School bus safety
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This research was initiated by the Bus Safety Technical Advisory Committee (BUSSTAC), a government and industry initiative led by the Ministry of Education. BUSSTAC also includes representatives from the Ministry of Transport, NZ Transport Agency (NZTA), NZ Police, Bus and Coach Association (NZ), and bus operators and coach builders. Funding was provided by NZTA with BUSSTAC acting as the steering group.

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Contents

Executive summary 7
Abstract 10
1 Introduction 11
2 The safety of children crossing the road to or from a school bus 14
2.1 Current situation 14
2.2 Options for improving safety 16
2.2.1 Eliminate the need for students to cross the road 16
2.2.2 Prevent students from heedlessly crossing the road 17
2.2.3 Minimise the consequences by slowing down traffic 18
2.3 Bus stop and turning point safety 20
2.3.1 Introduction 20
2.4 Evaluation of school bus signs 21
2.4.1 Method 21
2.4.2 Results 22
2.4.3 Discussion 31
3 Safety of children while on school buses 33
3.1 Bus occupant restraints 33
3.1.1 Safety belts 33
3.1.2 Compartmentalisation 35
3.1.3 Cost-benefit analysis of safety belts on school buses 35
3.1.4 Discussion 37
3.2 School bus management standards 37
3.2.1 Closing the loop 38
3.2.2 Performance standards 38
3.2.3 Ministry of Education school bus operator contract 41
4 Recommendations 42
4.1 Improving the safety of children who have to cross the road to and from school buses 42
4.1.1 Minimising the need for students to cross the road 42
4.1.2 Preventing children from running heedlessly across the road: 42
4.1.3 Minimising the consequences by slowing down the traffic when children are crossing: 43
4.2 Reducing the risk of injury while travelling on school buses 44
5 References 45
Appendix A: Draft school bus stop and turning point safety guide 48
Appendix B: Crashes during 1987 to 2007 involving students crossing the road to or from a school bus 89
Appendix C: Safety belt and occupant impact protection requirements 94
Appendix D: Maintenance management 96

Abbreviations and acronyms

ACC	Accident Compensation Corporation
BCA	Bus and Coach Association
BUSSTAC	Bus Safety Technical Advisory Committee
CAS	crash analysis system
CoF	certificate of fitness
H&S	health and safety
LTSA	Land Transport Safety Authority (now NZ Transport Agency)
NHVA	National Heavy Vehicle Accreditation
OECD	Organisation for Economic Co-operation and Development
NZTA	NZ Transport Agency
PSV	passenger service vehicle
SESTA	Special Education School Transport Assistance

Executive summary

This research project was initiated by the Bus Safety Technical Advisory Committee (BUSSTAC), which comprises representatives from the Ministry of Education (as lead organisation), NZ Transport Agency (NZTA), Ministry of Transport, NZ Police, Bus and Coach Association (BCA), bus builders and bus operators. BUSSTAC has taken a long-term (20 to 30 years) holistic approach that includes identifying the risks and risk management issues arising from travelling to school by bus (LTSA 2002). The purpose of this research was to advance the measures that were seen as having the most promise.

There is considerable concern in the community, especially the rural community, about the number of children being killed or seriously injured when crossing the road to or from school buses. In the 21 years from 1987 to 2007 inclusive, 22 children were killed, 45 were seriously injured and 91 received minor injuries when crossing the road to or from a school bus. This equates to, on average, one fatal, 2.1 serious and 4.3 minor injuries reported to the Police each year. In addition six children were killed, 35 seriously injured and 112 received minor injuries as passengers in school buses during that time. Approximately 20% of school pupils (106,000 pupils) are transported to school by Ministry of Education funded bus services.

School bus safety can be divided into two parts:

1 The safety of children crossing the road to or from a school bus

2 The safety of children while travelling on a school bus.

The safety of children crossing the road to or from a school bus

When considering the options to reduce the number of children killed or injured when crossing the road to or from school buses, it must be remembered that children, especially children of primary school age, are poor judges of traffic speed and are often impulsive.

It is standard health and safety practice to address hazards by eliminating them where possible; or if they can't be eliminated, isolating them; or if they can't be isolated, minimising them. In the context of the safety of children crossing the road to or from school buses, this translates to:

- eliminating the need for students to cross the road
- preventing children from running heedlessly across the road
- minimising the consequences by slowing down the traffic when children are crossing.

Eliminate the need for students to cross the road

Encourage caregivers to meet their children at the bus stop. The NZ Police, NZTA, Ministry of Education, schools and community groups have been raising awareness of the need for caregivers to meet their children at the bus stop, including parking on the same side of the road as the bus. Reminding caregivers of their responsibilities is not sufficient on its own because, as many studies have found, convenience plays an important role with perceived risks weighed up against the time and effort required (Lobb 2006). Overcoming this barrier may be difficult and may require engineering measures such as improved parking facilities near bus stops.

Rearrange bus routes to reduce the number of children who have to cross the road. The Ministry of Education and their service agents try to configure bus routes to minimise the number of children who have to cross the road. School bus routes are reviewed every two years. The limiting factors are extra running costs if the routes need to be extended and require students to stay on the bus longer, especially if the bus drives past their house on the way out but they are not allowed off until the bus returns on their side of the road.

Improve bus stops. Some road authorities have been improving school bus stops as the opportunity arises. A draft bus stop guide has been developed (see appendix A) to assist road authorities with upgrading bus stops, especially on major roads in rural areas. An important feature of rural bus stops is the provision of parking for caregivers who are waiting for a bus to arrive. Providing parking at bus stops will reduce the number of children who have to cross the road. It is recommended that the draft guide be adopted by the NZTA and that priority be given to upgrading bus stops on state highways and major local roads.

Preventing children from running heedlessly across the road

Caregivers, bus drivers, schools and other stakeholders have a shared responsibility to do what they can to make sure children cross the road safely. While there have been some questions about the effectiveness of educational and awareness-raising interventions, there are things that can be done that are not difficult or expensive. For example caregivers can be reminded regularly what safe road crossing is and that they need to model it to the children they are looking after. School community-based initiatives, such as bus wardens and neighbours taking turns to meet the bus should be encouraged. Children should be reminded of the need to take care. The Ministry of Education has produced a fact sheet that explains the responsibilities of all parties, including caregivers, bus drivers and schools.

Road safety education. Improving attitudes to and knowledge of how to cross safely is taught by the NZ Police as part of its road safety education programme. The Ministry of Transport is currently reviewing young person road safety education and the effectiveness of what is currently delivered by schools, driving instructors and other road safety education providers.

Minimising the consequences by slowing down traffic when children are crossing

The greatest gains will come from changes to bus routes, better bus stops and other measures that remove the need for children to cross the road. However, funding for engineering solutions and longer bus routes is limited and these will take time to implement. In the absence of these measures, the next most effective approach is to slow down the traffic when children need to cross. This is because children of primary school age, in particular, are poor judges of vehicle speed, are impulsive and caregivers cannot always be present when children need to cross the road. In order to be able to slow down the traffic, it is recommended that:

- The legal requirements should be changed to enable effective enforcement. It is currently difficult for the NZ Police to enforce the 20km/h speed limit on motorists passing school buses that are picking up or dropping off students. This has meant that there have been virtually no prosecutions of motorists speeding past school buses despite the very high level of non-compliance. It is recommended that the Land Transport (Road User) Rule 2004 (SR2004/427) section 5.6 be amended to enable effective enforcement of the speed limit. A number of studies have found that punishment can be more effective than awareness-raising campaigns and education in changing behaviour (Lobb 2006). When considering amendments to the Rule it is recommended that:

  - the speed limit be reviewed. The research suggests that the speed limit around school buses should be the same as that in other high-risk areas such as outside the school gate, in shared main street spaces and near road works. This uniformity is likely to increase driver awareness and the level of compliance
  - the speed limit should apply whenever approved warning lights are activated, including when the bus is moving to or away from a bus stop
  - the sign should only be activated when students are very likely to cross the road
- Active speed signs should be installed on school buses. A new active sign should be developed based on the findings of the trial undertaken for this project. Cost, ease of installation and effectiveness need to be considered. Ideally the new sign should be implemented in conjunction with a law change as proposed above, but if that is not possible, a '20' sign would help to slow motorists on its own. Some community groups have indicated that they may be able to fund the installation of a limited number of signs until their use can be included as a requirement in the Ministry of Education school bus services contracts.
- Driver awareness campaigns should be continued. A number of organisations, such as Rural Women New Zealand, SafeKids New Zealand, NZ School Trustees Association, the NZTA, Accident Compensation Corporation and local authority road safety coordinators have put a lot of effort and thought into trying to slow down traffic with billboards and other awareness-raising measures that remind drivers of the legal speed limit when passing a school bus.

