ON ROAD TEST
EVALUATION OF IMPACT OF WET NIGHT MARKINGS ON
DRIVER BEHAVIOUR AND ACCIDENTS

RAINVISION

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APPENDICES

EXECUTIVE SUMMARY

This element of the Rainvision Project sought to evaluate the impact of wet night markings upon road locations known to have accident histories linked to visibility and driver speed.

The following approach was implimented in order to achieve these aims:

- Collate historic data regarding accident levels at site for one climatic cycle, (12 months).
- Install wet night material markings as well as covert speed detection units at all allocated sites.
- Collect speed and accident data for a further climatic cycle, through management of speed detection equipment.
- Analyse and evaluate the data sets (speed and accidents) collated for sites identified to fall within the parameters of the objectives.
- Formulate conclusions regarding the likely affect of installing wet night markings has upon driver speed and accident rates.

This report, completed November 2014, provides illustrations of the changes in driving patterns (relevant to speed and accidents) throughout the testing period of one climatic cycle during the year prior to and following installations of wet night markings.

Outcomes presented by the report identified that:

Generally, speed differences between the sites, although small in absolute terms, tend to suggest that there have been decreases in speed between the start and finish dates of the test period. At the same time the increase in recorded road vehicle incidents identified during the investigation period, could not be directly associated to causes relating to performance of road markings.

More specifically, results indicated that enhanced retro-reflective road markings installed for this stage of the project did not lead to higher vehicle speeds, as potentially anticipated. On the contrary, speed decreases of about 2mph on average across all sites were observed when controlled for weather conditions. Based on this relationship, it is considered more than fair to conclude that decreased speed is linked with lower accident risk - amongst other accident influencing, extenuating factors, such as weather, complexity of road layout, traffic density.

PROPOSAL

This element of the RAINVISION project seeks to evaluate the impact wet night road markings have on driver behaviour when located at sites known to have a history for above average accident statistics linked to visibility and driver speed.

Description of the works

WP4 is to be led by RSMA, working in liaison with highways and enforcement authorities, to identify road locations. Sections of roads incorporating junctions and bends will be prioritized across two highways authority areas to provide a total of 20 assessment locations in order to provide a robust statistical base for analysis.

The 20 sites identified will be split into two sets of 10 locations; following the collection of baseline speed data road marking materials with two different levels of wet night performance will be installed, one type at each set of locations. Accident and driver speed data will then be collected over a full climatic cycle, before a detailed analysis is undertaken in order to evaluate the impact of the enhanced markings on accident levels and driver behaviour in terms of speeding.

A driver interaction campaign will be undertaken within each highway authority area to evaluate a range of responses from drivers in relation to the impact of the markings.

WP4 will involve the following stages of implementation:

STAGE 1 SITE IDENTIFICATION AND INITIAL DATA COLLECTION

Identification of high risk sites suitable for application of high performance materials

i. Initial data collation of accident statistics over the 12 months prior to commencement of DFS data collection.

ii. Establishment of baseline driver speed data on all selected sites with up to 6 weeks data collected from each site.

STAGE 2 ON ROAD TEST

i. Installation of high performance wet night visibility products to all identified sites.

   10 sites with Wet Night Visibility Performance product
   10 sites with Enhanced Wet Night Visibility Performance product

ii. Discrete monitoring of driver speed on each site over the duration of the climatic cycle (10 mobile cameras for 20 sites)

iii. Collation of accident statistics for period of one climatic cycle following initial installation

iv. Diver interaction programme via internet and regional radio

STAGE 3 DETAILED STATISTICAL ANALYSIS OF SPEED AND ACCIDENT DATA

i. Analysis of available speed data per site and across all sites

ii. Analysis of available accident data per site and across all sites

iii. Preparation and submission of On Road Test Report

STAGE 4 CONCLUSIONS

STAGE 1

RSMA approached a number of local authorities with the proposal for inclusion in the Rainvision project, requesting that suitable sites be found. Two responses expressed significant interest in participating, Durham County Council and Derbyshire County Council.

Durham County Council undertook an assessment of accident statistics for the county for the 12 months preceding the request period. All incidents recorded, were mapped and areas with above average accident frequencies were deemed viable for inclusion in the project. All of these cluster sites were additionally inspected to determine the suitability for each site to be included within the normally scheduled maintenance programme. Additionally the sites were assessed and 10 final sites were determined to be valid for inclusion in the project. Meetings held between RSMA and Durham Council between April 2012 and May 2012, site visits undertaken in June 2012 by RSMA, Durham Council representatives from the Strategic Traffic Management Department and, finally, by both RSMA and Durham Council, finalised the exact locations at which the chosen method of speed assessment (speed cameras) would best obtain a valid result at each location culminating in a full requirement of 10 sites being identified. These were selected to represent a mixture of rural, semi-rural and urban roads. The site layouts including brief description are shown below and location plan is shown in Appendix 1. The site's individual accident report data come in three separate reports for each site for data collected between Jan 2007 – Dec 2011, Jan – Dec 2012 and Jan – Dec 2013, which can be seen in Appendix 2. The location of the camera post at each site, together with traffic movements monitored is shown in Appendix 3.

Site No. **1 - Craghead**

Postcode DH9 6DY
Address B6313 Craghead Lane, 1 mile east of Craghead.
Description: Rural site, 60mph speed limit. Slight downhill west to east.

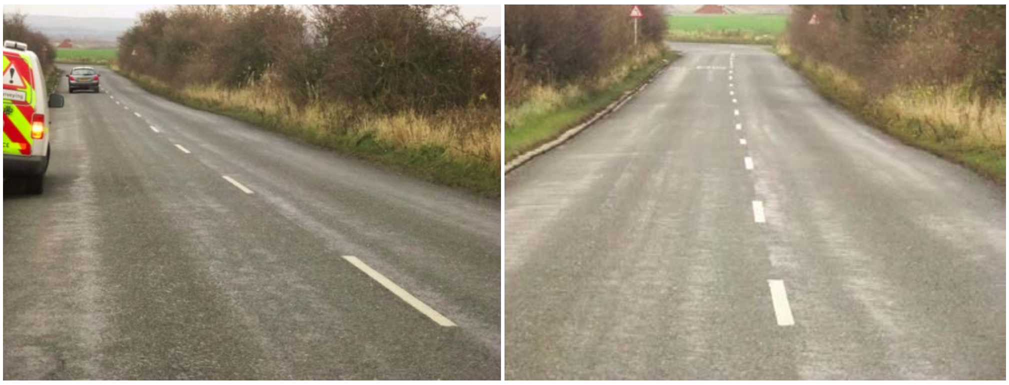
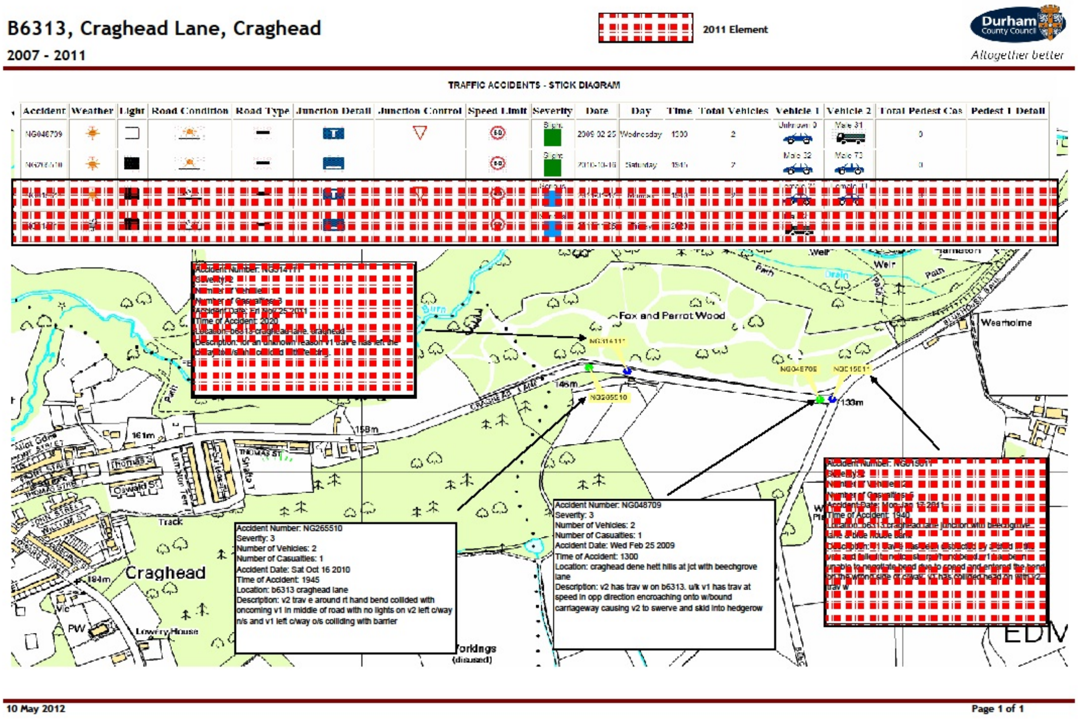


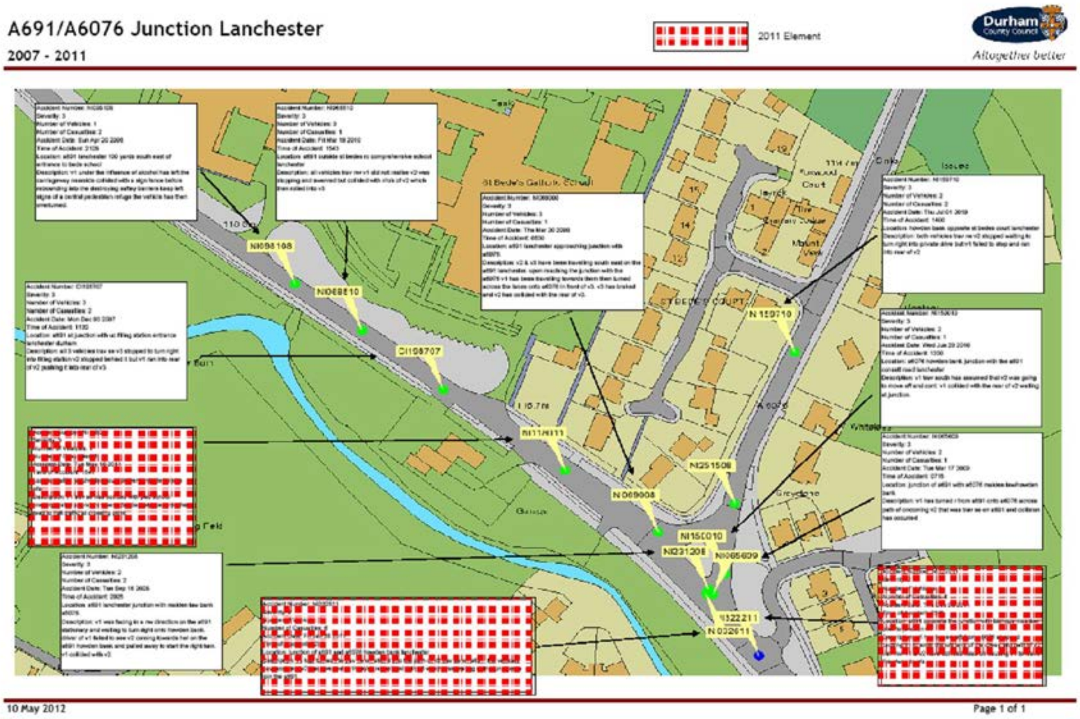
Figure 1: Site 1 Craghead



Site No. **2 - Lanchester**

Postcode DH7 0RB
Address B6076 Howden Bank, Lanchester, 200m north of junction with A691.
Description: Semi-rural site,30mph speed limit, with gentle slope north to south.

Figure 2: Site 2 Lanchester



Site No. **3 – Yoden Way, Peterlee**

Postcode SR8 5SD

Address B1320 Yoden Way, Peterlee, just east of junction with Manor Way.

Description Urban site, 30mph speed limit, with gentle downhill slope north to south, adjacent to school.

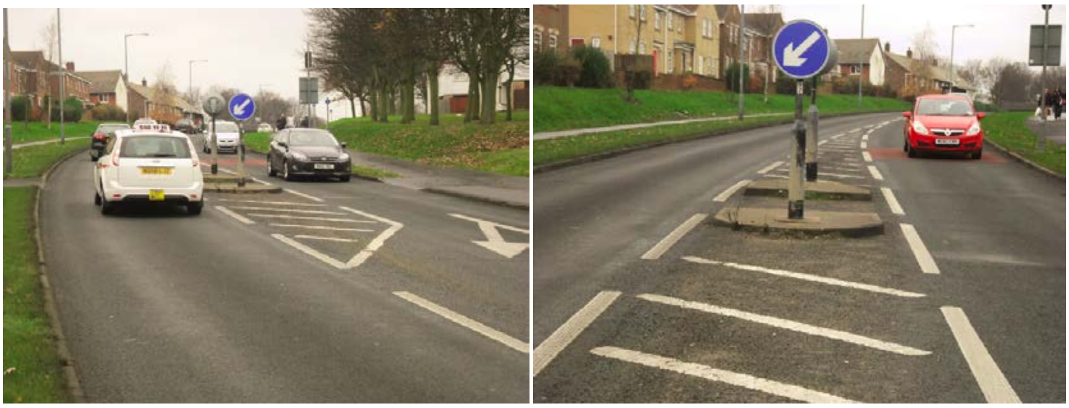
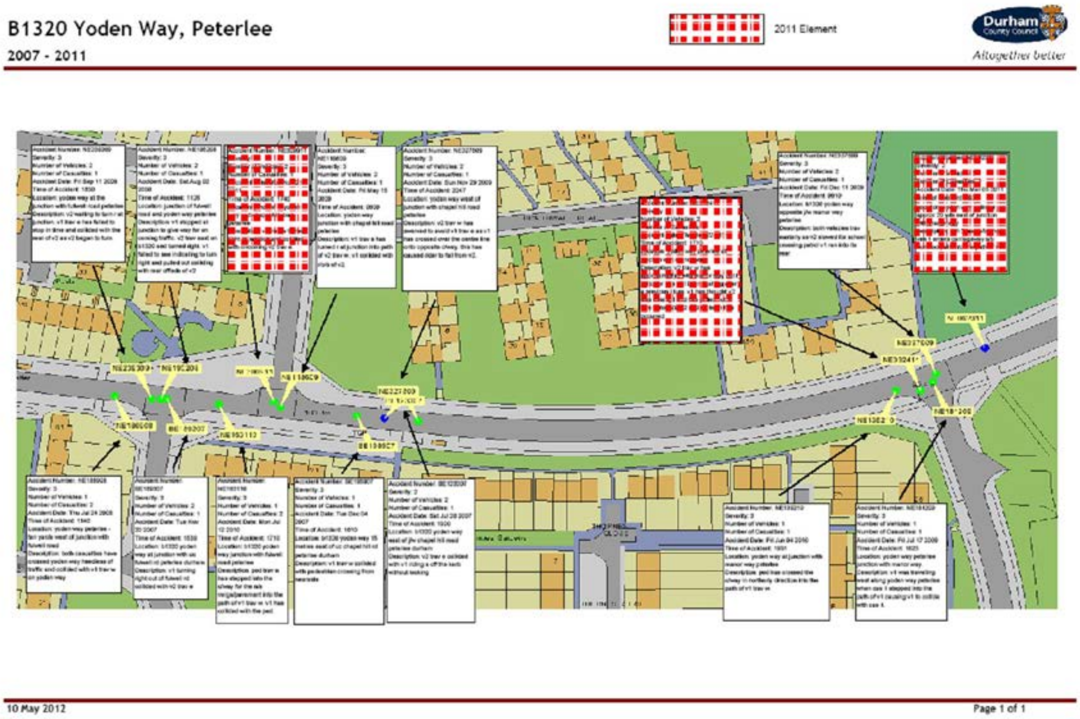


