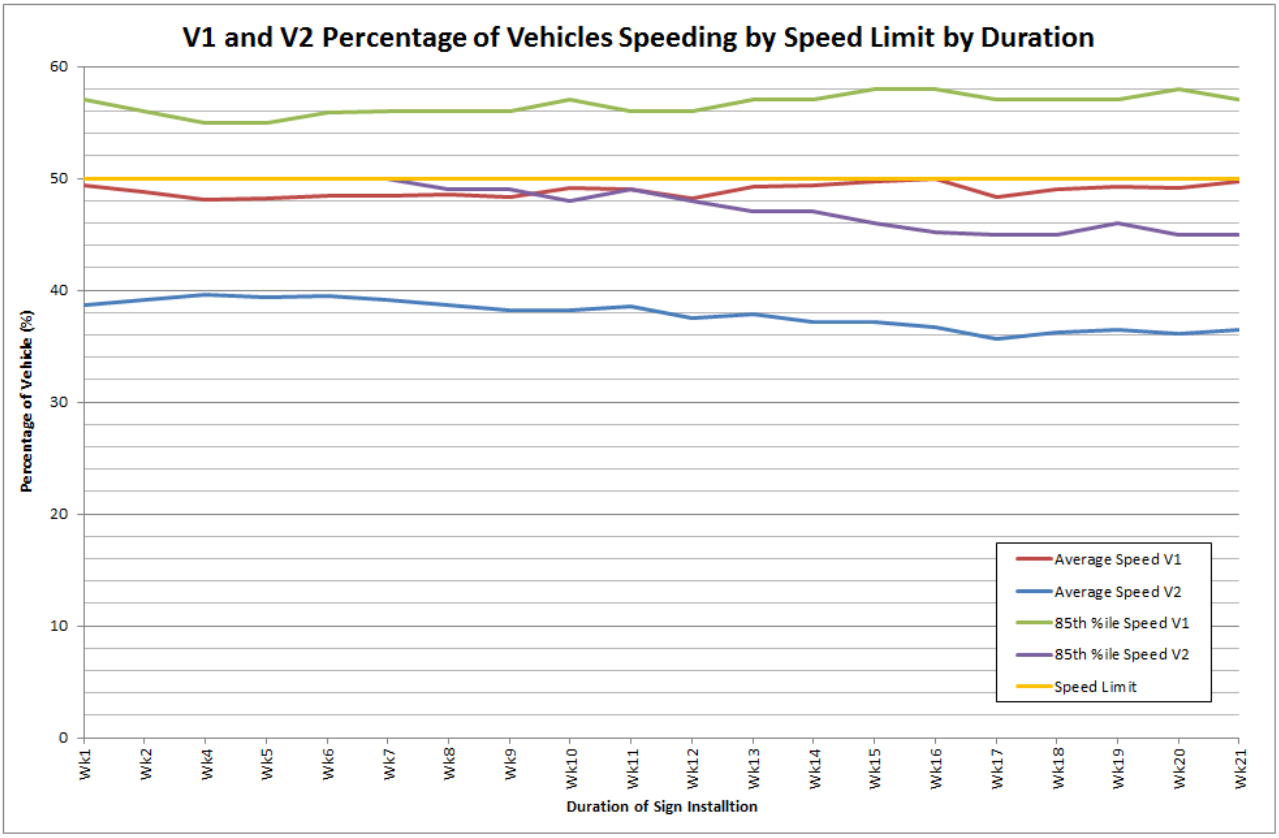
A week by week comparison of percentage of vehicles over the speed limit for both V1 and V2 records is shown in Figure 5.11. Figure 5.11 shows a reduction of slightly more than 10% of vehicles speeding for V1 speeds between week 23 and week 1 with only 1.5% reduction for V2 speeds. This data suggests that motorists are learning the speed limit of the street prior to the sign not just once seeing the sign, and/or changing their driving behaviour.

Figure 5.11 – Site 1 Week by Week Percentage of Vehicles Speeding



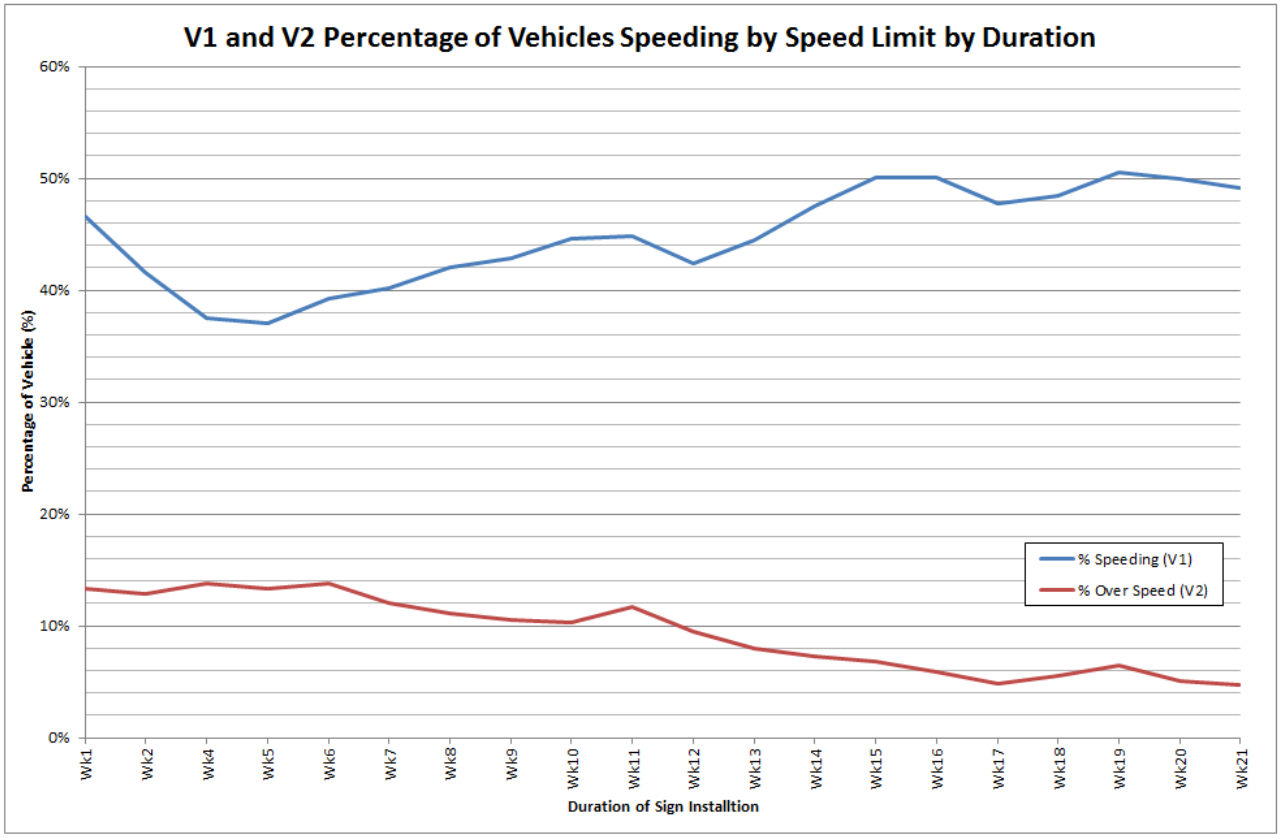
Site 2 is a street with a neighbourhood hierarchy with a 50km/hr speed limit and non-school zone. It was installed for 147 days or 21 weeks and had just over 100,000 records pass it. Figure 5.12 shows both V1 and V2 for the average speed and 85th percentile speed week by week. The data in Figure 5.12 shows fairly constant results week by week for V1 speeds but a reduction for V2 speeds in particular the 85th percentile speed of 5km/hr.