If funds are limited, priority should be given to improving bus stops, installing the new active signs on school buses, and enforcement of the speed limit rather than driver awareness campaigns. Active speed signs are of direct relevance to motorists in that if they ignore them, there is a risk they will be prosecuted or, worse could kill a child. Billboards and other passive measures rely on remembering the message the next time they come across a school bus.

The safety of children while travelling on a school bus

A 1987 rollover crash resulted in five of the six deaths of school bus passengers that occurred in the 21 years between 1987 and 2007. During that crash the bus structure failed, resulting in the occupants being ejected from the bus and crushed by the bus rolling on top of them. That incident resulted in bus and coach structural strength requirements being introduced.

The following options were investigated to further improve the safety of school bus passengers.

- **School bus management standards**. Since this research project started, the Ministry of Education has written into their school bus contracts more stringent requirements for the construction and maintenance of school buses. This appears to have been effective as a recent NZ Police sting operation in the Coromandel Peninsula found that none of the 39 school buses inspected had vehicle safety faults (BCANZ 2010). It is recommended that the Ministry of Education and the NZTA continue to encourage bus fleet operators to adopt best practice.
- **Occupant protection**. The bus structural strength requirements appear to have been effective in reducing the risk to injury during bus crashes. Further improvements in occupant protection could include having higher seat backs. However, retrofitting older buses with these seats may not be justified because of the cost.

Abstract

In the 21 years from 1987 to 2007 inclusive, 22 children were killed, 45 seriously injured and 91 received minor injuries when crossing the road to or from a school bus. In addition, six children were killed while passengers on a school bus. As a result, there is widespread concern about school bus safety. This research project aimed to identify and advance those measures seen as having the most promise in terms of improving school bus safety in New Zealand. The scope of the research included both safety on school buses and safety when crossing the road to or from a school bus. The research team and project steering group (the Bus Safety Technical Advisory Committee (BUSSTAC) led by the Ministry of Education, identified and evaluated a wide range of safety improvement options. Detailed recommendations for improving school bus safety, including road engineering improvements around bus stops, bus signage, enforcement and educational/information campaigns were developed.

1 Introduction

This project was initiated by the Bus Safety Technical Advisory Committee (BUSSTAC), which comprises representatives from the Ministry of Education (as lead organisation), NZ Transport Agency (NZTA), Ministry of Transport, NZ Police, Bus and Coach Association (BCA), bus builders and bus operators. Before being known as BUSSTAC the 'Overview Group on School Bus Safety' reviewed all aspects of safety in order to determine the types of measures that would be effective in minimising the risk to children travelling by school bus. It took a long-term (20 to 30 years) holistic approach that included identifying the risks and risk management issues arising from catching the bus, the journey, disembarking and the immediate vicinity of the bus post-journey, and vehicle and driver standards (LTSA 2002). The purpose of this research was to advance the measures that were seen as having the most promise in terms of improving safety.

There is considerable concern in the community, especially the rural community, about the number of school bus users being killed or seriously injured:

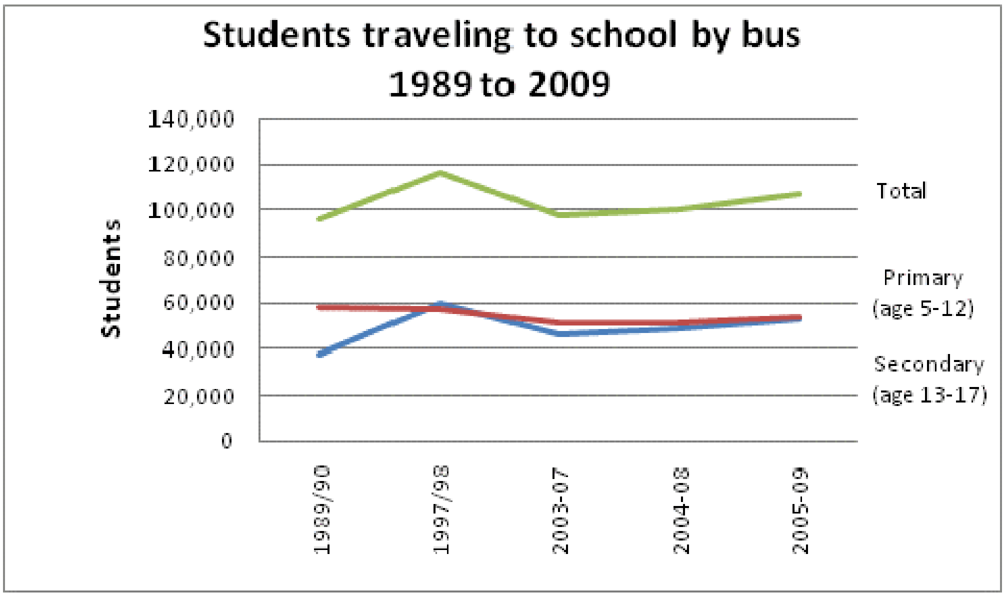
- School bus crashes receive a high level of media attention.
- Several recent coroners' reports have raised serious concerns about school bus safety and recommended that immediate action should be taken.
- The National Council of Women New Zealand recently passed a resolution calling for 'all school buses, while conveying children to and from school display distinctive and active signage, including the maximum speed at which a vehicle may pass a stationary school bus'.
- The New Zealand Society of Paediatric Surgeons, in a recent submission to government, expressed 'unprecedented concern at the increasing rates of admission for primary preventable conditions of a surgical nature in New Zealand children'. New Zealand has one of the highest death and injury rates in the OECD for accidents among children under 19.

Approximately 106,000, or 20% of all students who attend primary and secondary schools, travel to school by bus. This estimate is based on the results of the NZ Household Travel Survey and includes students aged between 5 and 17 who attended school between 2005 and 2009. The NZ Household Travel Survey is an on-going survey of 4600 households throughout New Zealand (MoT 2009). This estimate is similar to that obtained by Schofield et al (2008) who found that 23 ±0.45% of 5 to 17 year olds travelled to school by bus. That survey ('Census at Schools') was internet-administered in 2005 and was completed by 32,973 randomly selected students from 721 schools across New Zealand. The survey was nationally representative of school-related travel.

It should be noted that the Ministry of Education does not fund/provide transport for all students who travel to school on a bus. Most of the urban school bus services are provided by regional councils and most of the rural bus services are provided and/or funded by the Ministry of Education.

Figure 1.1 shows the number of students travelling by bus to school between 1987 and 2009 inclusive, based on the NZ Household Travel Survey data.

Figure 1.1 Number of students travelling to school by bus between 1989 and 2009



The Ministry of Education spent approximately $150 million on school transport services in the financial year to 30 June 2009 (Ministry of Education 2009c). This includes:

- Ministry-contracted school bus services. Ninety-five school bus operators provide services on 1470 Ministry-contracted daily bus routes and 701 technology routes (daily bus routes bring children to or from school while technology routes transfer primary school children from one school to another for technology lessons).
- Direct resourcing of schools to provide their own transport services. There are 576 directly resourced school transport routes.
- Special Education School Transport Assistance (SESTA). Approximately 4295 students were transported by taxis and minibuses to school in 2007 for an annual cost of approximately $24 million (Larcombe Consulting Ltd 2008).
- An allowance for children who qualify for school transport but no service is available.