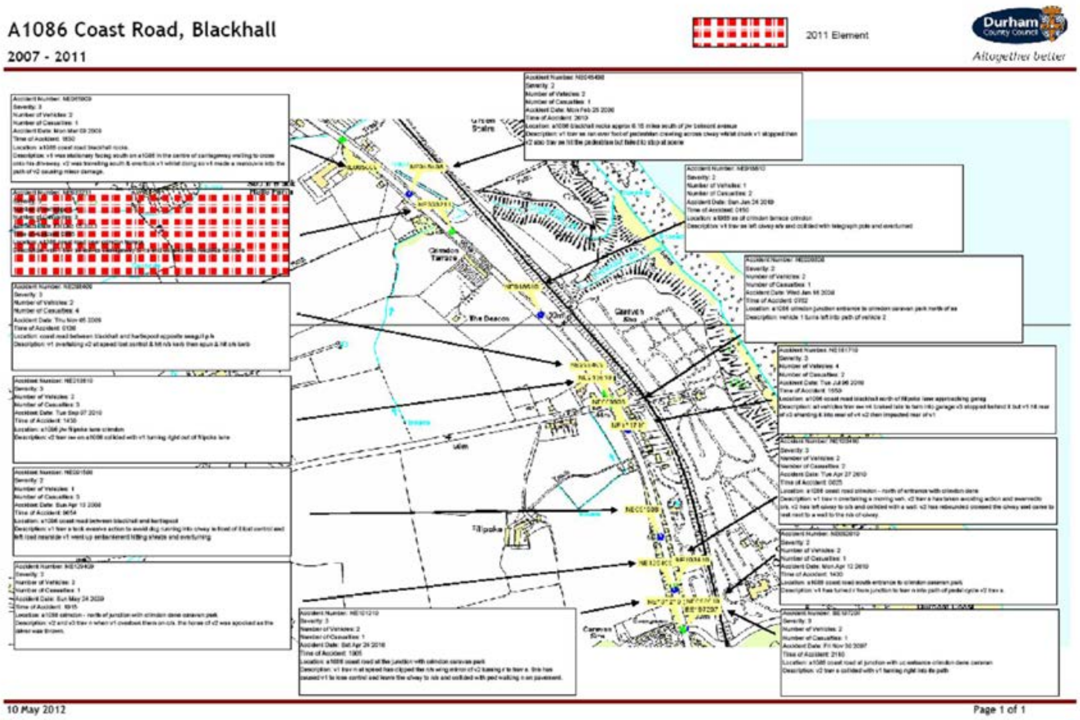
Figure 3: Site 3 Yoden Way, Peterlee



Site No. 4 – Coast Road, Blackhall

Postcode TS27 4BG
Address A1086 Blackhall Colliery, just north of entrance to Crimdon Dene beach.
Description: Semi rural site, 60mph speed limit, sloping north to south.

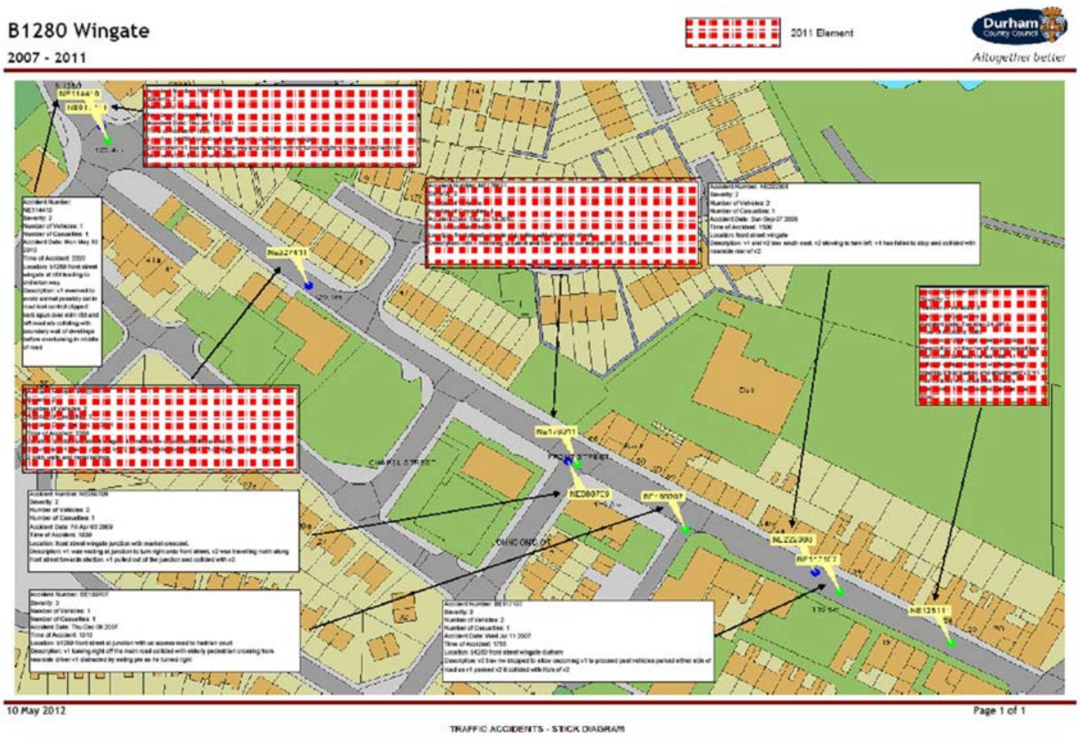
Figure 4: Site 4 Coast Road, Blackhall



Site No. **5 - Wingate**

Postcode TS28 5PZ
Address B1280 Front Street, Wingate, outside The Health Centre.
Description: Urban site, speed limit 30mph, fairly level site.

Figure 5: Site 5 Wingate



Site No. **6 – Cock 'o' the North**

Postcode DH1 3SX

Address A167 Darlington Road, ½ mile north of junction with A177.

Description Rural site, 60mph speed limit dual carriageway therefore camera only one direction, proximity of a roundabout.

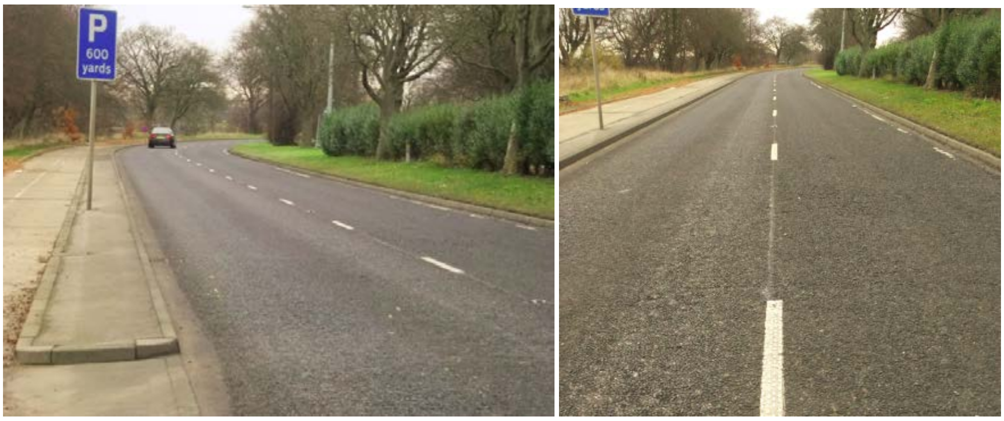
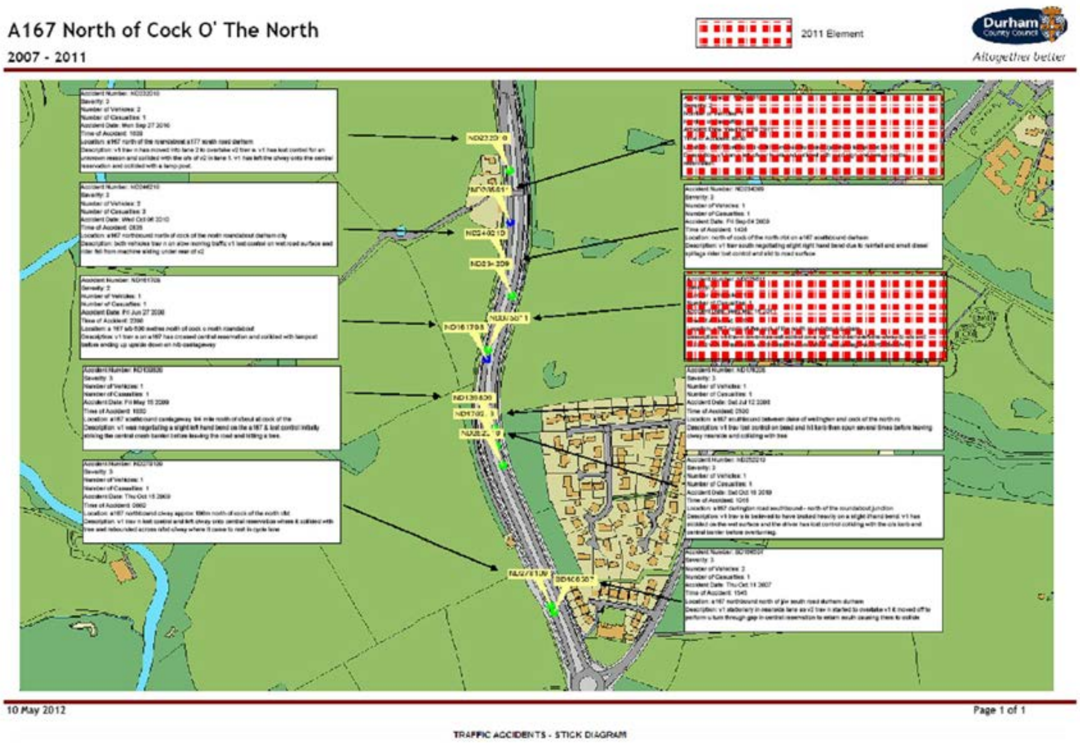


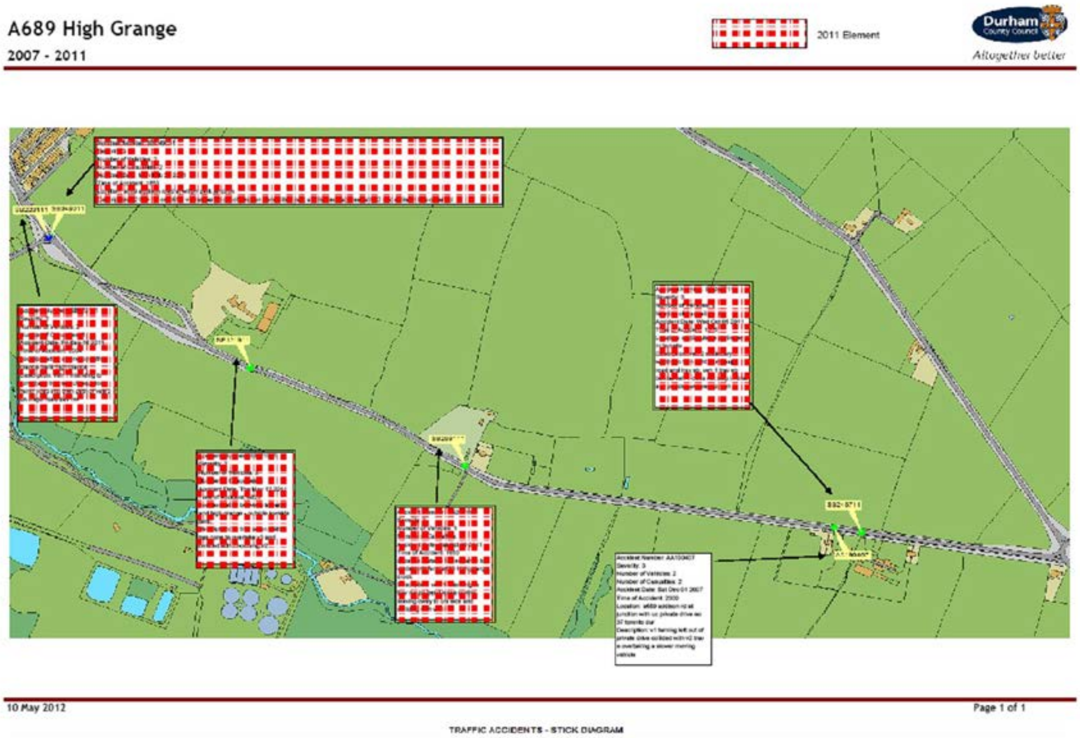
Figure 6: Site 6 Cock 'o ' the North



Site No. **7 - High Grange**

Postcode DL15 8AT
Address A689 Addison Road (nr Bishop Auckland), ½ mile north of junction with B6286.
Description Rural site, fairly level, speed limit 60mph.