Figure 5.12 – Site 2 Week by Week Vehicle Average and Percentile Speeds



A week by week comparison of percentage of vehicles over the speed limit for both V1 and V2 records is shown in Figure 5.13. Figure 5.13 shows a slight increase for V1 speeds between week 23 and week 1 but an 8.7% reduction of V2 speeds. This data suggests that motorists are reacting better to the messaging of the sign, and/or changing their driving behaviour.

Figure 5.13 – Site 2 Week by Week Percentage of Vehicles Speeding



Conclusions

Brisbane City Council proactive approach of installing 26 portable speed warning signs has reduced vehicle speeds by an average of 5.2km/hr for all vehicles and 9.5km/hr for vehicles travelling above the speed limit at V1. The visual reminder has delivered a significant reduction in motorists travelling above the speed limit from 22.1% of 25.1Million vehicles to 8.7%.

The data from each site no matter what speed limit, road hierarchy, or school or non-school zone has shown a marked decrease in the number of motorists travelling over the speed limit as a consequence of being advised of their entering speed.

The analysis has shown the three primary conclusions as follows:

1. Effective in reducing speeds which increases the compliance of vehicles over the speed limit,
2. Effective at reducing speeds and increasing the number vehicles adhering to the speed limit for all types of sites no matter their road hierarchy, speed limit or if a school zone, and
3. Continual effectiveness of reducing speeds and percentage speeding whilst in place for at least 23 weeks.

Lessons Learnt and Next Steps

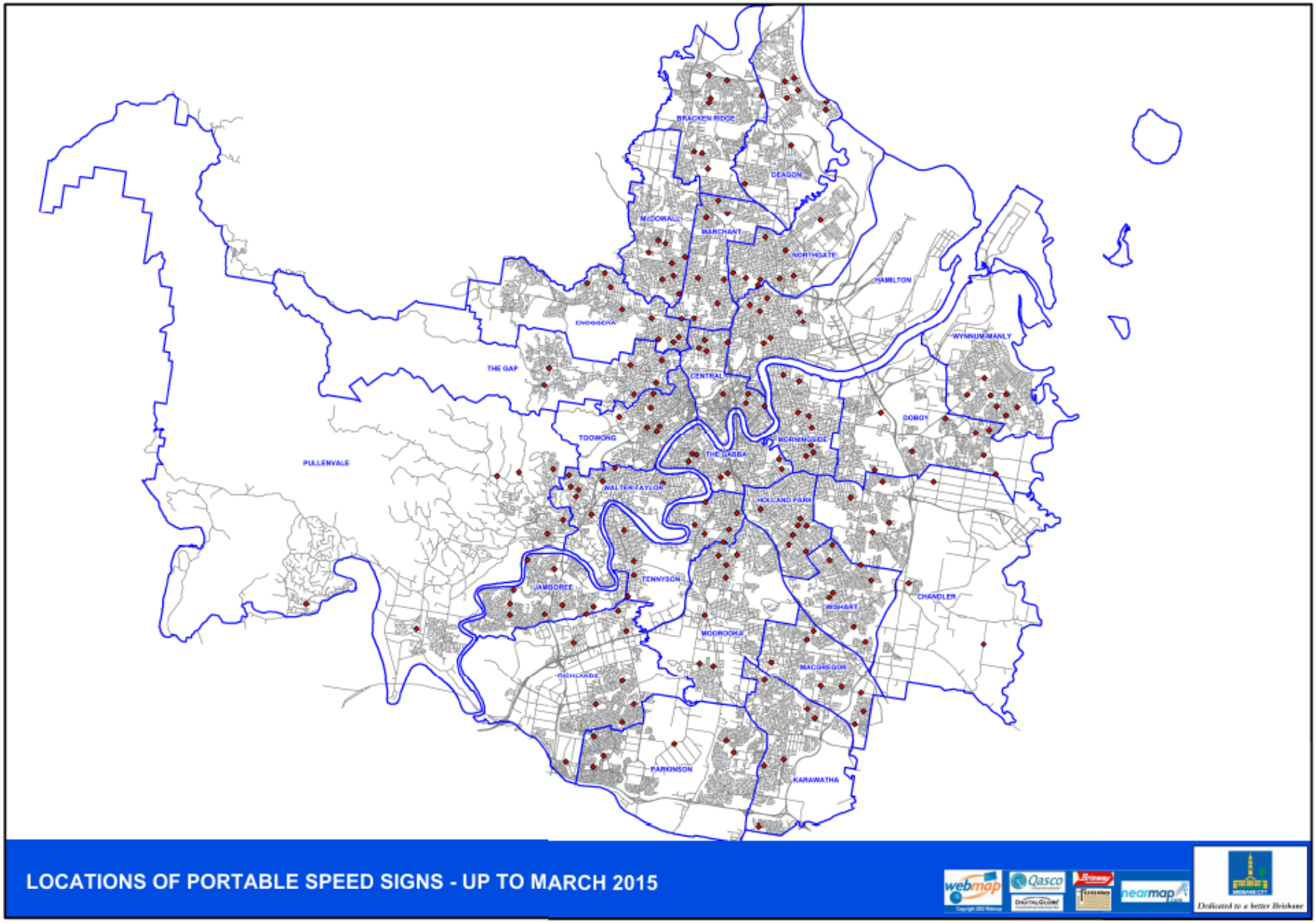
From managing the program over the last 17 months, the lessons learnt are broken down in three main areas:

1. Site assessment;
    - ensure adequate sight distance to read the sign,
    - ensure adequate sunlight for all months of the year, that is, in winter the sun is lower on the horizon,
    - ensure adequate distance from the start of street or from major traffic inflow to ensure vehicles are able to travelling at or above the speed and not still accelerating.
2. Community Consultation;
    - early engagement with local residents on proposed sign location/s as some residents feel a sense of ownership for their street.
3. Data Analysis;
    - most sites will provide a reduction in speed, just amount and the percentage of vehicles over the speed limit will vary,
    - the raw data allows detailed statistical analysis which provides very valuable information. Setting up this analysis can be quite time consuming so the process should be as automated as possible.

In terms of the next steps for the program the following are proposed:

- continued data analysis to determine most effective use of signs,
- potential alternative to use the signs as a permanent local area traffic management (LATM) device where speeding is the issue,
- provision of data to the Queensland Police Service.

Appendix A – Sites of Portable Speed Warning Signs within Brisbane City Council



Appendix B – Reduction of Average Speed for Vehicle Over the Speed Limit

Figure B.1 – Reduction of Average Speed by Volume

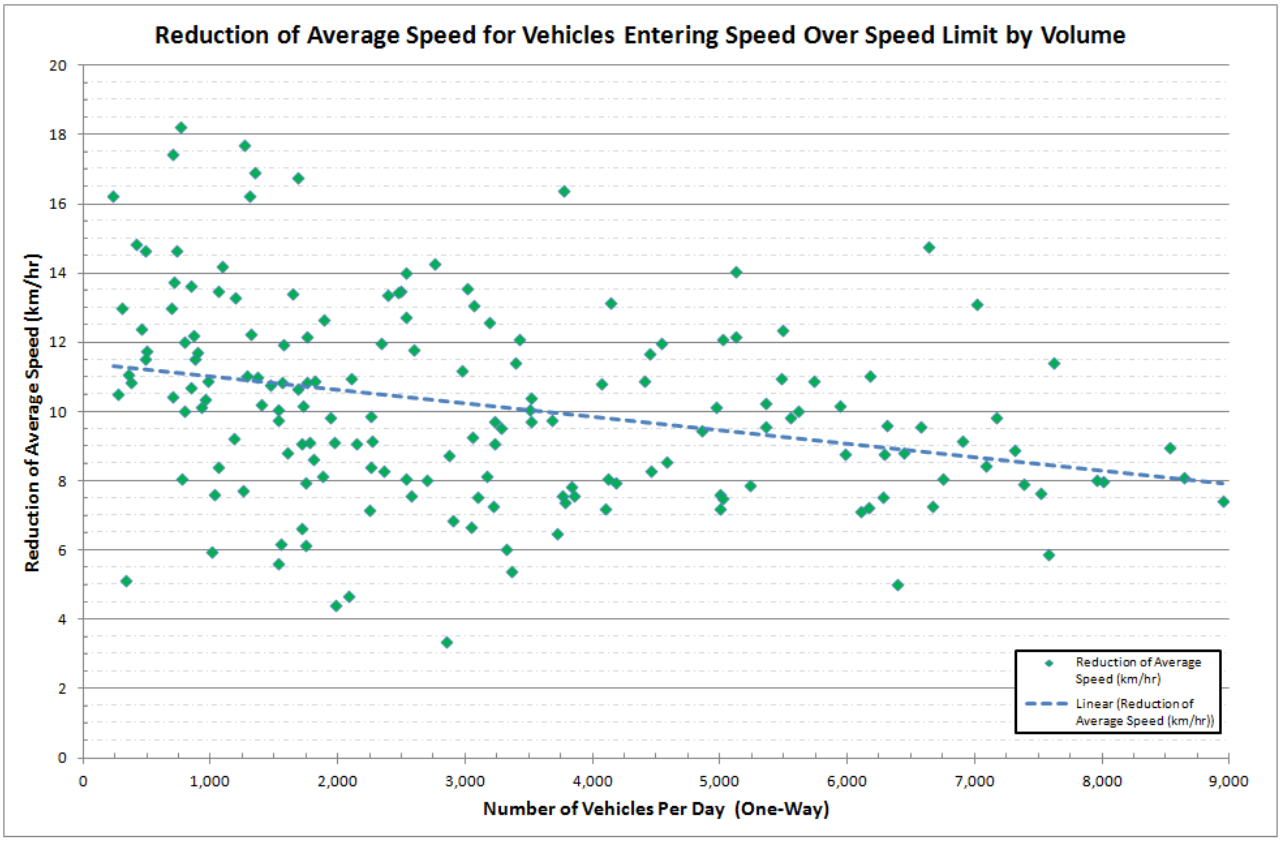


Figure B.2 – Reduction of Average Speed by Road Hierarchy

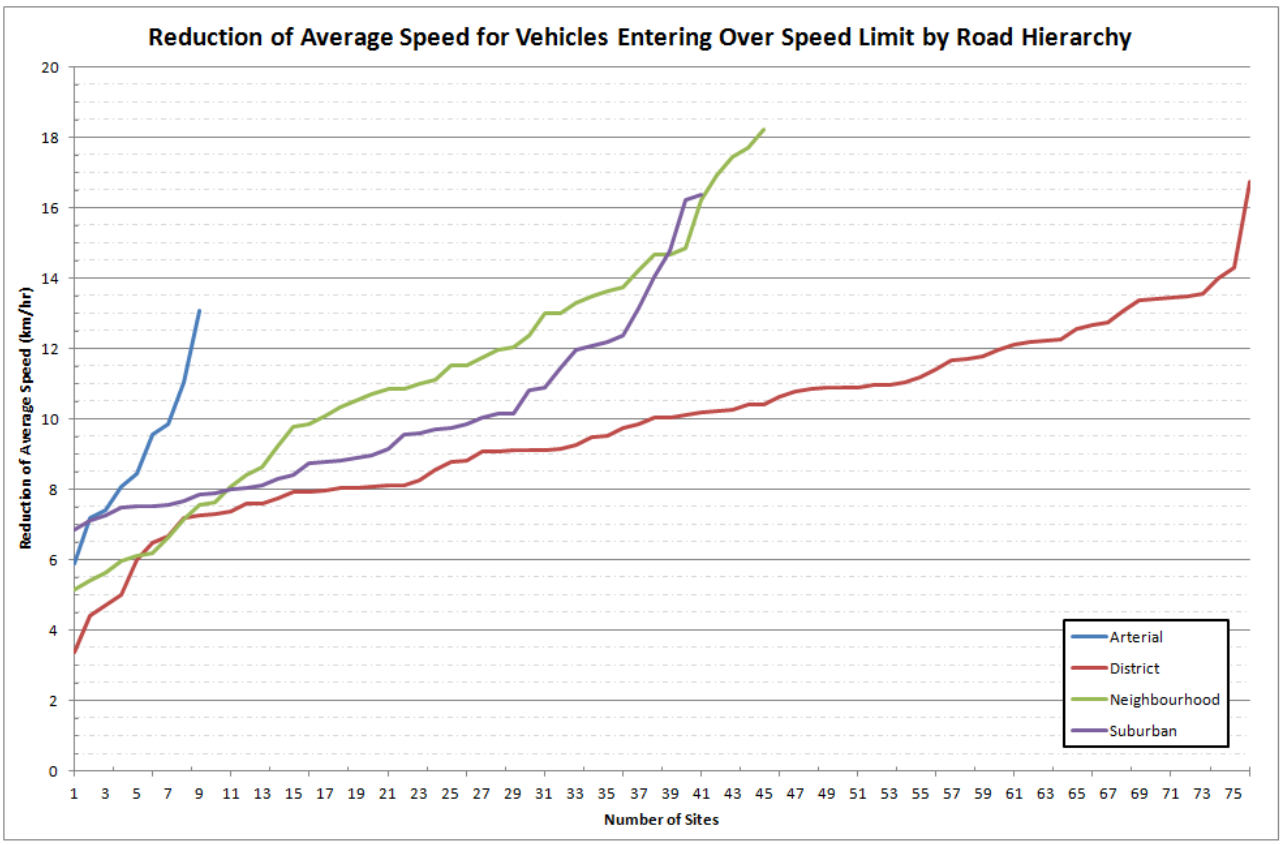
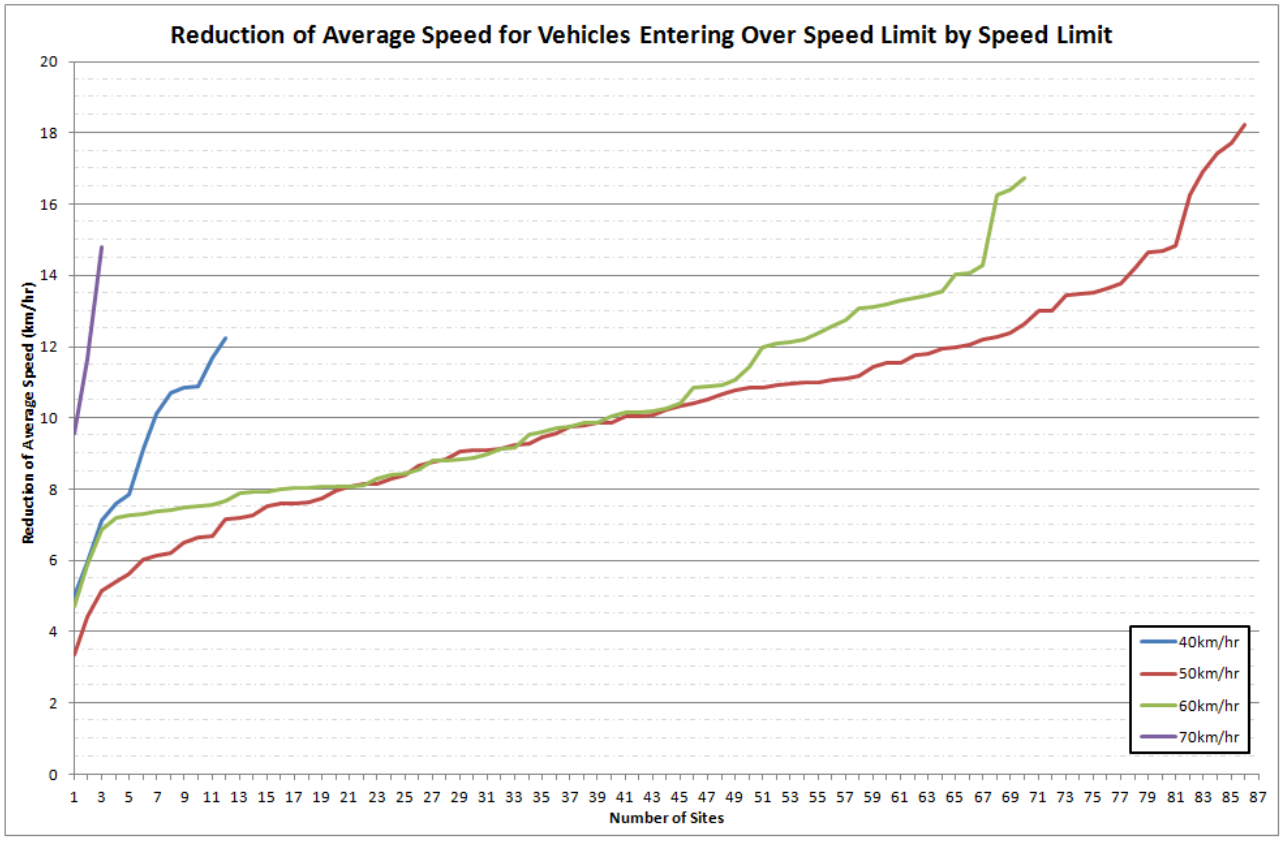