Research both in New Zealand and internationally shows that school buses are one of the safest ways for students to travel to and from school. Schofield et al (2008) used Accident Compensation Corporation (ACC) claim data to estimate the risk of injury during the trip to school for the different transport modes (walking, private motor vehicle, bus, cycling etc). They found there were 2.59 (±0.01) injuries per million bus trips compared with 6.08 (±0.03) injuries per million private motor vehicle trips and 10.3 (±0.05) injuries per million walking trips to school. Similarly Granville et al (2002) found that in Scotland children travelling by car to school had a higher incident rate (incidents per trip) than children travelling by bus by a factor of seven. For their analysis, a bus- or car-related incident was for the time they were in the vehicle, not walking to or from the vehicle. While school buses are relatively safe, children continue to be injured or killed while travelling by bus to school. Given that over 100,000 students travel to school by bus, any improvement in school bus safety has the potential to reduce injury for a substantial proportion of New Zealand students.

It is not possible to offer students door-to-door services. However, in providing school transport assistance the Ministry of Education, in conjunction with other government agencies, has a number of school-related safety initiatives. For example, the Ministry of Education and other agencies provide guidance for caregivers and school children on the correct way to cross the road after exiting a school bus. The children are told to find a safe place to wait until the bus has moved away and then check the road both ways before crossing. The NZ Police and the NZTA deliver education programmes and other resources designed to enable children and young people to act safely on roads and amongst traffic. The NZTA has guidelines for the establishment of school bus stops to ensure students are clearly visible to motorists.

A number of other organisations and individuals are also assisting with school bus safety. They include:

- Rural Women New Zealand
- Local authority road safety coordinators
- New Zealand School Trustees Association
- NZ Parent Teachers Association
- NZ National Council for Women
- SafeKids New Zealand
- New Zealand Principals' Federation
- Round Table New Zealand.

They have:

- produced posters, brochures and other material aimed at making motorists more aware of the 20km/h speed limit when passing a school bus that has stopped to pick up or drop off children
- trialled new signs on buses and supported child road safety awareness campaigns
- spoken to schools and community groups and lobbied for change
- provided training for children and parents

These efforts have been largely at a local level.

School bus safety can be divided into two separate parts:

1 **The safety of children crossing the road to or from a school bus.** This includes:
   a rearranging bus runs to reduce the number of children who have to cross the road
   b improving the visibility and condition of bus stops
   c encouraging caregivers to meet their children at the bus stop
   d assisting younger children with crossing the road
   e improving road safety awareness and skills
   f slowing down the traffic when passing a school bus that is picking up or dropping off children.
2 **The safety of children while travelling on a school bus.** This includes:
   a improving the safety of school buses, including how they are managed and maintained and how they are driven
   b improving passive safety systems, such as ensuring passengers are contained in the bus during a rollover incident to protect bus occupants should a crash occur.

The report addresses these issues in turn.

2 The safety of children crossing the road to or from a school bus

2.1 Current situation

A detailed analysis has been undertaken of all NZ Police reported crashes on the crash analysis system (CAS) database managed by the NZTA. The database was searched for incidents that involved:

- children who were pedestrians at the time of the incident
- children were aged between 0 and 17 years old
- a school bus that was in the vicinity of the crash scene
- crashes that occurred between 6am and 9am, and 2pm and 5pm on school days (not holidays or weekends)
- crashes during the period 1987 to 2007 inclusive.

Where available, the reporting officer's hand-written notes were extracted from the CAS database and included in the analysis.

In the 21 years from 1987 to 2007 inclusive, 22 children were killed, 45 were seriously injured and 91 received minor injuries when crossing the road to or from a school bus. This equates to, on average, one fatal, 2.1 serious and 4.3 minor injuries that are reported to the Police each year. Although it is required by law, not all injury accidents are reported. Further details are provided in appendix B

Of the reported crashes:

- 85% occurred in the afternoon on the way home from school
- 86% of the fatal incidents but only 39% of all incidents (fatal and injury) occurred in speed zones greater than 50km/h
- a similar number of children appeared from the front as from the rear of the bus
- there were no reported crashes on unsealed roads. As the number of children who travel by bus on unsealed roads is not known, it is not possible to say whether travelling on sealed roads is any more dangerous than unsealed roads and vice versa.

Figure 2.1 shows the annual fluctuation in the number of students killed and injured. It cannot be concluded from this graph that there has been any significant improvement or reduction in safety.

Figure 2.1 Number of children killed or injured annually crossing the road to or from school buses

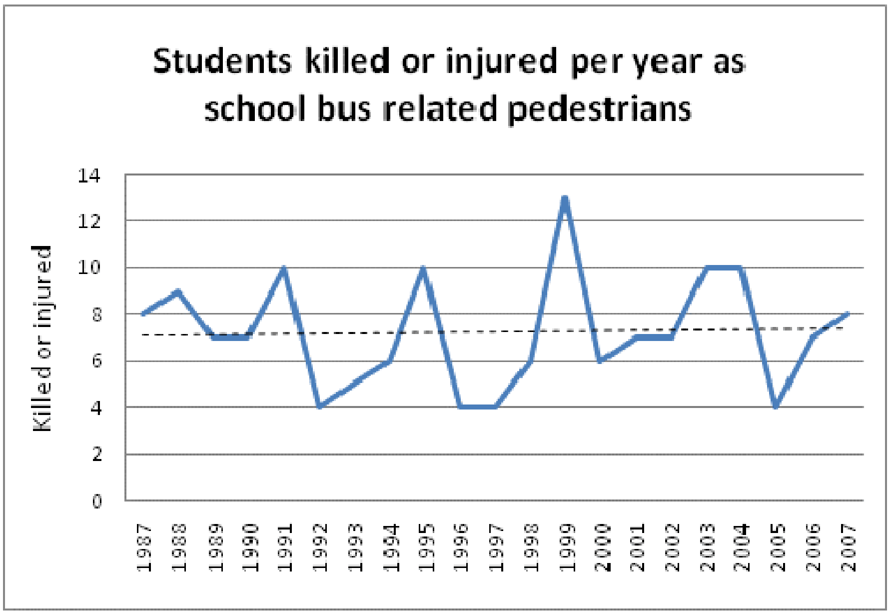
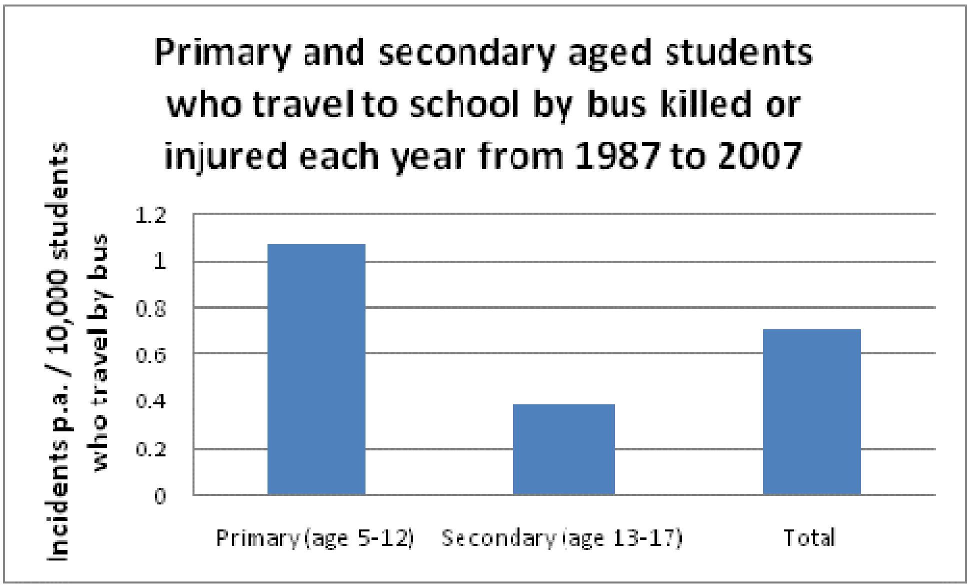


Figure 2.2 shows the number of incidents per 10,000 primary and secondary aged students who travel to school by bus each year. The number of students who travel by bus was estimated using NZ Household Travel Survey data.