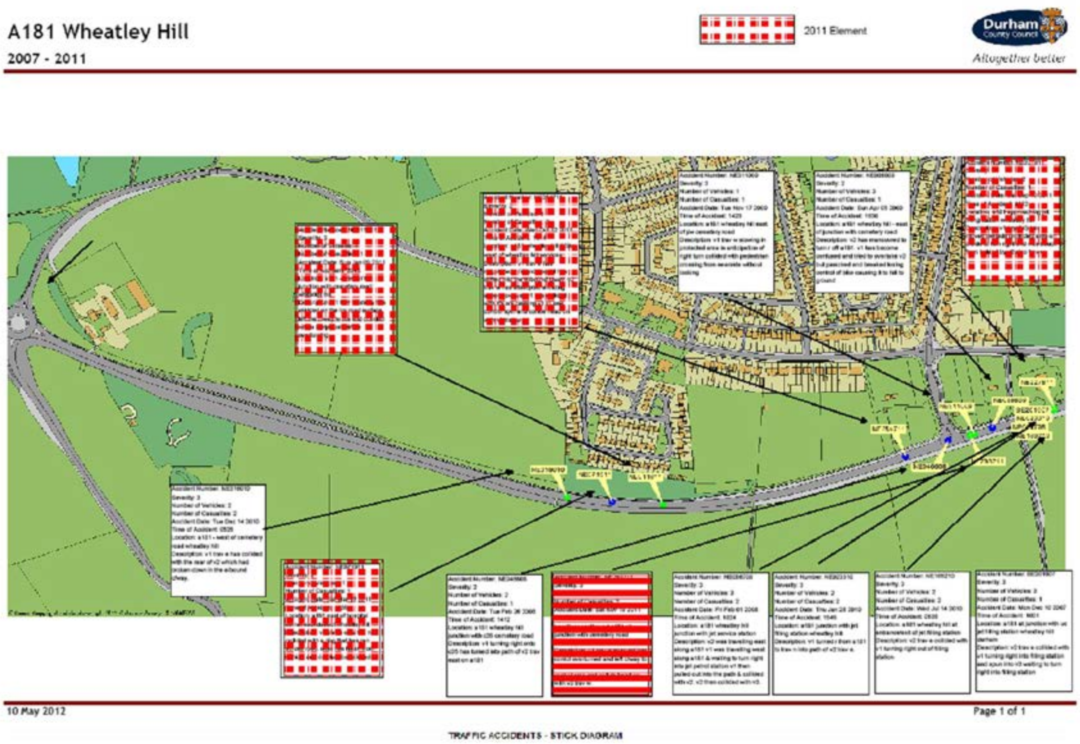
Figure 7: Site 7 High Grange



Site No. **8 - Wheatley Hill**

Postcode DH6 3LX
Address A181 Wheatley Hill (near Jet garage), on north corner of lane to Wingate Farm.
Description Rural site, fairly level, speed limit 60mph.

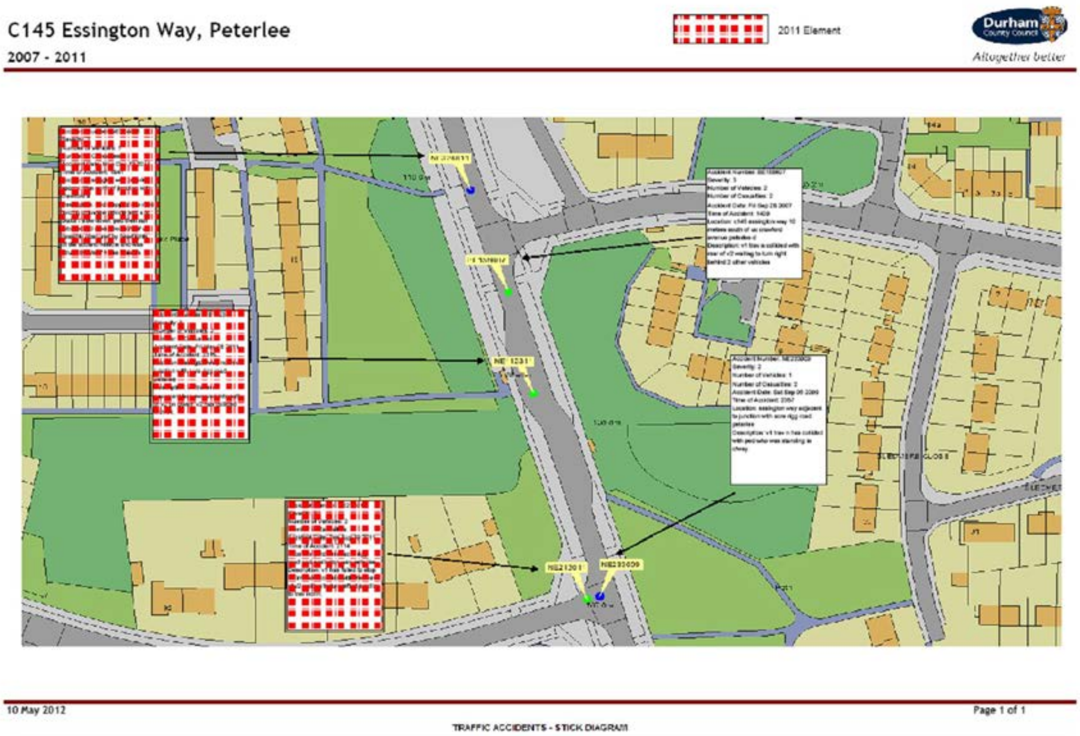
Figure 8: Site 8 Wheatley Hill



Site No. **9 – Essington Way**

Postcode SR8 5JT
Address Essington Way Peterlee, south of junction with Crawford Ave.
Description Urban site, speed limit 30mph, proximity of bus stops on both sides of road.

Figure 9: Site 9 Essington Way



Site No. **10 – Quarrington Hill**

Postcode DH6 4RT
Address B6291 Quarrington Hill 20m south of amenity tip entrance.
Description Fairly sloping site NE to SW, speed limit 60mph, proximity to amenity waste site.

Figure 10: Site 10 Quarrington Hill

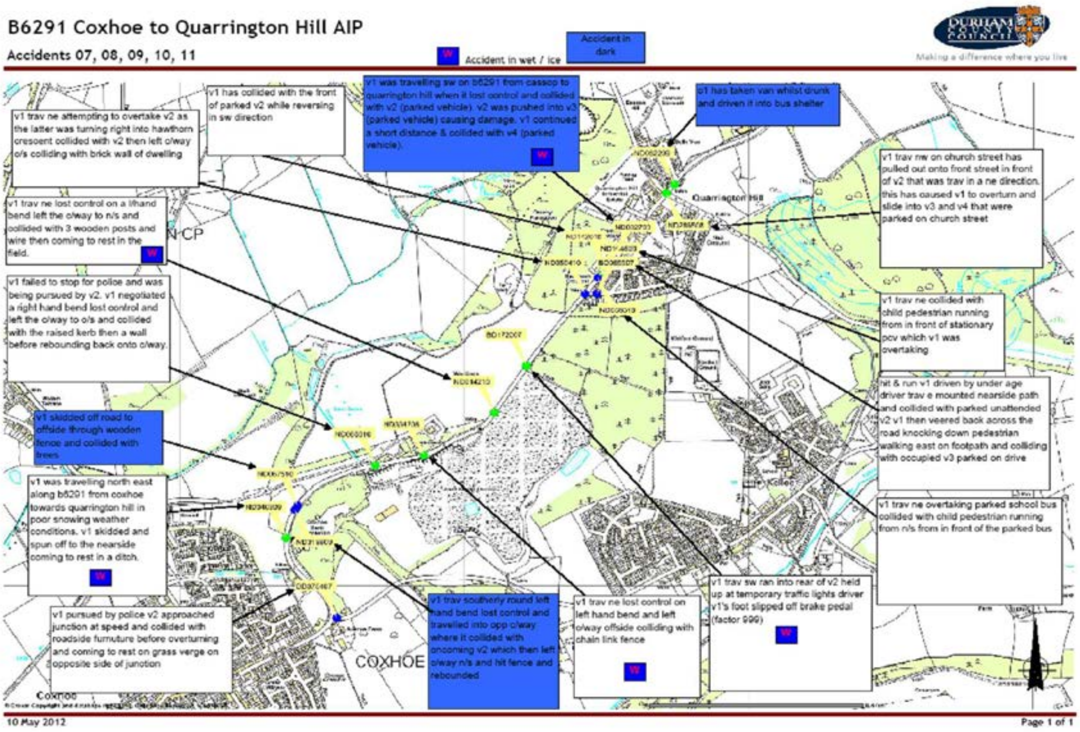


Table 1: Site description overview

Site No.	Speed limit	Group	Road type	Location type	Street Lighting
1	60	B	Straight	Rural	N
2	30	A	Semi-straight	Urban	Y
3	30	A	Straight	Urban	Y
4	60	B	Straight	Semi-urban	Y
5	30	A	Slight bend	Urban	Y
6	60	B	Semi-straight	Semi-urban	Y
7	60	B	Straight	Semi-rural	N
8	60	B	Straight	Semi-rural	Y
9	30	A	Slight bend	Urban	Y
10	60	B	Slight bend	Semi-rural	N

The ten sites were categorised into 2 groups (A and B) based on the speed limit, contour / shape of road and location of site. These groups were used in determining the speed difference analysis. These 10 sites were programmed to be tested using Wet night Visibility marking material. In contrast to the original proposal, authors could only include one county as Derbyshire Council were forced to withdraw from participation. Initially, Derbyshire Council expressed an interest of inclusion in the project. A similar site accident assessment to that in Northumberland was undertaken and a number of sites were identified. Unfortunately the sites were eventually deemed unsuitable by the council as they could not be assessed to meet a full complement of 10 sites which would fulfil all the criteria required.

Hampshire County Council was then approached to become involved in the project, however no relevant sites could be deemed appropriate for inclusion in the assessment.

The 10 sites validated for inclusion in the project are all from a sole regional authority. A works order to install a fixing post at each site was raised for completion by the authority.

Baseline driver speed data – Pneumatic Tube Monitoring

Having identified the locations of the assessment points, Durham Council installed and monitored the driver behaviour at all 10 sites for a four week period between 25th June 2012 and 23nd July 2012. The method of assessment of driver behaviour was through vehicle speed measurement using a pneumatic tube monitor.

Pneumatic tubes are portable traffic data collection devices and therefore ideal for short-term traffic engineering studies.

Method of Operation

A pair of rubber tubes, with a diameter of about 1 cm, were placed on the surface of the road. When a vehicle passes, the wheel presses the tube and the air inside the tube is pushed away. One end of the tube is connected to a box that contains a membrane and an electrical switch. The air pressure moves the membrane and engages the switch. The other end of the tube has a small opening, to prevent reflection of the air wave. The box collects data from vehicles that travel over the tubes and stores the data for later analysis. Pneumatic tubes are able to collect traffic data such as axle counts, instantaneous speed, direction of flow, volume, vehicle classification and the time of day associated with each data sample.
Simple installation process

- Nailing tubes on the road
- Programming the data recorder with a computer to collect the desired information
- Connecting the pneumatic tubes to the data collector
- Installation is complete and the system is collecting traffic data.

Benefits	Limitations
Reusable	Limited Lane Coverage
Portable	Temporary Use
Cost effective	Susceptible to damage by vehicles
Automatic traffic data collection	
Simple installation requirement	

As the system was to be in place for a period of four weeks only, across a maximum of two lanes of traffic, it was considered that potential effects of these limitations had therefore been designed out of the experiment.

The directionally sensitive raw data sets, collected from the pneumatic tubes (Appendix 4a), were analysed and assessed for each site with average vehicle speeds being calculated on an hourly, daily and weekly basis (Appendix 4b). These average speeds were analysed in such a way as to allow for indicative comparison of data with that taken from Stage 2 of the project – On Road Tests.

Figure 11: Example of installed Traffic Volume and Speed Measurement Pneumatic Tube

STAGE 2 - On Road Test

Principles of Wet Night Visibility

Retroreflectivity is a measure of the ability of a material to reflect light back to an originating source. It is a common property of traffic signs, delineators, object markers, barricades, raised pavement markers and pavement markings.

The visibility of a pavement marking is determined by the amount of light reflected off the marking's surface to a driver's eye. During daylight hours, marking visibility is achieved through light from the sun striking the marking surface and scattering in all directions, some of which reaches the driver's eyes. However, in dark environments or at night (without roadway lighting), vehicle headlamps produce most of the light striking a pavement surface, and therefore the retroreflective properties of the pavement marking govern the amount of light that reaches the driver's eyes.

Retroreflectivity in pavement markings is a measure of the amount of light from the vehicle's headlamps that is reflected back to the driver's eyes.

Retroreflectivity is a measure of how efficiently the pavement marking returns light from the headlamps back to the driver. In mathematical terms it is a ratio of the reflected luminance (light) to the headlamp illumination at a specific viewing geometry.

While glass beads are responsible for most of the retroreflectivity in pavement markings, retroreflectivity is influenced by numerous characteristics of the marking which includes the properties of the glass beads themselves. The following table shows some of the major factors that influence the amount of retroreflectivity that a marking produces.

Glass Beads	• Amount and Dispersion • Embedment Depth • Refractive Index • Size • Clarity • Roundness
Binder Material	• Colour • Type • Thickness
Other	• Pavement Surface Roughness • Dirt or Other "Blinding" Material • Type of Retroreflectometer Used for Measurements

Pavement markings are intended to perform well when new and dry, but a significant difference in the dry and wet covers a marking, there are several factors that can reduce the ability of the marking to reflect the incoming light.

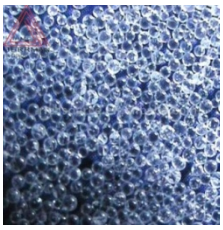
The major factors are a distribution of light, away from origin, due to specular reflection off the water's surface and the change in refraction of light due to the light rays passing through an additional medium (water) with a different refractive index (RI) from that of the bead and the air.

<u>Wet Night Visibility Road Markings</u>

The primary objective of a wet night visibility road marking is for it to perform efficiently as regards retroreflectivity in conditions of wet and rain. To do this the surface applied glass beads need to project from the water film on the surface of the line by the optimum 40% of the diameter of the bead or be raised above the carriageway on a type of profile marking.