Figure B.3 – Reduction of Average Speed by Speed Limit



Appendix C – Percentage of Vehicles Speeding

Figure C.1 – Percentage of Vehicles Speeding by Volume

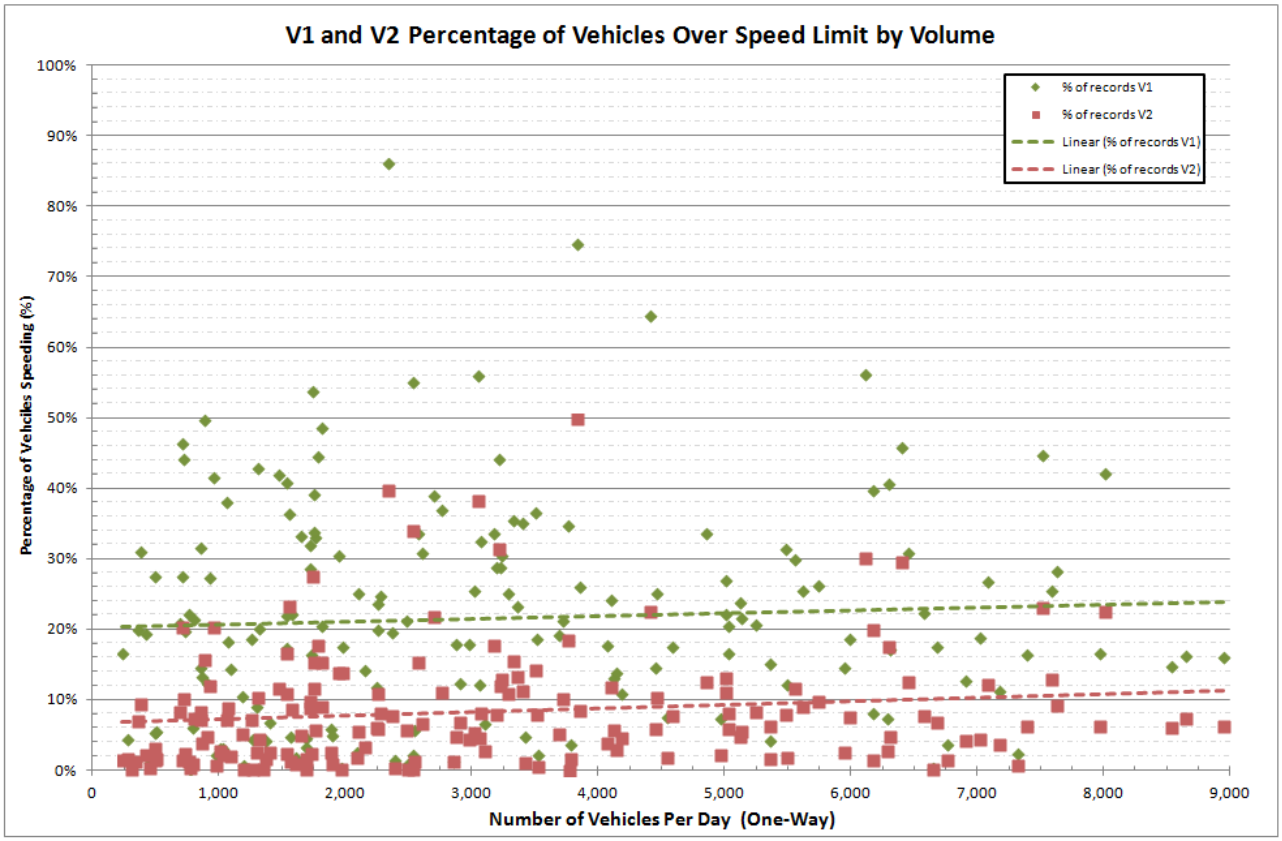


Figure C.2 – Percentage of Vehicles Speeding by Road Hierarchy

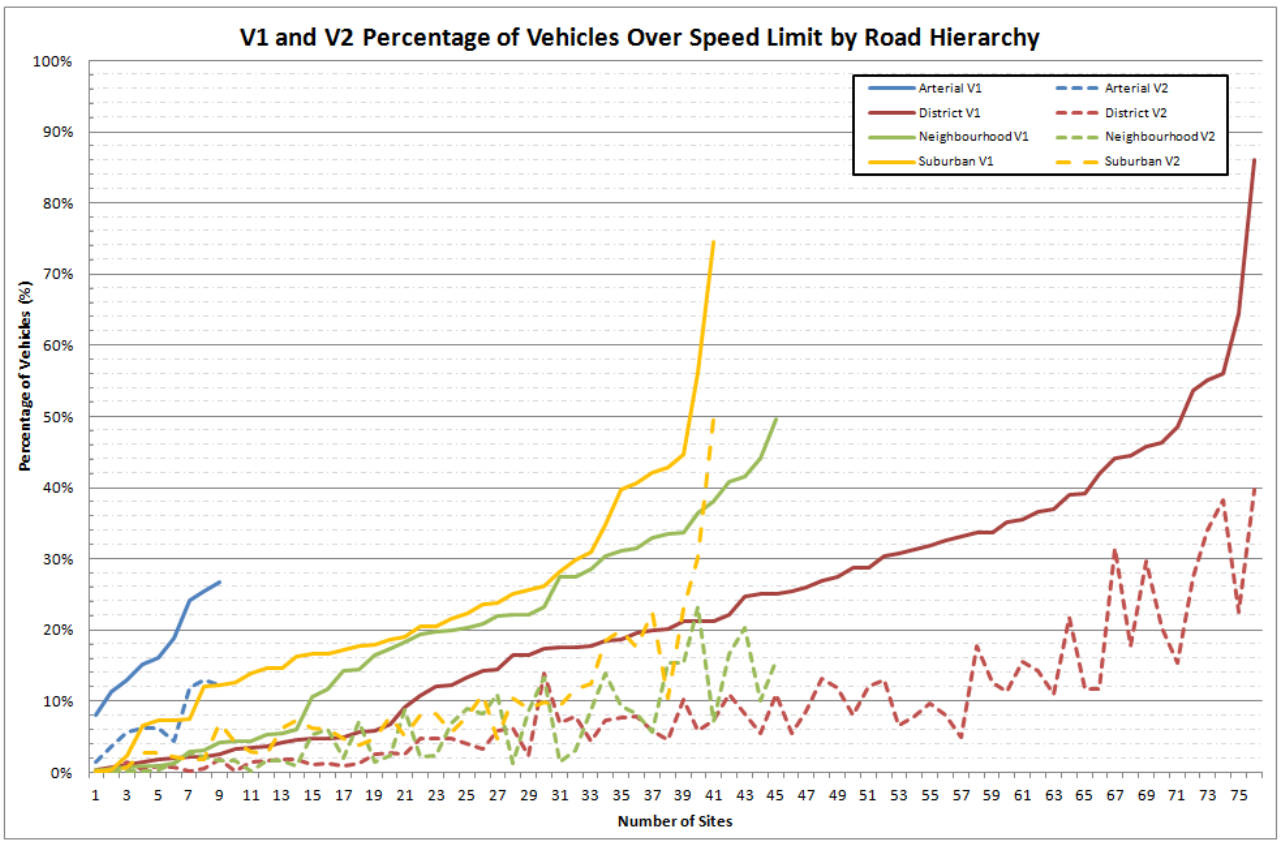
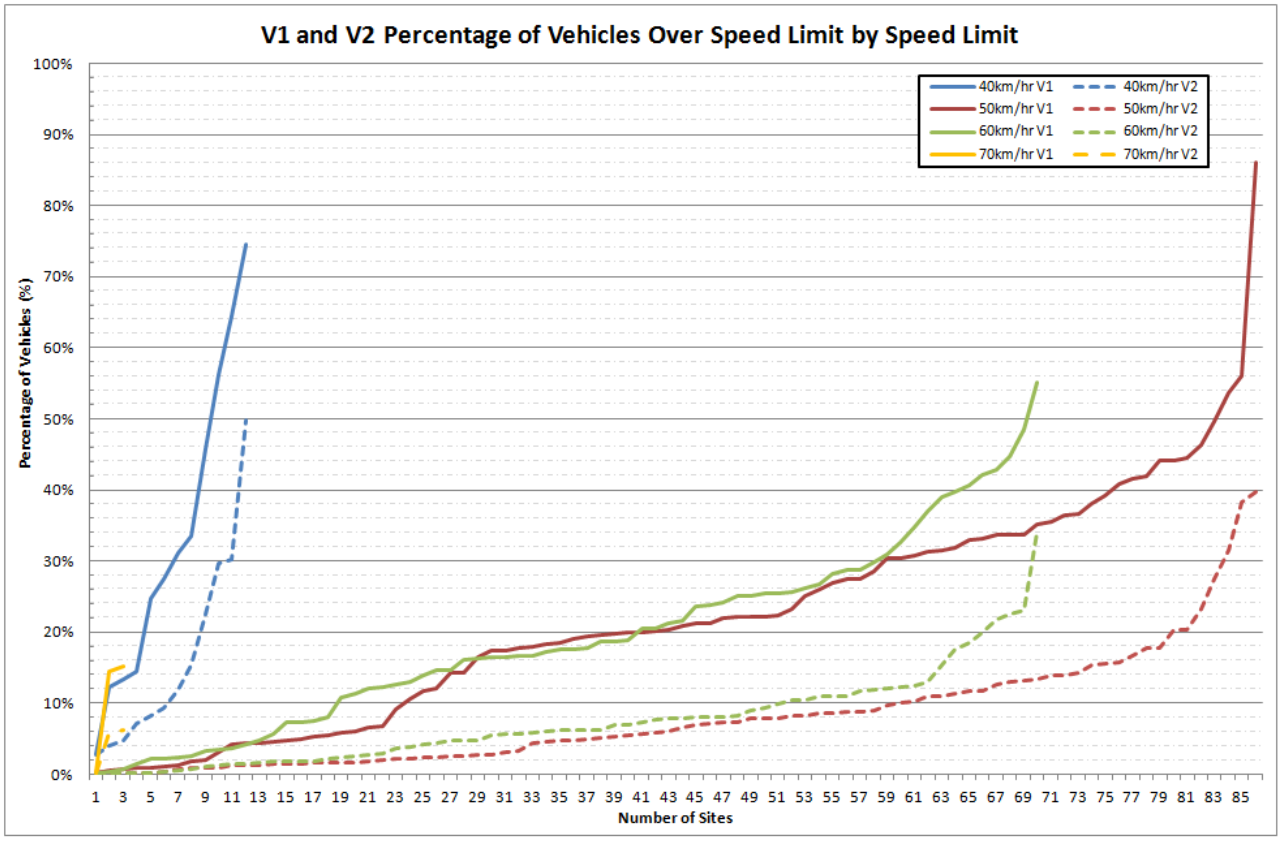