Figure 2.2 Annual incidents per 10,000 primary and secondary school students



It would appear that there is a greater risk of primary-aged children being killed or injured than secondary-aged students. This is consistent with the published literature on child pedestrian injures. A meta analysis undertaken by Wazana et al (1997) found that pedestrians aged from 5 to 12 had the highest risk of being injured by a vehicle. Eight to 12 year olds had rates of injury per km travelled, time spent on the road or on road crossings that were about twice as high as children three to seven years old and six times higher than children aged 13 to 17. Children aged five had rates of injury per crossing per child that was 3.6 times higher than nine year olds. Five-year-old boys were 2.3 times more likely to be injured while crossing the road than girls of the same age. Read et al (1963), cited in Wazana et al (1997), found that child pedestrians who were injured were likely to be more impulsive, less attentive, more daring and less well adjusted socially than other children.

No correlation was found between the number of incidents and which month they occurred in. This is consistent with the findings of Stevenson et al (1993), cited in Wazana et al (1997), who found that day and month were not correlated with pedestrian injuries.

2.2 Options for improving safety

After considering a wide range of options to strengthen the current safety arrangements BUSSTAC, as the project steering group, agreed that no single solution existed. Rather a package of measures was required. It is standard health and safety practice to address hazards by eliminating them where possible; or if they can't be eliminated, isolating them; or if they can't be isolated, minimising them. In the context of the safety of children crossing the road to or from school buses, this translates to:

1. eliminating the need for students to cross the road
2. preventing children from running heedlessly across the road
3. minimising the consequences by slowing down the traffic when children are crossing.

These options were discussed at length with BUSSTAC, at key stakeholder consultation meetings and with officials in the relevant government ministries and agencies. The following is an analysis of the options that were raised.

When considering the options it needs to be remembered that children are poor judges of traffic speed and often impulsive. Connelly et al (1998) found that while some 11 to 12 year olds, especially girls, can be expected to make safe crossing decisions, younger school children are not able to reliably or consistently estimate approaching vehicle speeds, especially when speeds are over 60km/h. They primarily base their decisions on distance rather than both speed and distance. Connelly et al (1998) also note that children are often impulsive, distracted and delay decision making to the last moment.

2.2.1 Eliminate the need for students to cross the road

The safest option is to eliminate the need for children to cross the road or, if they have to, that they do so with a responsible adult. The options for achieving this include:

- **Rearrange bus runs** to enable more children to be dropped off on the side of the road where they live. Within current constraints, the Ministry of Education service agents are required to consider safety when considering changes in school bus runs. The Ministry of Education policy and procedures could be strengthened by making specific reference to the aim of eliminating (where possible) the need for students to cross the road.

- **Caregivers meeting their children at a bus stop.** Some of the crashes occurred when caregivers were waiting on the opposite side of the road while their children crossed. An awareness campaign will help to encourage caregivers to drop off or meet their children at the bus stop. The provision of better bus stops may also encourage more caregivers to wait on the same side of the road as the bus stop.

- **Improve school bus stops.** Some local authorities have been improving school bus stops in rural areas by, for example, providing parking for caregivers at afternoon bus stops to avoid the children having to cross the road. They have also widened the seal to enable buses to pull off the road and there have been improvements to the areas where children have to walk. Highest priority should be directed to stops on high-speed, high-volume roads (eg state highways), used in the afternoon by a number of children (eg greater than four to start with) and that are likely to be used on a permanent basis. However, while ensuring that the bus stops will be used on a permanent basis is important from a funding perspective, this may reduce flexibility in routing buses. A draft bus stop and turning bay guide has been developed as part of this project and is described in section 2.3 and appendix A.

2.2.2 Prevent students from heedlessly crossing the road

The next broad category of interventions is to provide children with help and supervision to prevent them from crossing in the face of on-coming traffic. This includes: adults helping younger children to cross the road, teaching children how to cross the road safely and making children very aware of the dangers involved.

Supervision of children crossing the road. School transport assistance policy operates on the basis of a shared responsibility between the Crown and caregivers. More clearly defining who is responsible for the safety of children at various stages of their trip to and from school could strengthen the current safety regime. As caregivers have the responsibility for ensuring the safety of their children once they leave a school bus, more emphasis should be put on ensuring parents do not place their children at risk by, for example, waiting for them on the opposite side of the road. School community-based initiatives, such as bus wardens and neighbours taking turns to meet the bus should be encouraged.

Education. Road safety education is included in the overall programme for student wellbeing and is taught within the normal school curriculum. A review of what is provided may identify areas where further improvements can be made. For example, road safety education programmes currently target students. In future, caregivers could also be targeted. Morrongiello and Barton (2009) found that, in Canada, few parents actually provided their children with any instruction on how to cross the road safely and were not able to assess their child's ability to cross the road independently. There is no reason to believe the situation is any different in New Zealand as there is currently very little training for caregivers.

An OECD report on keeping children safe in traffic noted that:

> *although parents wish to keep their children safe and often accompany them in the traffic environment, they may not exhibit appropriate road safety behaviour themselves. Children learn by imitation and careful observation of adults and begin developing road safety skills well before they reach school age. As children mature, their parents may have less influence over their actions than their peers. It is therefore important to instil sound safety habits in children early in their development. For pre-teens and adolescents, safety skills need to be reinforced and positive attitudes towards safe behaviour, such as strategies for handling peer pressure and risks, need to be developed. The emerging responsibility of youngsters for road safety of other road users, like young children, the elderly and handicapped, also offers a subject for discussion* (OECD 2004).

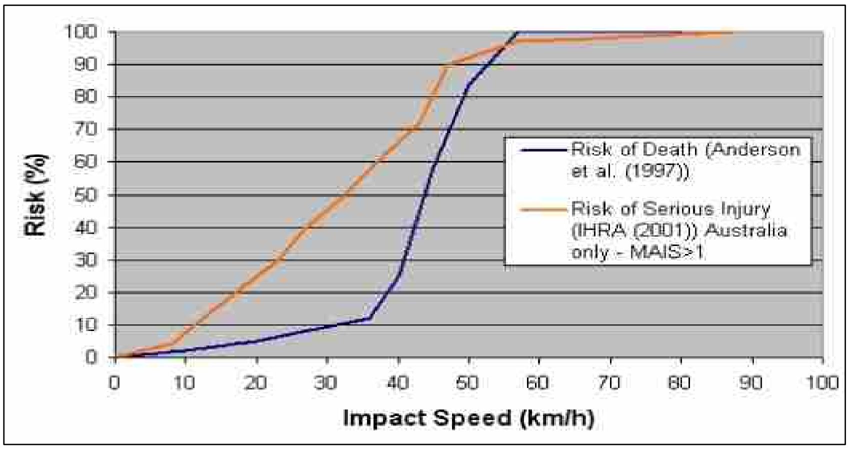
There may also be a case for a focus on training pre-schoolers given that automaticity may be more easily established in the young. Congiu et al (2008) found that appropriate traffic exposure was beneficial in acquiring road skills.

While there is some evidence that attitudes towards safe behaviour may be improved, research has not yet demonstrated convincingly that raising awareness is sufficient on its own to reduce incidence of unsafe behaviour (Lobb et al 2003). The Ministry of Transport is currently reviewing young person safety education and the effectiveness of what is delivered by schools, driving instructors and other road safety education providers.