Surface Applied Beads

High index beads of diameter ≥ 1.0mm



Agglomerate beads

Figure 12: Surface bead examples

Figure 13: Profiled marking examples

Profiled markings are higher performing than standard thermoplastic or cold plastic markings. They provide very high retroreflectivity, improved water shedding capability, skid resistance and a rumble or noise effect with vehicle contact. Profiled markings can be used on both urban and highway segments, and are most often applied as centre lines, lane lines and edge lines.

Benefits include:
- Improved safety in dark/rainy conditions
- Great water-shedding capabilities
- Highest visibility and retro-reflectivity
- Rumble noise when driven over

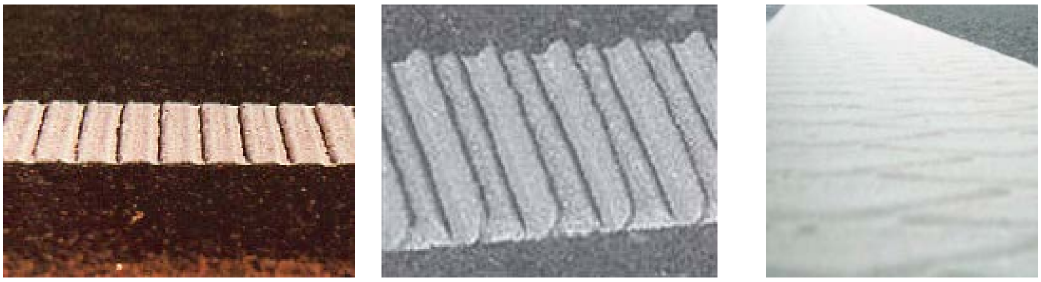


Figure 14: Embossed markings

Contractors apply a base of thermoplastic material spread with glass beads for additional retroreflectivity. Using special equipment, they imprint one of several available patterns on the plastic while it's still pliable (transverse, diagonal, diamond, gear and multi-dot patterns available). The equipment creates a "stamp" on the plastic that allows water to drain from the line. The benefits are equivalent to that of a profiled marking.

<u>Installation of Project Specific Wet Night Visibility Product</u>

During August and September of 2012 a Road Safety Markings Association contracting member installed a Wet night visibility performance product on all 10 sites. The longitudinal lines on the sites were laid with the Line 'n' Dot road marking system. The material used was a thermoplastic road marking material consisting of a mixture of aggregate, pigment, extender, synthetic resins, mineral oil and glass beads blended and supplied in granular form (see full specification Appendix 7).

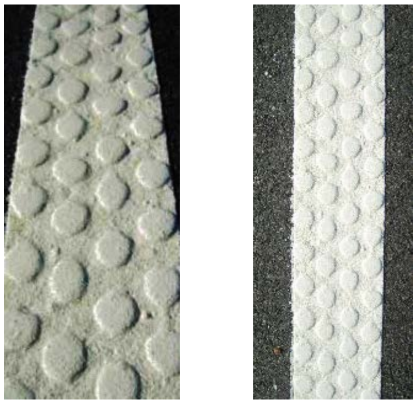


Figure 15: Wet night markings

It is designed for producing structured markings via extruder application, however can also be laid through any thermoplastic road marking equipment, hand mould or pram.

Table 2: Summary of locations of lines installed on each site

Site No.	Location	Marking width	Marking length
1	B6313 Craghead	100mm	576m
2	A691/A6076 Lanchester	100mm	350m
		150mm	408m
3	B1320 Yoden Way, Peterlee	100mm	472m
		150mm	336m
4	A1086 Coast Road, Blackhall	100mm	1868m
5	B1280 Wingate	100mm	336m
6	A167 North of Cock o´ The North	100mm	236m
7	A689 High Grange	100mm	1536m
8	A181 Wheatley Hill	150mm	4008m
9	C145 Essington Way	100mm	336m
10	B6291 Coxhoe to Quarrington Hill	100mm	2998m

Speed camera description:

The speed camera used was a 3M Driver Feedback Sign DFS 700, which is the DFS, a temporary vehicle activated sign which detects and displays, in real time, the speeds of vehicles driving into the radar beam. These measurements are displayed to the vehicle, recorded and can be evaluated statistically by the user program DFS-CAS.

Figure 16: sample picture of speed camera display

Full manufacturer's details of the equipment are shown in Appendix 3.

Discrete Monitoring

To ensure that a best and truest reflection of any change in driver behaviour was obtained the face of the speed detection equipment was masked with black plastic sheet. While drivers might have, at first, wondered what the sign was for and modified their usual conduct, it is determined that they rapidly reverted to their 'normal' driving behaviour. The table below from TRL Report PPR 314 containing speed measurements of respective sites reveals that unmasked signs do affect driver behaviour, but this may be a novelty effect with drivers reverting to norm over a number of weeks:

Table 3: Discrete monitoring data before, during and after display conditions

Site No.	Location	Mean speed (mph)		
		Before	During	After
1	King Henry´s Drive	35.4	32.5	34.9
2	Manor Road	28.4	26.9	28.3
3	Welling Way	34.9	32.5	34.8
4	Bromley Hill	31.7	29.6	31.6
5	Parkhill Road	32.3	30.0	32.1
6	Maiden Rod	30.7	29.3	30.8
7	Kings Hall Road	33.2	32.5	33.6
8	Shooters Hill Road	28.6	27.8	28.7
9	Beddington Lane	31.9	31.3	Missing
10	Brownhill Road	30.4	30.5	30.7

However, to eliminate any doubt as to the accuracy of the survey, the signs were kept masked for the whole of the exercise.

As only eight cameras were available for this work package, a programme of camera movement diary was established in order to monitor duration and direction of traffic assessment. The cameras were then alternated between the sites and between the direction of observed traffic movement in order that a comprehensive dataset could be obtained for all sites for a full climatic cycle.

The diary of DFS camera operation is shown in Appendix 5.

STAGE 3

STAGE 3a - Detailed Statistical analysis of accident data

Road Accident Incident Statistics

Durham County Council have recorded and compiled all accident reports for the specific sites included in the survey. Additionally, Durham Police Incident Causation reports have been investigated. These reports are, solely and necessarily, restricted to those incidents where police involvement and / or a police report has been made as a result of one or more vehicles being involved in an incident. The incident reports have been categorized into two time periods Jan 2012 – Dec 2012 and Jan 2013 – Dec 2013. The original incident reports for both of these time periods, as summarised by Durham Police, are shown in Appendix 2.

These reports have been analysed and, in the absence of a detailed extensive report, a best estimate determination as to the possible underlying cause of the incident has been made, also according to the attending police officer filling out the most likely contributing accident causation factor(s) according to accident causation grid codes (see Appendix 2).

Authors carried out an in-depth analysis of police reported accidents and assessed the potential links between incidents and possible marking causation effects. This analysis concluded that none of the accidents occurred as a direct result of missing, obscured or inadequate markings or perception of the same.

STAGE 3b – Detailed Statistical analysis of vehicle speed data

Pneumatic Tube information collated was analysed to allow for comparison of average speed of vehicles for each hour of the day over a 4 week period of assessment June 2012 – July 2012.

Once the new DFS camera locations had been agreed and posts installed, additional data from a full climatic cycle was recorded (Dec 2012 – Jan 2014). A comparison assessment of specific time periods was undertaken. These assessments were carried out on data collected over periods of up to eight weeks to allow for camera movements between sites.

The assessment periods are:

- (June / July 2012 – Pneumatic Loop survey)
- (Dec2012 / Feb 2013 DFS Data Analysis – Commencement period)
- (June / July 2013 DFS Data Analysis – Loop data comparison period) and
- (Nov / Dec 2013 DFS Data analysis – Termination period).

The tables of the results of these analyses are shown in Appendix 5. The tables identify the total number of vehicles in a week passing the site in a single direction for a given hour of the day. The average speed of these vehicles is also shown. In order to create a true average speed per hour, the sum of the individual speeds multiplied by the numbers of vehicles at that speed was then divided by the total number of vehicles, i.e.

Week 1

12.00am – 01.00am

(No vehicles at 1mph x 1) +(No Vehicles at 2mph x 2)+(No vehicles at 3mph x 3)..........(No vehicles at 125mph x 125)
Total Number Vehicles

01.00am – 02.00am

(No vehicles at 1mph x 1) +(No Vehicles at 2mph x 2)+(No vehicles at 3mph x 3)..........(No vehicles at 125mph x 125)
Total Number Vehicles

02.00am – 03.00am etc

Week 2

12.00am – 01.00am

(No vehicles at 1mph x 1) +(No Vehicles at 2mph x 2)+(No vehicles at 3mph x 3).....
Total Number Vehicles

01.00am – 02.00am

(No vehicles at 1mph x 1) +(No Vehicles at 2mph x 2)+(No vehicles at 3mph x 3).....
Total Number Vehicles

02.00am – 03.00am etc

Averages for 4 week period is calculated in the same way i.e.

Average for 4 week period

12.00am – 01.00am

(No vehicles at 1mph wk 1 – wk4 x 1) +(No Vehicles at 2mph wk 1-wk4 x 2) + (No vehicles at 3mph wk1-wk4 x3).....
Total Number Vehicles

01.00am – 02.00am

(No vehicles at 1mph wk 1 – wk4 x 1) + (No Vehicles at 2mph wk 1-wk4 x 2) + (No vehicles at 3mph wk1-wk4 x3).....
Total Number Vehicles

The average hourly speeds of an assessment period are plotted onto a graph and the associated comparative line plotted against it (e.g. June/July 2012 & June/July 2013). The comparison graphs are shown in Appendix 5.

By assessing the similarity, or otherwise, between the two sets of lines an appropriate determination regarding the affect of enhanced material at any given site may be made.

In respect to these graphs, it was noted that anomalies present at times between 11pm and 6am were caused as a result of low numbers of vehicles passing through the sites and, as a consequence, validity of data comparison was being compromised.

The data for times between 11pm and 6am were removed from the data sets and the resulting graphs once again produced to allow for comparison of June / July data as well as Jan / Jan data. These resulting graphs were considered to be more robust in terms of statistical validity as there did not appear to be any irregularities to the shape of the resulting lines. The new graphs are shown below and associated data sets in Appendix 5.

Weather Station Data Analysis

Having undertaken this analysis it was identified that the possibility of climatic variation, not weather, could be a factor affecting the driving behaviour. Durham University Geography Department was approached for provision of historical meteorological data from weather stations near to the sites of the survey.

The data provided was from the Durham weather station at Potters Bank, Durham, which was identified to be in close proximity to all 10 assessment sites and therefore considered that all data was pertinent to the investigation.

Table 4: Distance of weather station to sites

Site No.	Site Search Address	**Straight Line Distance** : Weather Station – Site (miles)
1	Craghead Lane, Craghead	6.7
2	Howden Bank, Lanchester	7.7
3	Yoden Way, Peterlee	10.4
4	Coast Road, Blackhall	13.4
5	Front Street, Wingate	8.8
6	Cock o' the North, Durham	0.9
7	Addison Road, Bishop Auckland	7.9
8	A181, Wheatley Hill	7.0
9	Essington Way, Peterlee	9.8
10	B6291, Quarrington Hill	4.9

January 2013 – Dec 2013 Meteorological Data Assessment

The variation in speed averages between Jan 2013 and Dec 2013 (Winter – Winter) is best displayed by assessing the 'Urban' (Sites 2,3,5,9) and 'All site combined' comparison graphs, whilst the site displaying most notable individual changes in speed during winter is Site 1, also noted as the most rural location of the 10 sites.

Urban Sites

Demonstrate a consistent difference between hourly average speeds throughout the day (8am – 10pm) for the duration of the test. Speeds at the end of the monitoring period (Dec 2013) are notably higher than at the beginning (Jan 2013). This may in part be caused by the adverse obscuring of markings caused by snowfall in the early part of the year.

The full Meteorological Data itemised for the Durham Weather Station, Potters Bank, Durham is shown in Appendix 6, together with a summarised breakdown of the targeted survey periods:

- June – July 2012
- Dec – Feb 2012/13
- June – July 2013
- Nov – Dec 2013

COMPARISON OF DATA - December12/Jan 13 to Nov/Dec 13

A detailed analysis of vehicle speed vs. time for each site as well as all sites combined is undertaken in the following section.

All Sites combined

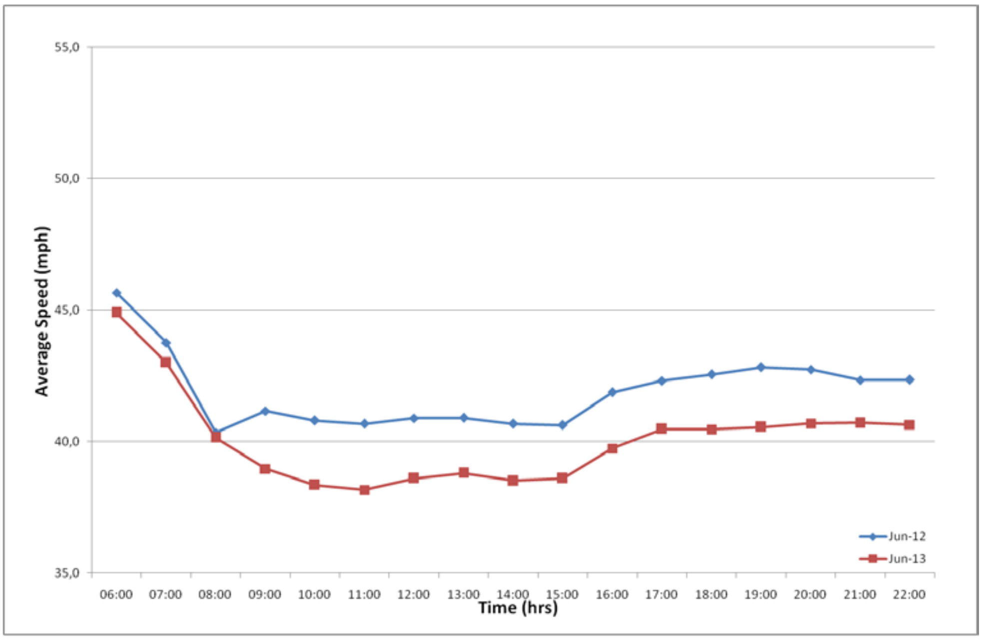


Figure 17: Average Speed v Time All Sites Combined - Jun/July 12 - June/July 13

June to June (all sites combined vehicle data). General consistent decrease in speed of approximately 2mph from June '12 to June '13 and a marginal difference in speeds displayed during morning commuting times (6am – 9am). Speeds drop by around 5mph - 7mph around morning commuting and rise again by approximately 2.25mph during the mid afternoon commute (3pm – 6pm), remaining at that level through the evening.