Figure C.3 – Percentage of Vehicles Speeding by Speed Limit



Appendix D – Figures of Results for School Zone Sites

Figure D.1 – Reduction of Average Speed During School Times

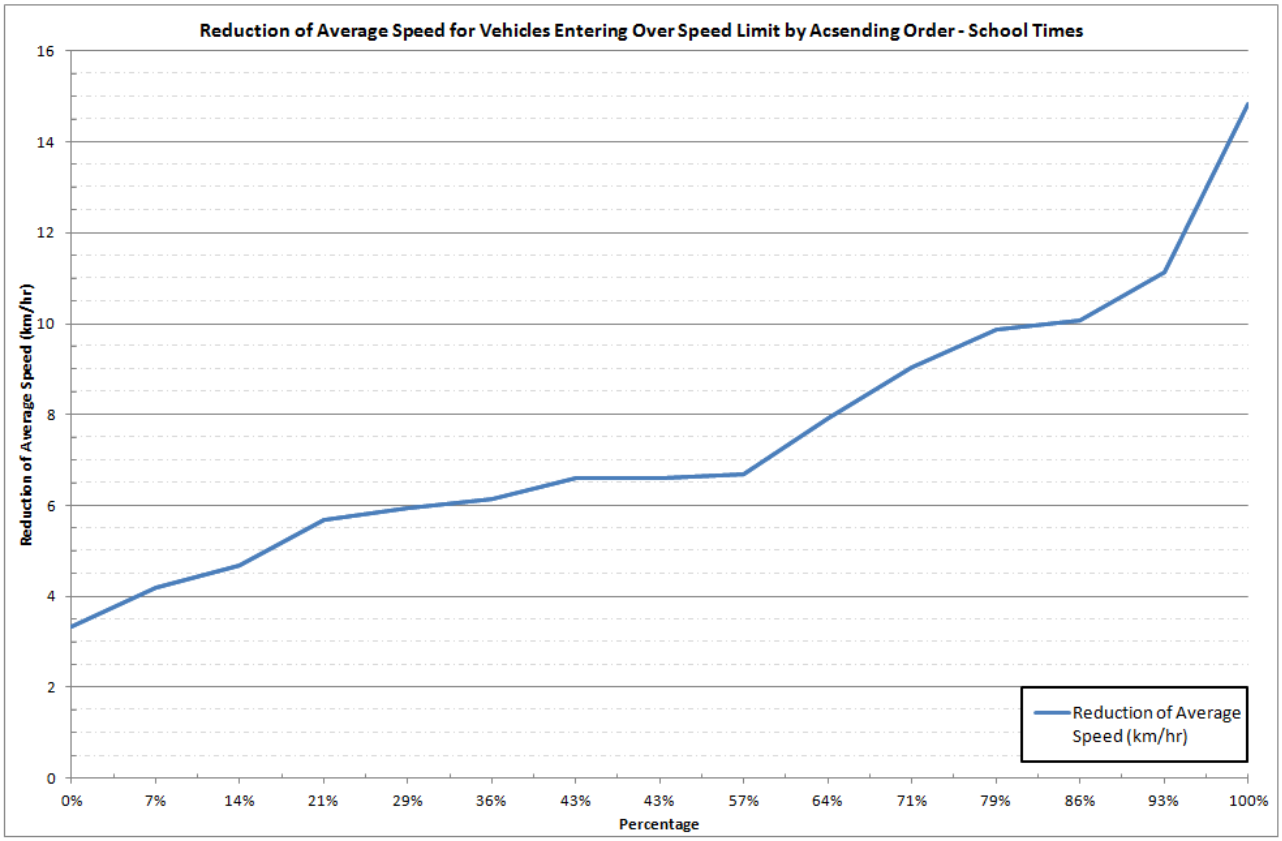


Figure D.2 – Reduction of Average Speed by Volume During School Times

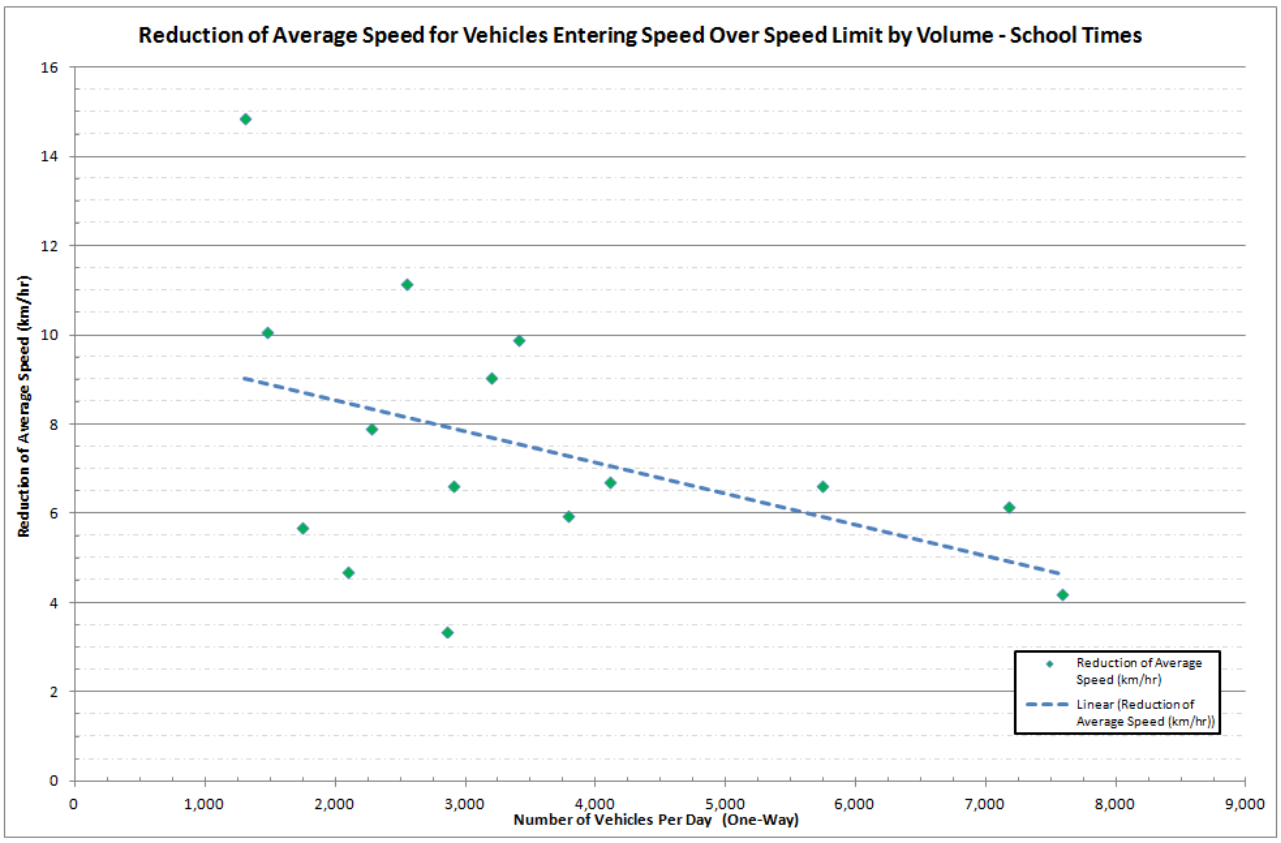