2.2.3 Minimise the consequences by slowing down traffic

The third option is to minimise the likelihood of children being killed or injured if they do happen to cross the road in the face of on-coming traffic. In many instances, children have suddenly appeared from behind the bus, giving speeding motorists no time to respond. The only practical option available is to slow down the traffic. However, very few motorists observe, or are aware of, the current 20km/h speed limit when travelling past a school bus and this speed limit has proved to be difficult to enforce. The penalty for travelling 50km/h over the speed limit (ie at 70km/h) is automatic loss of licence. Despite that, average speeds of over 84km/h were recorded on a 100km/h road during the BUSSTAC school bus signs trial (see section 2.4 below). In considering options for slowing down the traffic, it is important to consider two inter-related factors: the dangers posed by speed, and stopping distance. Archer et al (2008) contains the census view of the probability of a pedestrian being killed or seriously injured when hit by a vehicle. A copy of the graph from Archer et al (2008) is shown in figure 2.4. Hamilton-Baillie (2008) noted that human skull thickness and physiology had evolved to be able to survive an impact at our maximum running speed, which is about 30km/h.

Figure 2.4 Census view on the risk of death and serious injury if pedestrian struck by a car (Archer et al



2008)

Drivers need to be warned at least 250m ahead if they are to slow down from 100km/h to 40km/h using gentle braking[1], or 275m ahead if they have to slow down to 20km/h (Paine and Fisher 1996). That will enable them to slow down 30m before the bus so they can brake hard if a child suddenly appears. They could brake harder when they first see the school bus, and hence reduce the stopping distance, but that would increase the risk of nose-to-tail crashes, dangerous overtaking and other unsafe practices.

From 40km/h, a vehicle will be able to stop by braking hard if a child steps out 30m ahead. At 20km/h they will be able to stop in 11m (about the length of a bus). At 60km/h they will still be doing 54km/h 30m after they start braking hard.

The current NZTA guideline for the safe placement of school bus stops requires the stops to be visible from a distance of at least 250m in both directions on roads with a 100km/h speed limit (LTSA 2004). This is not always physically possible because of the number of curves and hills on our roads.

[1] It is assumed that vehicles typically slow down at approximately 0.1g with just engine braking, 0.2g under gentle braking and 0.5g under hard braking. Heavy vehicles are required to have brakes that will stop them at a deceleration of, at least 0.5g.

In the USA, all traffic must stop when a yellow school bus has stopped to pick up or drop off children. This requirement has been in place for over 60 years and there is a high level of public acceptance and awareness. The (NHTSA 2000) survey on speeding and other unsafe driving behaviours found that 99% of US drivers interviewed felt that passing a school bus with its lights flashing and stop arm extended was more dangerous than any other unsafe driving behaviour, more dangerous even than racing another driver, driving through a stop sign or red light, crossing railroad tracks with red lights blinking, passing in a no-passing zone, and speeding. By comparison speed surveys undertaken as part of the school bus sign evaluation (section 2.4) and by the Central Otago and Queenstown Lakes District Councils (pers com J Robinson) found there was very little compliance with the requirement to slow to 20km/h when passing a school bus in New Zealand. Even in the USA with their level of acceptance and familiarity of the requirements, some motorists do not stop and children are still killed, although proportionally a lot fewer than in New Zealand (NHTSA 2006).

Along with other well-practised behaviours, most driving actions are performed semi-automatically. For example, when we see a stop sign ahead, we generally slow down without consciously thinking about it. Most drivers only occasionally pass a school bus at a bus stop and therefore the appropriate response, to slow down, has not become automatic, as reflected in the high level of non-compliance. In order to develop automaticity of this response, international best practice is to have the same speed limit for all situations where vulnerable road users may be present, for example in the vicinity of schools, school buses, shopping precincts, road works and engineered residential ‘liveable streets’.

Motorists will then know instinctively that they need to slow down, and by how much, whenever they sense pedestrians may be present. In Sweden the speed limit when pedestrians are present is 30km/hr (Archer et al 2008). The UK government favours the adoption of the 20mph (32km/h) speed limit, which has been adopted by a number of UK local authorities, and other countries are adopting the 30km/h speed limit to protect vulnerable road users (Dept for Transport UK 2009). Wellington and Manukau City Councils are considering adopting 30km/h speed zones in pedestrian areas and outside all schools.

The speed limit around school buses would benefit from being standardised to that around schools in order to increase compliance by drivers. The New Zealand Society of Paediatric Surgeons has petitioned government for a reduction of the speed limit around schools and in other areas of high child populations to 20km/h, the same as the current school bus speed limit (Collins 2009). The NZ Automobile Association and other groups believe that the school bus speed limit should be raised to 40km/h because familiarity with 40km/h school zones will result in greater compliance when passing buses. They are also concerned that it is too dangerous for motorists to slow down to 20km/h with little advance warning, especially from high speeds, and that it will be difficult to achieve a high level of compliance because of the risk of being tail ended or overtaken dangerously. A number of instances of dangerous overtaking were observed during the BUSSTAC school bus sign trial undertaken on a 100km/h road.

According to the US Transportation Research Board (TRB 1998), compliance with any regulation, such as a speed limit, requires that it is perceived as a reasonable constraint on behaviour. It is believed that public support (ie willingness to obey) is closely linked with the requirement of reasonableness of speed limits. If attempts are made to enforce unreasonable speed limits, large numbers of violations will result and law enforcement will provide little help in controlling speeds.

Once the speed limit has public support, a learning process is required to change driver behaviour to the point where it becomes normal for them to slow down for school buses. This learning process requires a combination of public awareness, warning devices, driver education and enforcement.

The following two sections describe in more detail two of the interventions: 1) improved bus stops and turning bays, and 2) improved warning devices on school buses.

2.3 Bus stop and turning point safety

2.3.1 Introduction

This section describes the technical and safety considerations involved in the placement and design of school bus stops and turning points. It covers school bus stops at or near schools and on roads in both urban and rural areas. However, in urban areas, school buses generally use bus stops provided by the local authorities for other bus or coach services.

In November 2004, the Land Transport Safety Authority (LTSA), now the NZ Transport Agency, published *Guidelines for the safe siting of school bus stops* (LTSA 2004). This brief document covers the main principles that should be considered when locating school bus stops. It also provides basic technical advice, including check lists, for considering single school bus stops and school bus routes.

With the exception of the LTSA guideline, there is very little published information about the design and safe operation of school bus stops and turning points which could be relevant to the type of school bus services that operate in New Zealand. However, an unpublished report prepared in 2006 by ARUP consultants for the Ministry of Transport in Victoria, Australia, (previously the Department of Infrastructure (DOI)), is very thorough and well thought out (ARUP 2006). This report titled *Rural school bus stop and school interchanges – safety guidelines and typical treatment* covers rural roadside school bus stops and school-located interchanges in Victoria. The report provides guidance on principles, guidelines for good practice, hierarchy of potential treatments, typical treatments and costs together with case studies.

Due to the comprehensiveness and completeness of the ARUP (2006) report, its use of technical traffic engineering standards which are also used in New Zealand (AUSTROADS *Guide To traffic engineering practice* (2005)), and the presentation of solutions which could also apply in New Zealand conditions, permission was obtained from the Ministry of Transport in Victoria, to use the relevant content, together with the existing NZTA guidelines and the results of industry consultation as the basis for a draft New Zealand guide.

A copy of the draft 'New Zealand bus stop and turning point guide' is included in appendix A. The draft guide commences with a brief summary of road safety practice and some general guidance on bus stop design. These are applied to the development of good practice and a hierarchy of potential treatments for both roadside and school-located bus stops, considering traffic safety and passenger requirements. Typical treatments for school bus stops at midblock, intersection and school locations are illustrated, with a number of case studies and indicative costs for the treatment options. Checklists to assist review and audit of roadside and school-located school bus stops are provided.

It is accepted that the upgrading of bus stops will be an evolutionally process, often occurring when other work is being undertaken on the adjacent section of road or at specific locations of public concern. The crash data suggests that, in general, priority should be given to upgrading bus stops on sealed roads, with high traffic flows and speeds that are used in the afternoon to drop off children. This is because, while 61% of the relevant crashes occurred in 50km/h or lower speed zones, only 14% of the fatal crashes were in those zones. Eighty-five percent occurred after school. A similar number of students walked from the front and rear of the bus. There were no crashes on unsealed road.