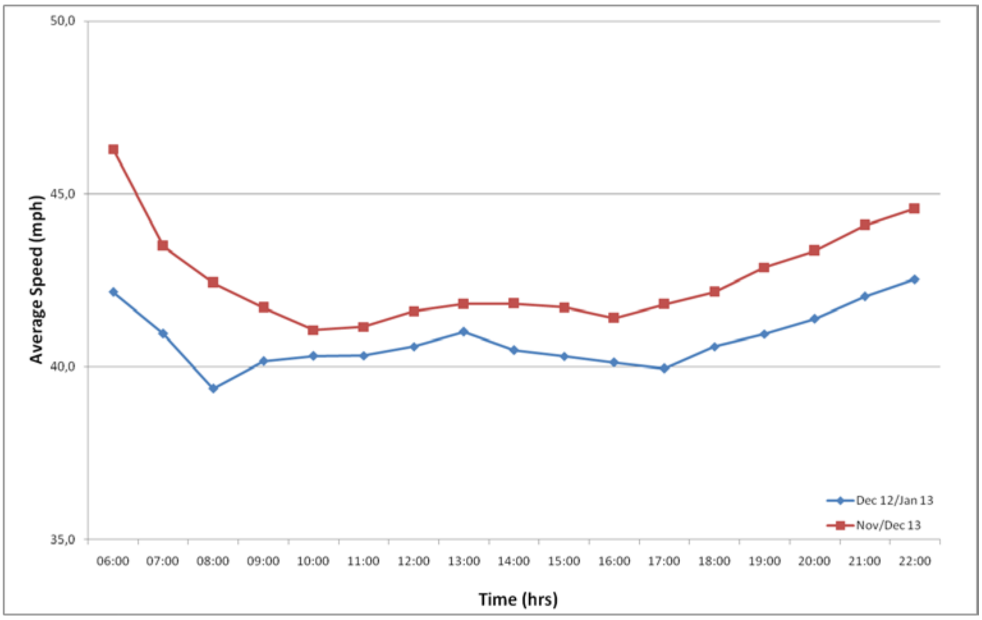


Figure 18: Average Speed v Time All Sites Combined - Dec 12/Jan 13 - Nov/Dec13

Dec to Dec (all sites combined vehicle data). General consistent increase in speed of approximately 0.75mph – 3.75mph from Dec ‘12 to Dec ‘13. Vehicle speeds generally fall by up to 5mph over the morning commute times (6am – 9am) remain constant through the daytime and rise again following the afternoon commute throughout the evening.

Site 1 Craghead

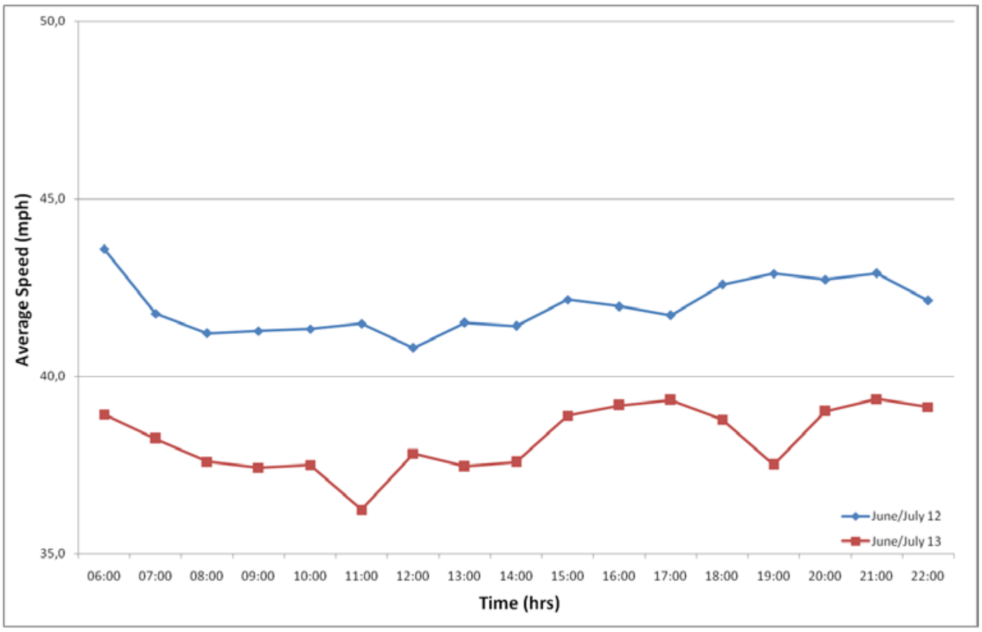


Figure 19: Average Speed v Time Site 1 Westbound – June/July 12 – June/July 13

June to June (westbound vehicle data only). Data displays a consistent decrease in average speeds of between 2.5 mph– 5.5 mph.

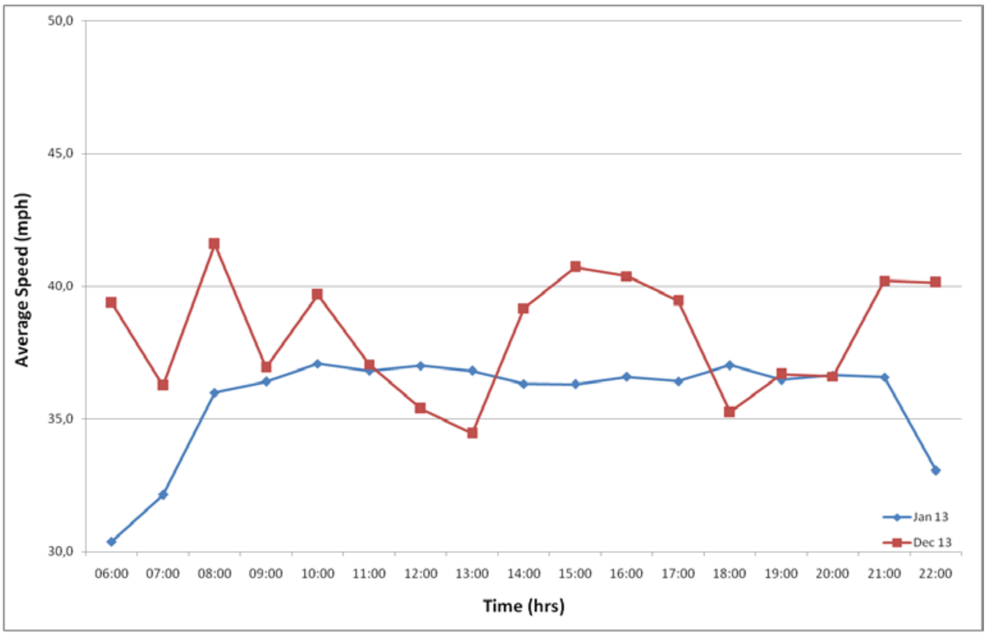


Figure 20: Average Speed v Time Site 1 Combined direction - Jan 13 - Dec 13

December to December (combined directions) vehicle speeds generally marginally elevated from Jan '13 to Dec '13. Speeds drop by approximately 4mph during morning commute and rise again more slowly over the course of the afternoon.

The vehicle speeds observed during Jan 2013 plateaux at approximately 8am and only decrease in the evening at approximate 9pm. Dec 2013 speeds demonstrate a periodic rise and fall pattern throughout the day, generally displaying vehicle speeds in excess of those for Jan 2013. This is potentially due, in part, to a period throughout weeks 2 and 3 of the test where temperatures were predominantly fluctuating between -7˚C to 2˚C with 85% (Source: Durham University Meteorological Data) chance of experiencing precipitation each day.

This would have led to a high likelihood that the road conditions were such that there was either ice or snow covering the road, thus making driving difficult or obscuring visibility of markings especially on rural roads.

Site 2 Lanchester

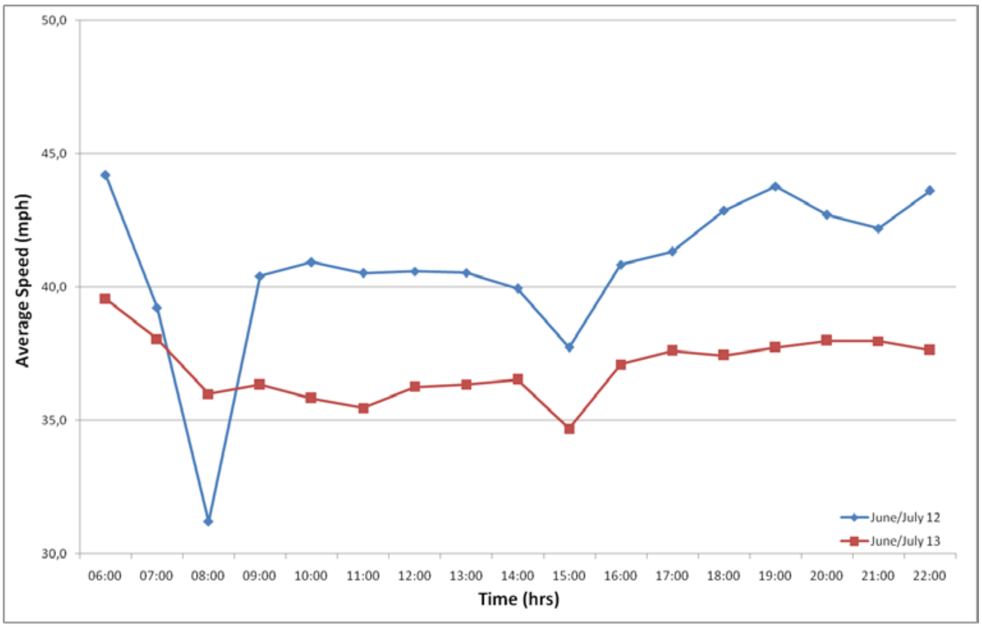


Figure 21: Average Speed v Time Site 2 Northwestbound – June/July 12 – June/July 13

June to June (northbound vehicle data only).General decrease in speeds from June '12 to June '13 of between 3mph and 6mph. Speeds drop around morning commuting as well as afternoon school leaving times, and may therefore result from school buses travelling in the area.

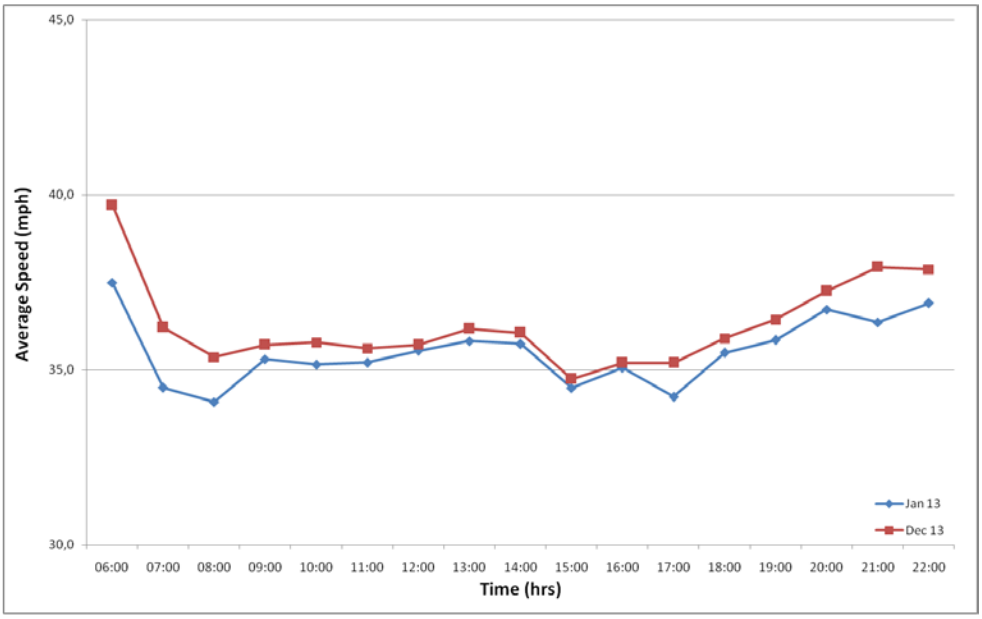


Figure 22: Average Speed v Time Site 2 Combined direction - Jan 13 - Dec 13

December to December (combined directions) vehicle speeds generally marginally elevated from Jan ‘13 to Dec ‘13. Speeds drop by approximately 4.5mph during morning commute and rise again more slowly over the course of the afternoon.

Site 3 Yoden Way, Peterlee

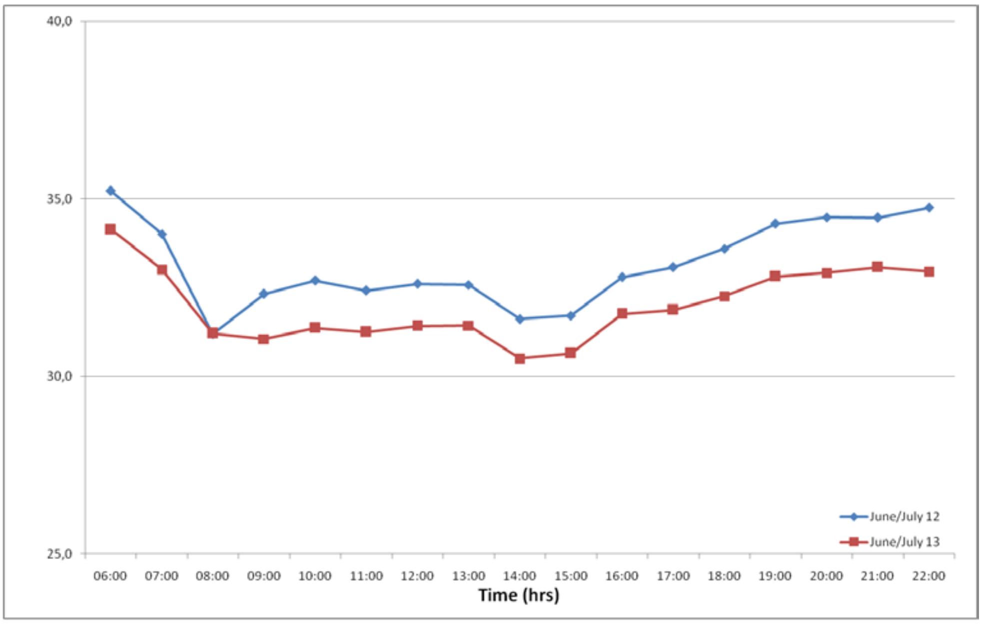


Figure 23: Average Speed v Time Eastbound – June/July 12 – June/July 13

June to June (eastbound vehicle data only).General minor decrease in speeds from June '12 to June '13 of between 1.25mph and 2mph. Speeds drop around morning commuting as well as afternoon school leaving times, and may therefore result from school buses travelling in the area.