Figure D.3 – Reduction of Average Speed by Road Hierarchy During School Times

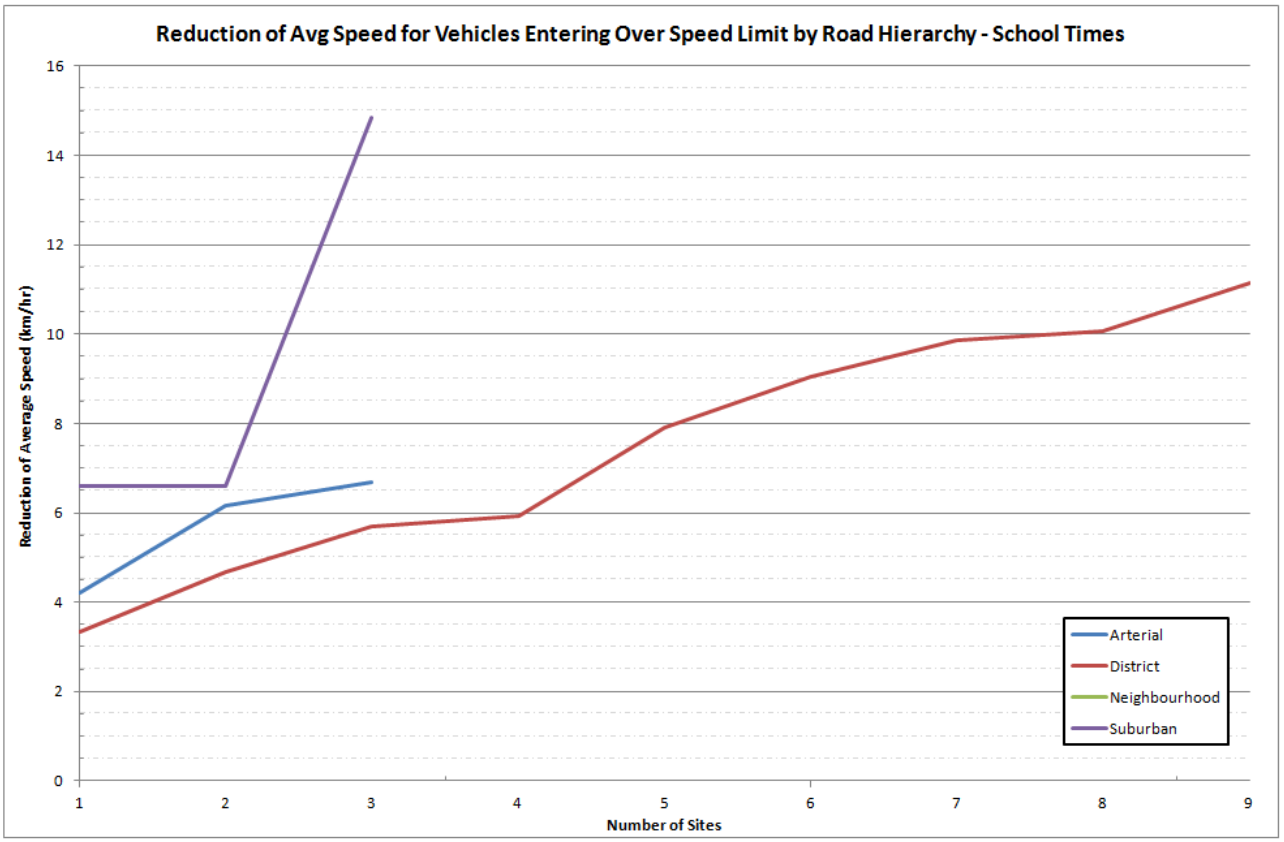


Figure D.4 – Reduction of Average Speed by Speed Limit During School Times

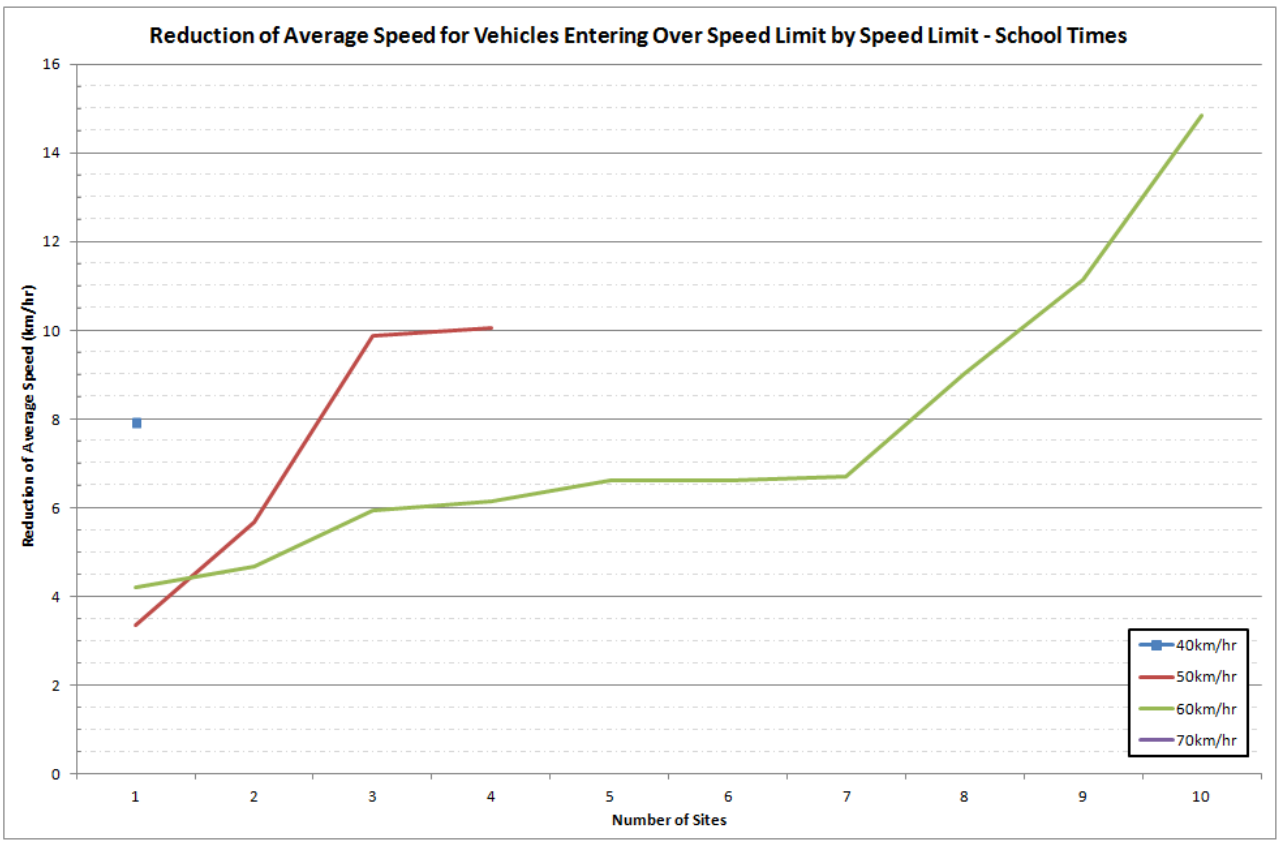


Figure D.5 – Comparison of Average Speeds for V1 & V2 by Speed Limit