2.4 Evaluation of school bus signs

The current speed limit of 20km/h when travelling past a school bus that is dropping off or picking up children is rarely observed despite being in the Road Code since at least the mid 1970s. A Central Otago and Queenstown Lakes District Councils' survey found that 95% of vehicles were speeding while passing a school bus that had stopped on the side of a 100km/h speed limited road. The average speed was approximately 83km/h (pers com J Robinson, Central Otago and Queenstown Lakes District Councils). Surveys in other parts of the country have also found that very few motorists slow down to 20km/h. The aim of this investigation was to provide an indication of the speed reductions that could be achieved through the use of signs, flashing lights and other measures on school buses. The current means of alerting motorists to a school bus are the yellow and black 'school bus' or 'school' signs, that must always be displayed when a bus is being used as a school bus.

2.4.1 Method

The evaluation of the signs was undertaken in two stages:

2.4.1.1 Effect on motorist speed and driving behaviour

The effect of the signs on traffic speed and behaviour was measured by trialling six signs on a school bus that was parked outside Te Kura Kaupapa Māori o Te Rau Aroha School on SH27 north of Matamata. This is a straight, flat section of road with a speed limit of 100km/h. To make the situation as realistic as possible, the bus was placed outside a school during normal school hours. The bus was parked adjacent to the northbound lane. It was not possible to undertake the tests during the times when motorists would expect children to be travelling to and from school because buses were not available then. The signs were placed on both the front and rear of the bus and tested for approximately 1.5 hours each. Traffic tube counters were placed on both sides of the road to measure traffic speeds and the number of vehicles passing in both directions. The behaviour of motorists was recorded on video. Table 2.1 shows the signs that were tested.

2.4.1.2 Warning sign perception survey

The purpose of the survey was to find out whether motorists consciously noticed flashing signs and to obtain their views on the effectiveness of the signs. The arrangements for the intercept were similar to those used by ACC for their roadside driver fatigue rest stop campaigns. ACC and NZ Police assisted with the arrangements and conduct of the survey. A school bus with the children symbolic sign and flashing lights (sign 4) was parked on the roadside approximately 1km north of Tatuanui School on SH27. The intercept was well out of sight from the stretch of road where the bus was parked and the motorists would not have been aware of the presence of the police or other activities related to the intercept until they had travelled passed the bus, through a major intersection and around a corner. Motorists were stopped by the police just past the intersection at the front of the school. They were invited to take part in the survey in exchange for free coffee and food. The following questions were asked:

Q1: Do you recall seeing any other vehicles stopped along the highway on your way here, and if so, what type of vehicle was it? (If school bus, go to Q3)

Q2: Did you notice a school bus stopped on the road on your way here? (If 'no' finish interview)

Q3: Was it on the left or right side of road?

Q4: Did you notice anything about the bus? (If 'signs' skip to Q6)

Q5: Did you see any signage on the bus? (If 'no' skip to Q7)

Q6: Can you describe the signage you saw?

Q7: Did the bus affect your driving and, if so, how?

Q8: Finally, how would you rate the overall safety of the signs and lighting on that school bus on a scale of 1 to 5 with 1 being very unsafe and 5 being very safe?

At the end of the survey, the motorists were invited to comment on the other signs. Figure 2.5 shows the intercept stop and the bus that was used.

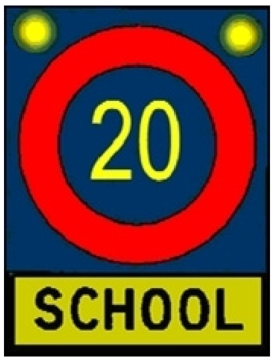
Figure 2.5 Intercept stop location and bus and sign used for the survey

2.4.2 Results

The results are summarised below.

In the analysis northbound traffic was on the same side of the road as the bus and southbound traffic was on the opposite side. Measured traffic volumes when the signs were being evaluated during school time were very similar to those measured before school on the same days between 7.30am and 9am (283 vehicles/h during the trial versus 304 vehicles/h between 7.30am and 9am). Dangerous driving incidents were selected from the videos. Those events included vehicles passing other vehicles while passing the bus. Some incidents involved light vehicles passing trucks. It is possible in those instances the light vehicle could not see the school bus signs because they were mounted relatively low on the rear of the buses.

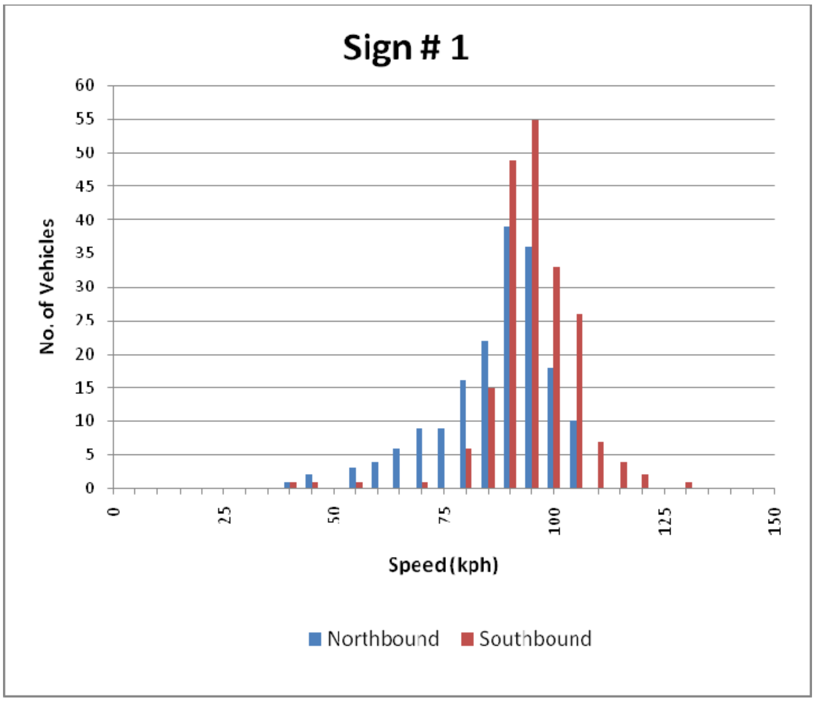
Table 2.1 Signs tested

1 Baseline: (825 x 300) to establish the 'status quo' (current sign).	
2 Current sign with normal bus hazard lights flashing.	
3 Symbolic sign (570 x 500) to establish the value of using the children symbol.	
4 Dynamic sign (570 x 500) to establish the value of using a symbolic sign with adjacent flashing lights. Estimated cost $1,000 to $1,500 per sign installed (100 or more units).	
5 Sign 4 plus text to examine any benefits of the accompanying word message.	
6 LED speed warning sign. New school speed zone sign installed near some schools. The sign is black when not activated. Using the school zone sign would help to raise public awareness of the sign and what it means. A '40' sign was used because of the time and cost involved in constructing a prototype '20' sign. Estimated cost $2,500 to $3,000 per sign installed (100 or more units).	