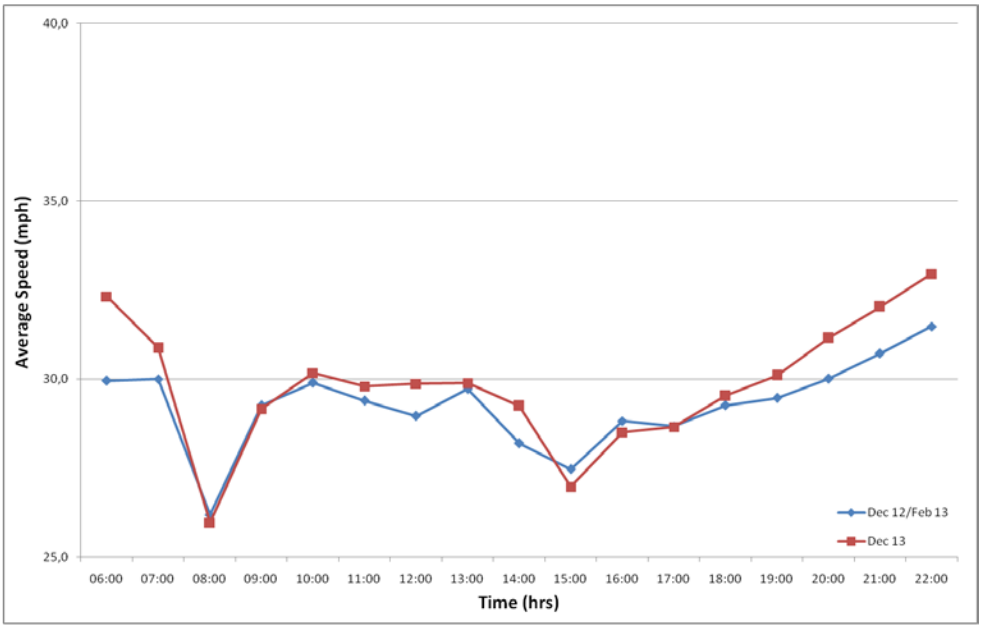


Figure 24: Average Speed v Time Site 3 Combined direction - Dec/Feb 13 - Dec 13

December to December (combined directions) vehicle speeds generally marginally elevated from Jan '13 to Dec '13. Speeds drop by approximately 4mph – 6mph during morning commute and rises sharply again near original levels shortly thereafter. Speeds drop again around lunchtime by 2.5mph and rise slowly by 5mph through the evening.

Site 4 Coast Road, Blackhall

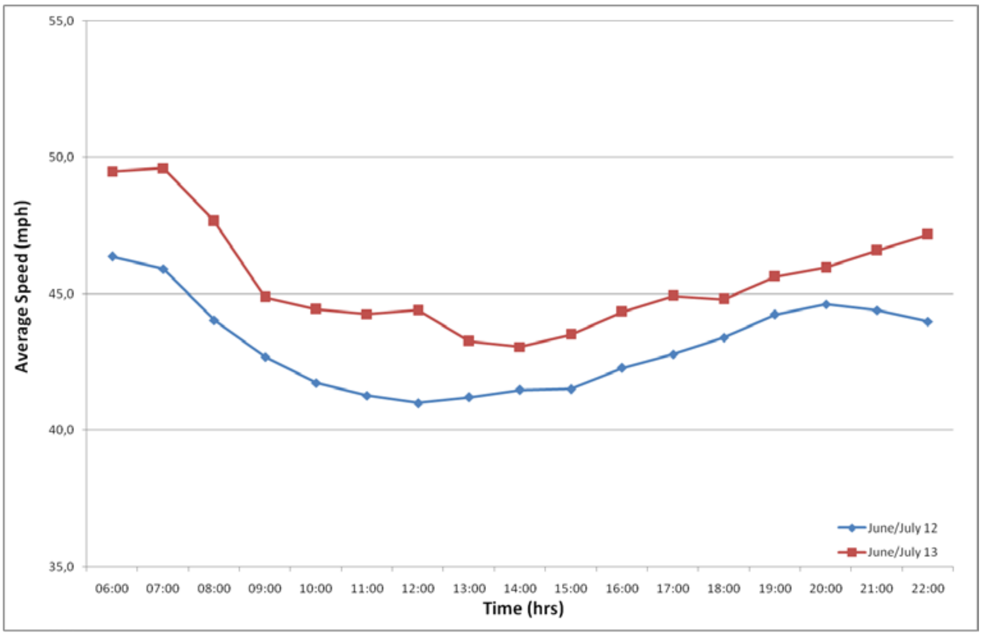


Figure 25: Average Speed v Time Site 4 Northbound – June/July 12 – June/July 13

June to June (northbound vehicle data only).General increase in speeds from June '12 to June '13 of between 1.5mph and 3.5mph. Speeds drop steadily from around morning commuting as and rise again at noon.

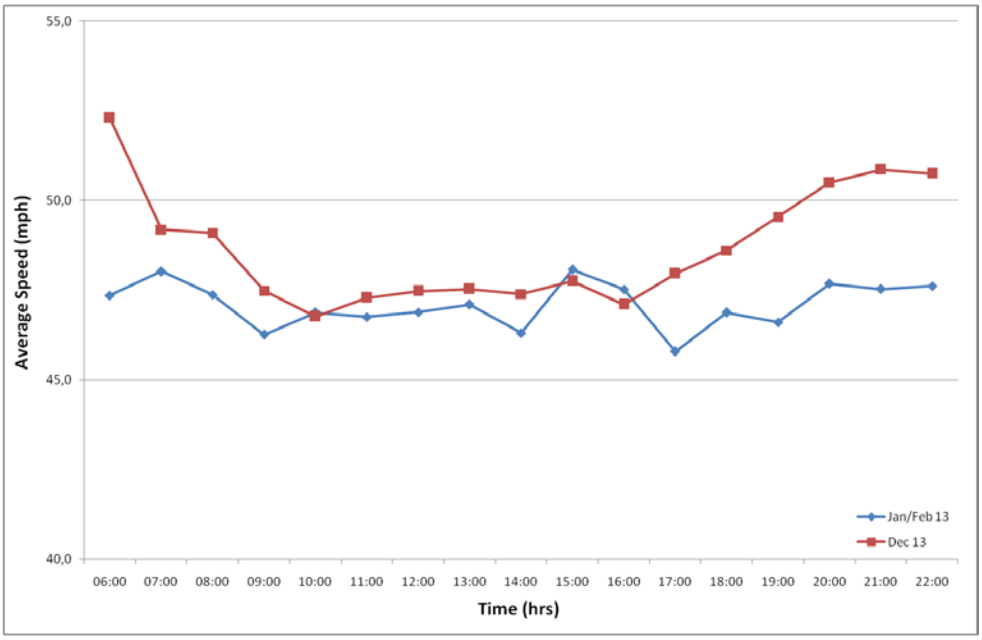


Figure 26: Average Speed v Time Site 4 Southbound - Jan/Feb 13 - Dec 13

December to December (southbound vehicle data only) vehicle speeds generally marginally elevated from Jan '13 to Dec '13.

Jan 2013 – Speeds generally remain unchanged throughout the day fluctuating only slightly. Dec 2013 – Speeds drop by approximately 5mph during morning commute and rise again slowly over the course of afternoon commute into the evening.

Site 5 Wingate

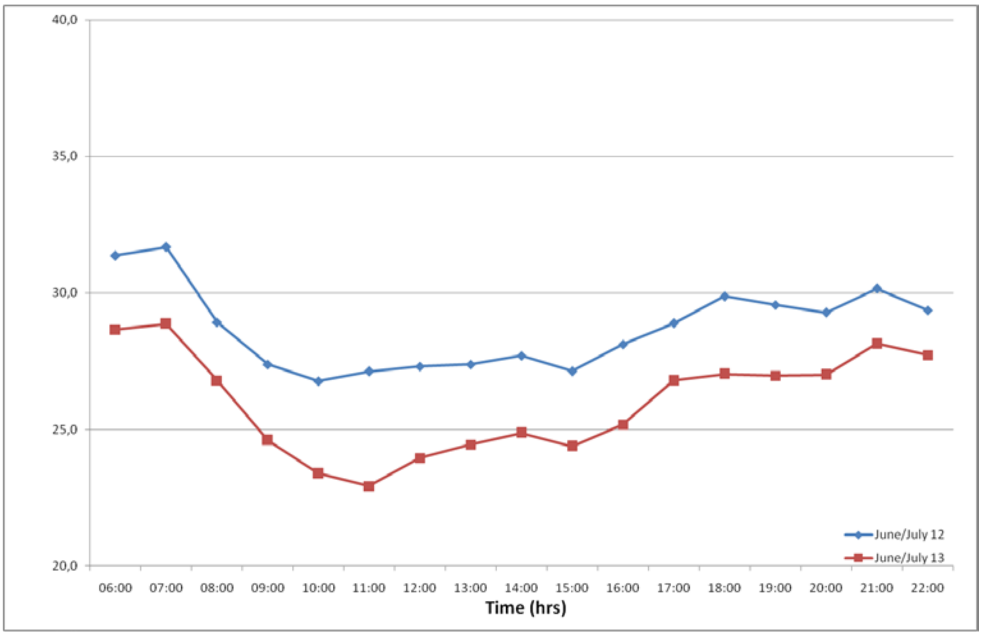


Figure 27: Average Speed v Time Site 5 Northbound – June/July 12 – June/July 13

June to June (northbound vehicle data only). General minor decrease in speeds from June '12 to June '13 of between 1.5mph and 3.5mph. Speeds drop around morning commuting as well as afternoon school leaving times, and may therefore result from school buses travelling in the area.

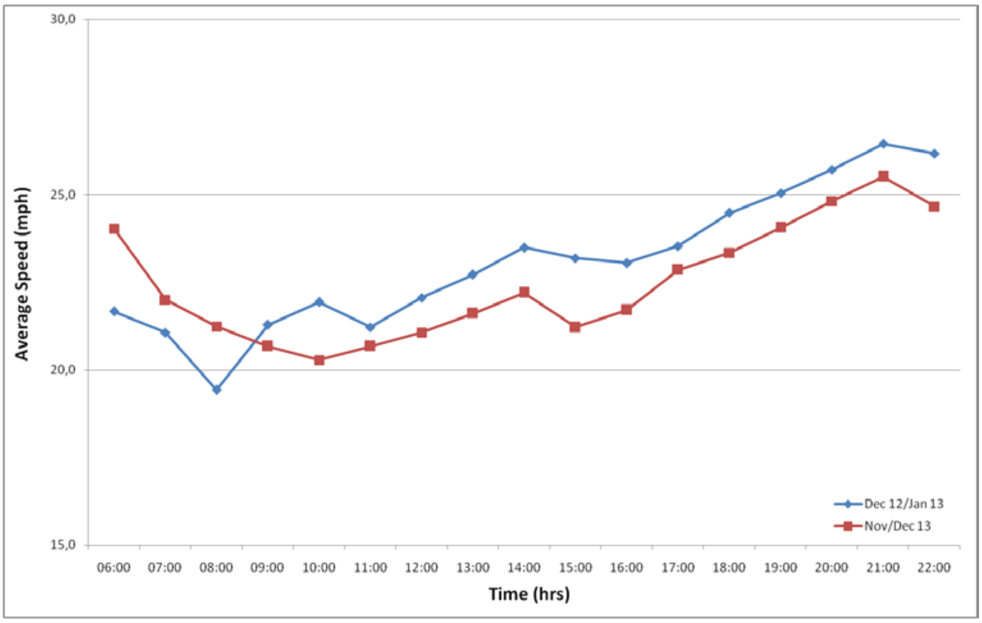


Figure 28: Average Speed v Time Site 5 Northbound – Dec12/Jan 13 – Nov/Dec 13

December to December (northbound vehicle data only) vehicle speeds generally marginally decreased (0.75mph – 2.25mph) from Jan '13 to Dec '13. Speeds drop by approximate 4mph during morning traffic and steadily increase throughout the day until late evening when they are approximately 5mph higher (25% increase).

Ste 6 Cock o´ The North

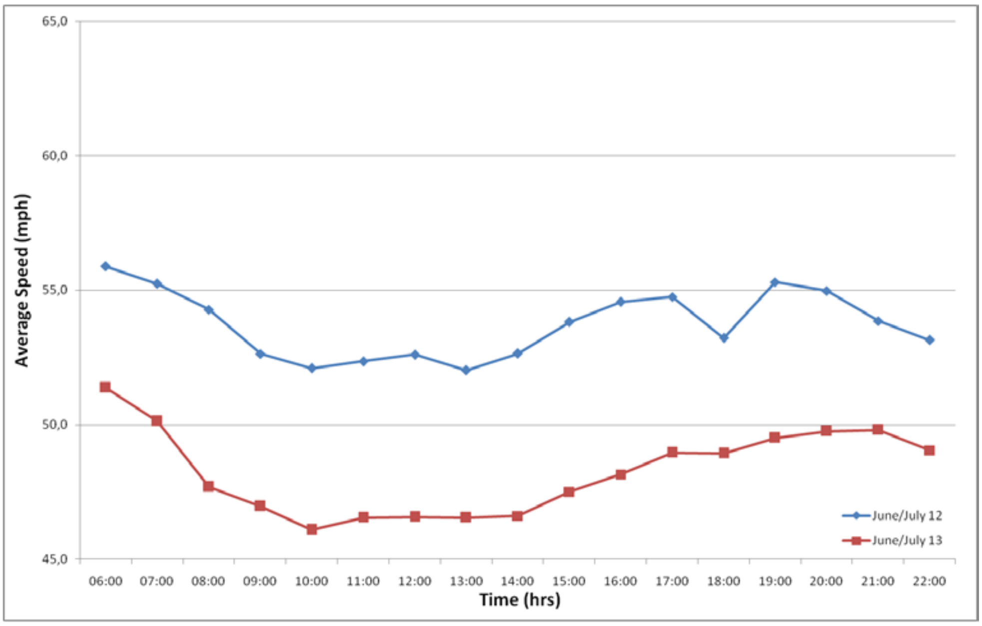


Figure 29: Average Speed v Time Site 6 Northbound – June/July 12 – June/July 13

June to June (northbound vehicle data only).General decrease in speeds from June '12 to June '13 of between 4mph and 6mph. Vehicle speeds trend to drop steadily from around morning commuting and rise again from around 10am.