Sign 1: Baseline – (825 x 300) to establish 'status quo' (current sign)

Sign # 1	Northbound	Southbound
Vehicle count	175	202
Average speed	84	93
Standard deviation	13	10
Minimum speed	38	37
Maximum speed	104	129

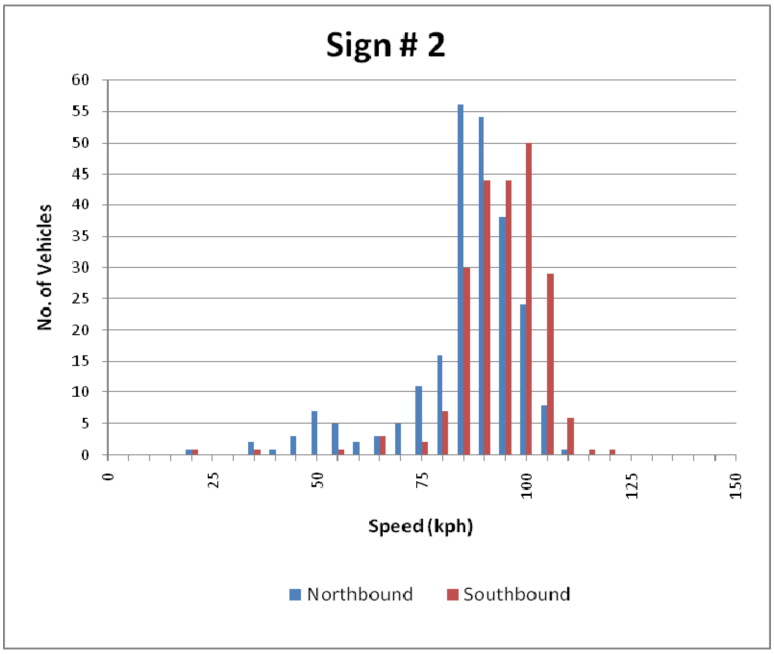
Dangerous driving incidents in 1.5 hours
3 involving traffic on bus side of the road
1 involving traffic on other side of road



Sign 2: Current sign plus normal bus hazard lights flashing

Sign # 2	Northbound	Southbound
Vehicle count	237	220
Average speed	83.	91
Standard deviation	14	11
Minimum speed	16	19
Maximum speed	106	118

Dangerous driving incidents in 1.5 hours
1 involving traffic on bus side of the road
0 involving traffic on other side of road



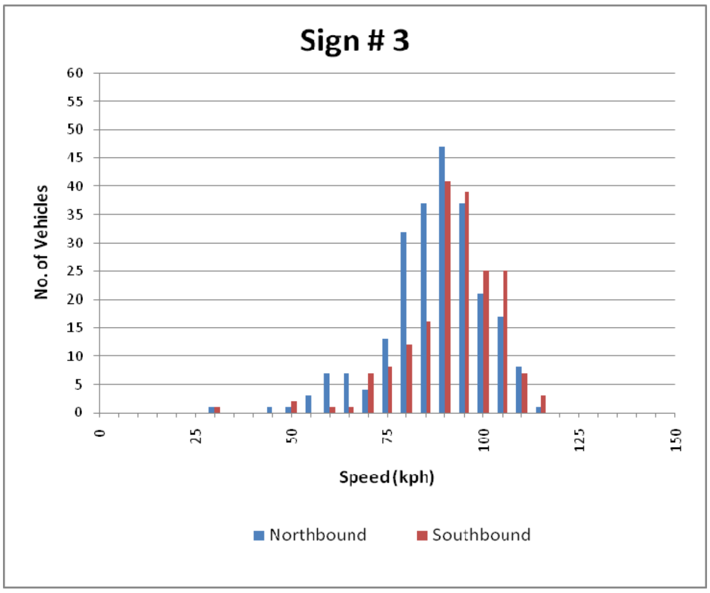
Sign 3: Symbolic sign (570 x 500) to establish value of using children symbol

Sign # 3	Northbound	Southbound
Vehicle count	237	188
Average speed	85	90
Standard deviation	13	12
Minimum speed	27	30
Maximum speed	113	113

Dangerous driving incidents in 1.5 hours

3 involving traffic on bus side of the road

0 involving traffic on other side of road



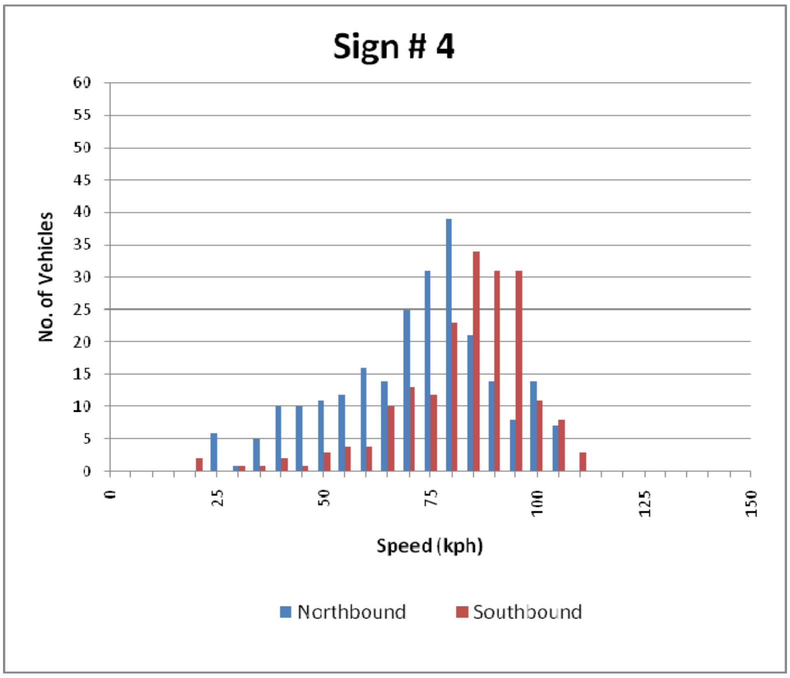
Sign 4: Dynamic sign (570 x 500) to establish value of symbol plus lights, and lights in proximity to signage

Sign # 4	Northbound	Southbound
Vehicle count	244	194
Average speed	69	80
Standard deviation	19	16
Minimum speed	20	15
Maximum speed	104	107

Dangerous driving incidents in 1.5 hours

3 involving traffic on bus side of the road

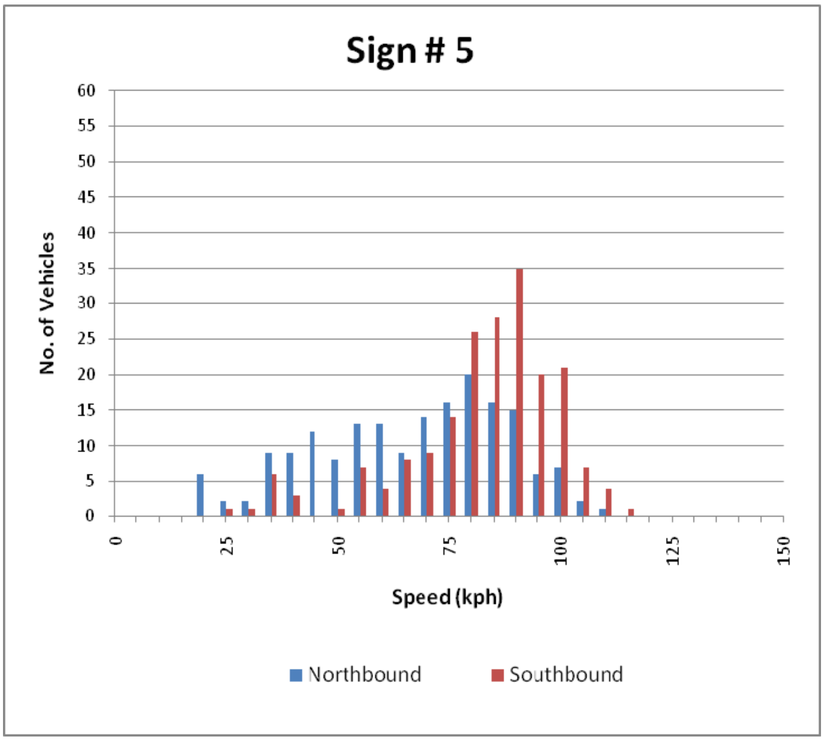
0 involving traffic on other side of the road



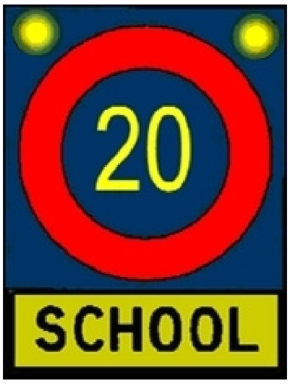
Sign 5: Sign 4 plus text to examine any benefits of the accompanying word message