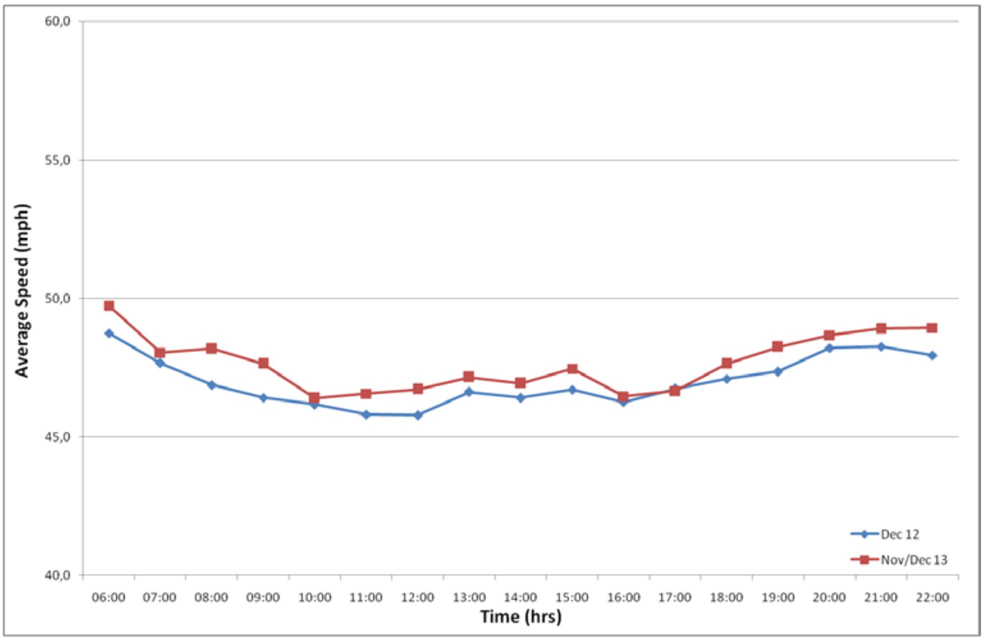


Figure 30: Average Speed v Time Site 6 Northbound – Dec12 – Nov/Dec 13

December to December (northbound vehicle data only) vehicle speeds generally marginally increased (0.0mph – 1.25mph) from Dec '13 to Dec '13. Speeds drop by approximate 3.5mph during morning traffic remaining low during the day (approximately 42mph) and steadily increase throughout the late afternoon following commuting traffic times.

Site 7 High Grange

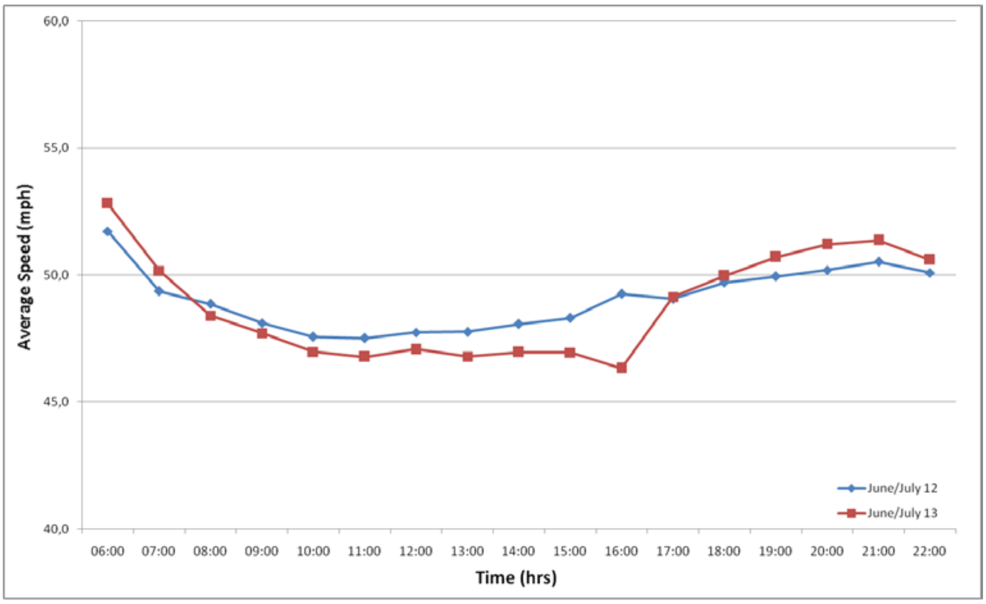


Figure 31: Average Speed v Time Site 7 Eastbound – June/July 12 – June/July 13

June to June (eastbound vehicle data only). There is little significant difference between vehicle speeds from June '12 to June '13. Throughout the day speeds drop around morning commuting by approximately 6mph and rise steadily again from approximately 4pm-5pm.

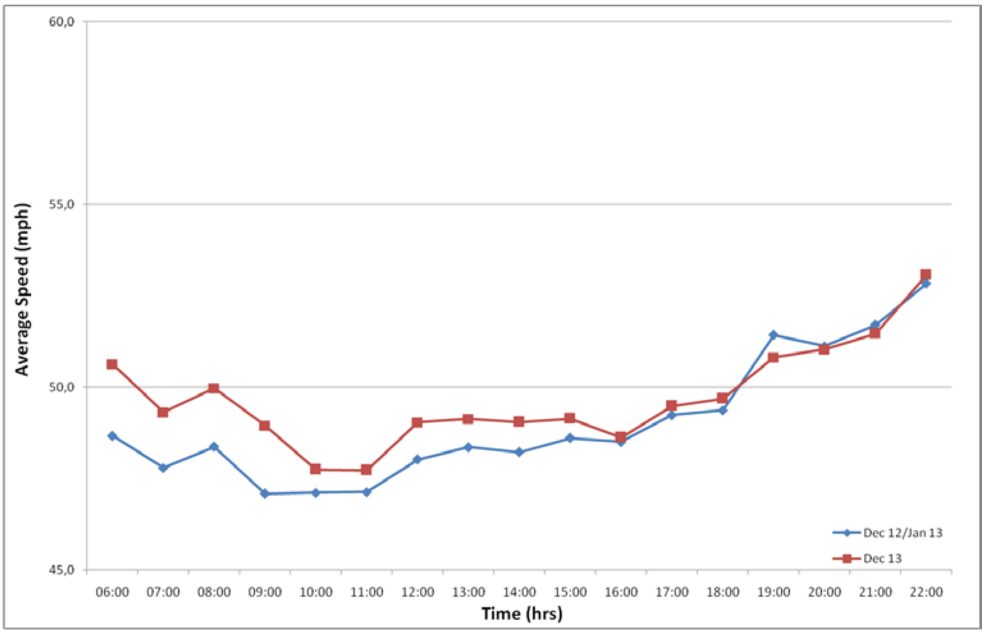


Figure 32: Average Speed v Time Site 7 Combined direction – Dec12/Jan 13 - Dec 13

December to December (combined direction vehicle data) vehicle speeds generally marginally increased (0mph – 1.75mph) from Dec '13 to Dec '13. Speeds drop by approximate 2.75mph during morning traffic remaining steady during the day (approximately 48mph) and steadily increase throughout the late afternoon following commuting traffic times.

Site 8 Wheatley Hill

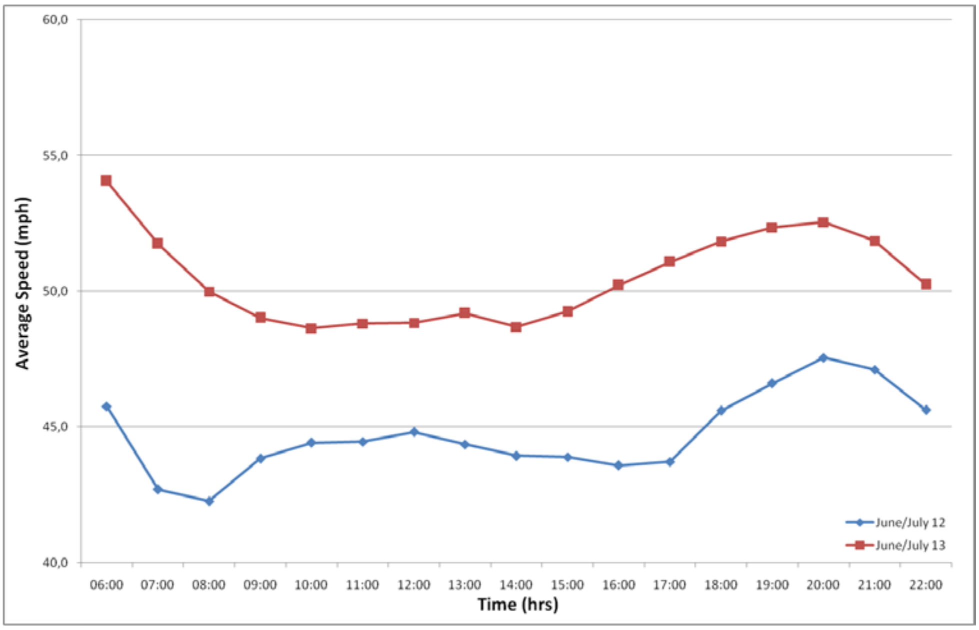


Figure 33: Average Speed v Time Site 8 Westbound – June/July 12 – June/July 13

June to June (westbound vehicle data only).General increase in speeds from June '12 to June '13 of between 4.0mph and 8.75mph. Speeds drop steadily from around morning commuting as and rise again in the evening between 5pm – 9pm before dropping again into the late evening.

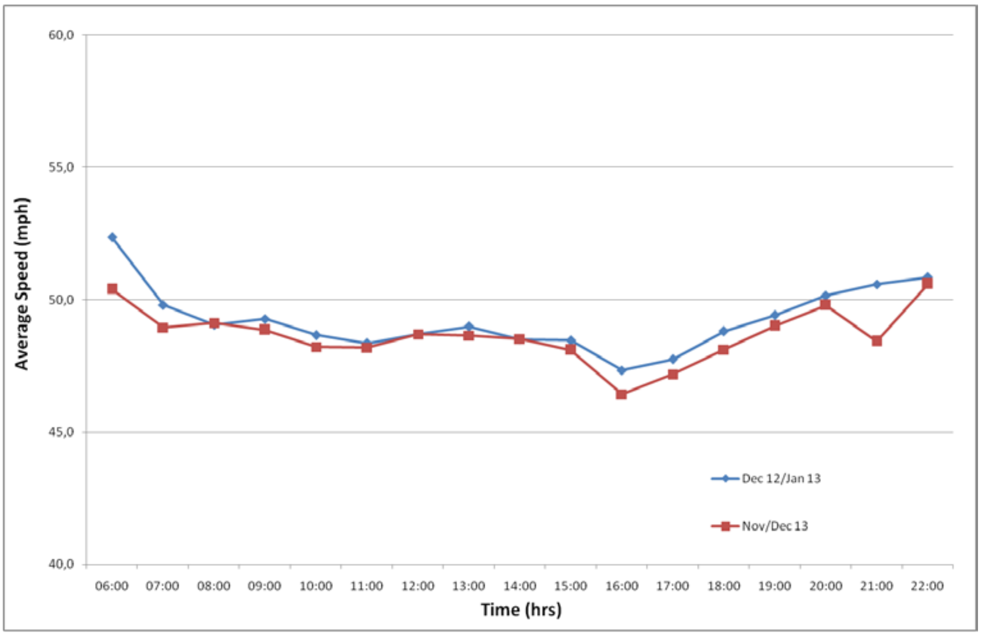


Figure 34: Average Speed v Time Site 8 Westbound – Dec12/Jan 13 – Nov/Dec 13

Dec to Dec (westbound vehicle data only). General identical speeds from Dec '12 to Dec '13. Speeds drop by around 2.0 – 3.0mph around morning commuting remaining constant at approximately 48mph, until an additional small decrease around afternoon commute and rising slightly thereafter throughout the evening.

Site 9 Essington Way

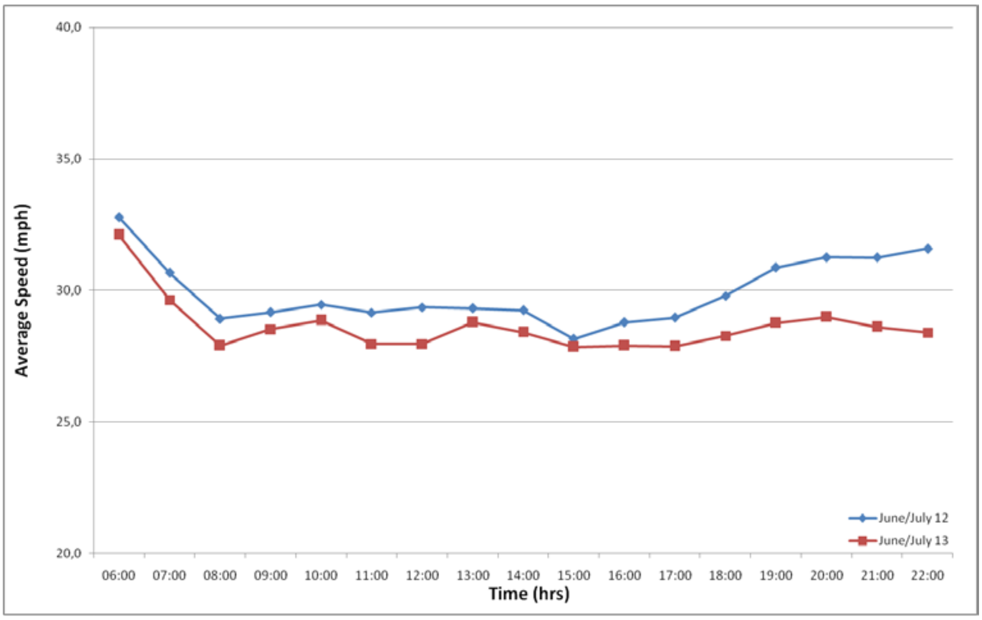


Figure 35: Average Speed v Time Site 9 Northbound – June/July 12 – June/July 13

June to June (northbound vehicle data only). General minor decrease in speeds from June '12 to June '13 of between 0.5mph and 3.0mph. Speeds drop by around 4mph around morning commuting and rise slightly again following afternoon school leaving times, and may therefore result from buses including school buses travelling in the area.

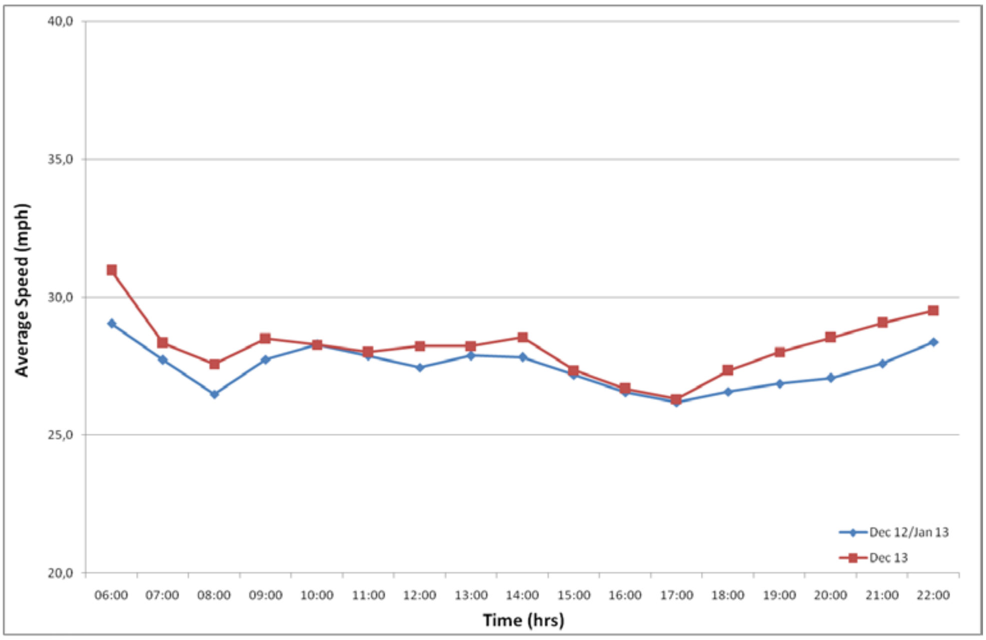


Figure 36: Average Speed v Time Site 9 Northbound – Dec12/Jan 13 – Dec 13

Dec to Dec (northbound vehicle data only).General minor increase in speeds from June ‘12 to June ‘13 of between 0mph and 2.0mph. Speeds drop by around 3mph around morning commuting and rising slightly thereafter and display a small drop and slow rise around afternoon school leaving times, and may therefore result from buses including school buses travelling in the area.

Site 10 Quarrington Hill

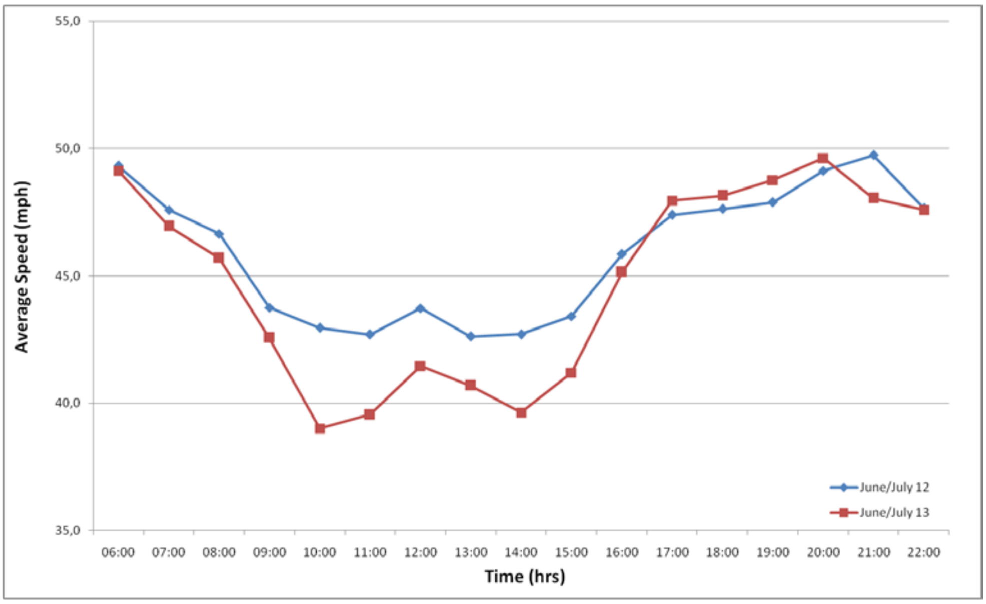


Figure 37: Average Speed v Time Site 10 Southwest bound – June/July 12 – June/July 13

June to June (southbound vehicle data only). General minor decrease in speeds from June ‘12 to June ‘13 of between 0.5mph and a maximum difference of 4.0mph decrease around late morning / lunchtime. Speeds drop by around 10mph around morning commuting and rise again to the same levels between early-late afternoon.

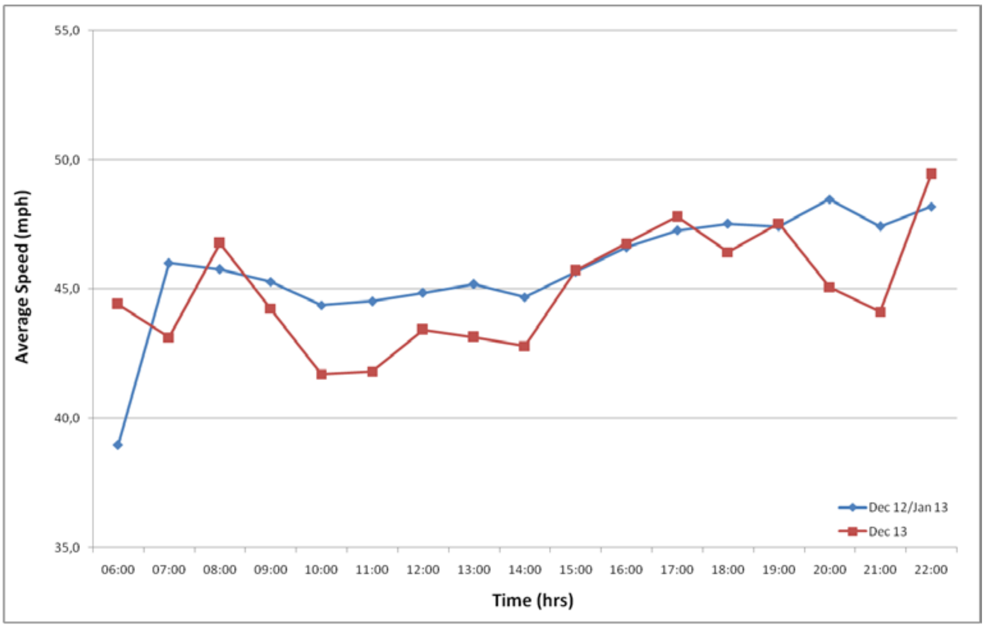


Figure 38: Average Speed v Time Site 10 Southwest bound – Dec12/Jan 13 – Dec 13

Dec to Dec (southwest vehicle data only).General fluctuations in speeds from Dec '12 to Dec '13 of between -3,5mph and +1,0mph. Speeds generally steadily increase throughout the day with a range of approximately 8mph between the start of the day and end of day recordings.

Sites (Rural)

Average speeds slightly higher on rural roads during summer months.
Speeds drop significantly leading into early morning commuting times and rise slightly during evening commuting times remaining at a constant thereafter.

June to June average speeds trend to fluctuating between a slight increase (0.25mph-1.50mph) over the DFS monitoring period (June '12 – June '13) during the early morning and night time traffic, but a slight decrease in average speeds during the daytime (9am – 5pm) of between 0.5mph and 1.0mph. Vehicles speeds trend to decrease significantly during morning commute times (6am – 10am) by approximately 3.5mph – 6.5mph, after which they remain at approximately 45mph – 46.5mph until early afternoon when they steadily increase to approximately 48mph dipping slightly late in the night.
Dec to Dec little notable change in average vehicle speeds. Marginal increase in speed from Dec '12 to Dec '13. Speeds trend to remain consistent throughout the day and rise slightly during and following the afternoon commuting times.

Sites (Urban)

Average speeds higher during pre survey monitoring (June 2012) then slightly lower for DFS monitoring.

Dec to Dec slight and consistent increase in average vehicle speeds from Dec '12 to Dec '13 ranging from 1.25mph – 3.0mph. Average vehicle speeds generally decrease by approximately 3.75mph during the morning commuting times (5am – 9am) remaining constant at approximately 28mph - 32mph during this time and begin to steadily increase during and following the afternoon commute times and into the evening.

June to June slight but consistent decrease in average vehicle speeds. Speeds trend towards reducing during morning commuting and increasing during mid afternoon.

June to June slight and consistent decrease in average vehicle speeds from Dec '12 to Dec '13 ranging from 3.0mph – 4.25mph. Average vehicle speeds generally decrease by approximately 5.0mph - 6.0mph during the morning commuting times (5am – 9am) remaining constant at approximately 30mph - 34mph during this time and begin to slightly and steadily increase during and following the afternoon commute times and into the evening.

ALL Sites
Daytime Visibility

It was noted from draft analysis that the speeds of vehicles across most observed sites during hours of daytime were affected by the installation of the enhanced marking material. One of the improvements in the materials used was that of increased luminance from a minimum manufactured level of 0.70 to a minimum of 0.80 and an installation level of 0.30 to 0.40. This would have a noticeable affect during daylight hours by increasing the contrast between the lines against the carriageway background.

Street Lighting

Street lighting was observed to be installed at three out of the ten sites. There has been no notable trends regarding the lack of illumination of markings during the survey period compared with those which possess lighting columns. In order to better determine the effects, if any, of presence of lighting on vehicle behaviour we would advise that further studies of larger groups of sites, both lit and unlit, be undertaken.

ALL Sites – Year on Year comparison

The comparison of data was undertaken for June 2012 vs June 2013 and also for Dec 2012 vs Dec 2013. Whilst it was understood that the comparison of June to June was the only method undertaken with which to analyse the effect of installation this was purposely done so as ensure that the installation of markings was the major contributing factor. Analysis of Dec 2012 vs Dec 2013 was undertaken in order to assess the performance of the new markings over a climatic cycle. Meteorological data for the investigation area has been researched and assessed. It has been determined that for the comparison periods of the investigation the reports identify a number of variations in comparable periods of the climatic cycle. Most notably the winter periods Dec 2012 / Jan 2013 vs Dec 2013 was noted to have a much colder period involving much rural snow cover, therefore significantly restricting road surface visibility and presumably also affecting vehicle behaviour..

Stage 4 - Conclusions

It has been shown by analysis of the vehicle speed data collected that there are significant patterns relating to vehicle speeds throughout the day, increasing and decreasing around the morning and afternoon travel times. When all sites are taken into account the average speed decrease after installation of enhanced wet night visibility markings is 2.0mph (summer'12 to summer'13). A speed increase was noted of approximately 0.75mph to 3.75mph for the observation periods winter'12/'13 to winter'13/'14. However, it should be considered that this comparison is a consequence of weather conditions rather than potential for deterioration of markings. Moreover, it should also be noted that Site 1 and site 7, being the most rural of the locations, experienced the greatest weather variation between the two winter recordings and as such an elevation in average speeds of 5.0mph and 5.2mph, respectively, was not considered solely resultant from the markings alterations.

Generally, speed differences between the sites, although small in absolute terms, tend to suggest that there have been decreases in speed between the start and finish dates of the test period. Although only a small data set of accidents is available for the investigation period, it appears that accident causes were not directly associated with performance limitations of road markings.

To summarise, results indicate that enhanced retro-reflective road marking do not lead to higher vehicle speeds. On the contrary, speed decreases of about 2mph on average across all sites were observed when controlled for weather conditions. In terms of road safety, results can be interpreted as being promising at least, according to Taylor et al. (2000, 2002), as changes in driving speed alters accident numbers. Based on this relationship, it is more than fair to conclude that decreased speed is linked with lower accident risk - amongst other accident influencing, extenuating factors, such as weather, complexity of road layout, traffic density, etc.

In order to determine a more robust deduction, i.e. the extent of this relationship, it is considered necessary to extend the survey to a larger area, for a longer duration as well as using a single monitoring methodology. This approach would allow for reducing unwanted biasing factors, such as variations in weather, climate, apparatus and traffic.

References and Literature

Burt, Professor T.P (2014). Weather data for the County of Durham. Durham University Department of Geography. Durham, England

European Road Safety Observatory (ERSO), (2014) The web: Speed and Accident Risk [online] Available at : http://ec.europa.eu/transport/wcm/road_safety/erso/knowledge/Content/20_speed/speed_and_accident_risk.htm [Accessed October 2014]

Taylor, M., Lynam, D.A. & Baruya, A. (2000) The effect of drivers' speed on the frequency of accidents. TRL Report TRL421. Transport Research Laboratory, Wokingham, Berkshire

Taylor, M., Baruya, A., & Kennedy, J.V. (2002) The relationship between speed and accidents on rural single carriageway roads. TRL Report TRL511. Transport Research Laboratory, Wokingham, Berkshire

Water, L. & Knowles, J. (2008) Effectiveness of speed indicators devices on reading reducing vehicle speeds in London. TRL Report PPR 314. Transport Research Laboratory, Wokingham, Berkshire
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