Sign # 5	Northbound	Southbound
Vehicle count	180	196
Average speed	64	80
Standard deviation	21	17
Minimum speed	16	23
Maximum speed	106	111

Dangerous driving incidents in 1.5 hours
2 involving traffic on bus side of the road
0 involving traffic on other side of the road



Sign 6: Speed LED sign used for school zones



Sign # 6	Northbound	Southbound
Vehicle count	228	217
Average speed	57	67
Standard deviation	15	17
Minimum speed	30	27
Maximum speed	99	104

Dangerous driving incidents in 1.5 hours

4 involving traffic on bus side of the road

0 involving traffic on other side of the road

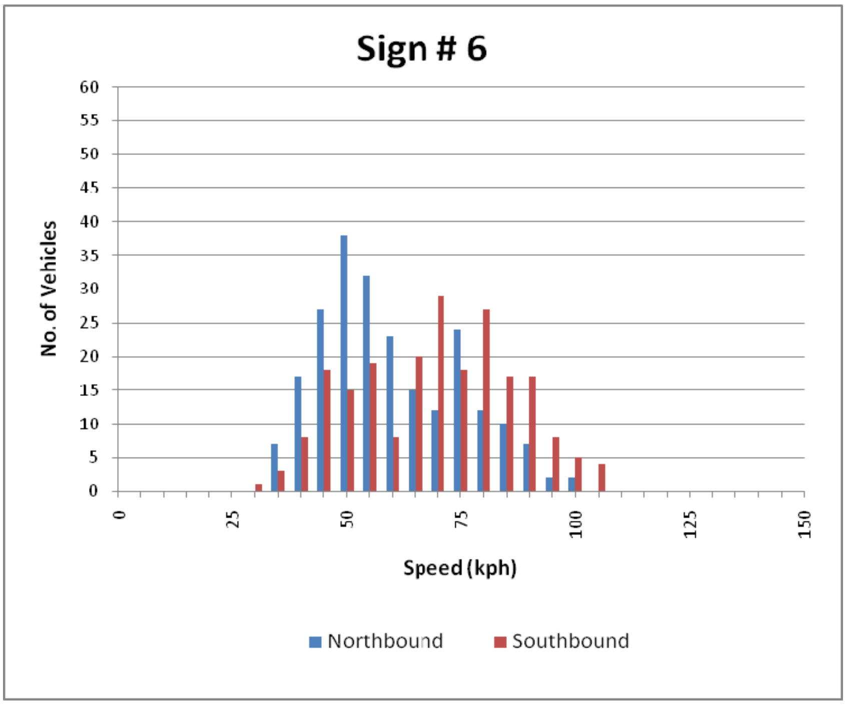
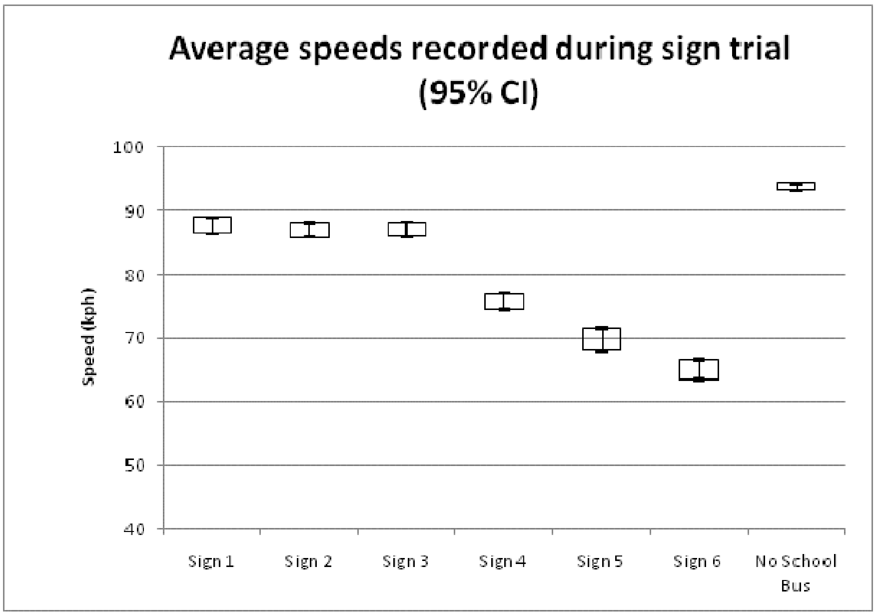


Figure 2.6 shows the average speeds for both directions of travel for the six signs and when no school bus was present. The boxes show the 95% confidence estimates of the average speeds. The results indicate that:

- in the presence of the bus with the current 'school' sign mean speeds were lower by approximately 6km/h
- there was no discernible difference in speeds in the presence of signs 1, 2 and 3
- in the presence of signs 4, 5 and 6 mean speeds were lower by 12km/h, 18 km/h and 23km/h respectively compared with when the school sign that is currently on nearly all school buses was present.

Figure 2.6 Average speeds passed a school bus with signs 1 to 6



2.4.2.1 Warning sign perception survey

The aim of the perception survey was to provide a reality check on the effectiveness of the signs from a driver perspective. Care needs to be taken in interpreting the results of the survey because of the small sample size (23 drivers) and the fact that participation was voluntary. The visible presence of the police may have also resulted in only the more safety-conscious motorists participating.

Approximately 40% of the drivers approached agreed to take part in the survey. Of these drivers:

- 87% said they had noticed the bus
- 78% said they had noticed the flashing lights
- 43% said they had noticed the symbol or school bus sign
- 61% said that they slowed down, 13% did not slow down and 26% did not know if it affected their behaviour.

Comments included:

- big improvement, highly recommended
- bigger sign needed with high-visibility strobe lights

- flashing light drew the attention
- having the flashing lights close together grabbed the attention – normal hazard warning lights don't
- enforce the 20km/h speed limit
- traffic should stop, change the law
- fluorescent vests should be provided to children
- bus stops should be made more visible.

2.4.3 Discussion

The results suggest that:

- The current sign (sign 1) had only a small effect on vehicle speed, reducing speeds by approximately 6km/h. However this reduction may well have been simply because of the presence of the bus.
- The addition of the bus hazard warning lights on (sign 2) made no discernible difference to vehicle speeds.
- Replacing the current signs with the standard children walking symbolic sign (sign 3) also made no discernible difference.
- The children symbolic signs that included two closely spaced flashing lights (sign 4) reduced average traffic speeds by 12km/h compared with sign 1. Drivers surveyed said that they noticed the flashing lights because they were clustered together.
- The addition of words telling motorists to slow down (sign 5) slowed the traffic by a further 6km/h.
- The flashing LED '40' signs (sign 6) reduced average speeds by 23km/h compared with the current sign (sign 1).
- There were, on average, 1.5 incidences of 'dangerous' driving per hour during the trial. The sample size was too small to determine if there were any differences between signs.

There are several factors, other than the signs, that may have influenced the speeds and behaviours of motorists:

- The signs were evaluated during school hours because there were no spare buses or drivers available when the buses would normally be out on their school bus runs. This would have had some effect on vehicle speed with drivers more likely to slow down when they are expecting children to be getting on or off a bus.
- The bus was empty while the measurements were being made. Again it is expected that drivers will slow down more if they can see students on the bus.
- Average traffic volumes were slightly higher before and after school (329 vehicles per hour) than when the measurements were taken (276 vehicles per hour). This may have affected the number of passing opportunities but there was no sign that traffic speeds were affected by congestion before or after school because of the traffic volume.
- Sign 6, which displayed the '40' sign, would have suggested to motorists that the speed limit was 40km/h rather than 20km/h. It is common at road works and other speed restricted sites for motorists to slow down to a speed that is close to but higher than that posted.

There are advantages in having the speed limit and signage around school zones the same as that around school buses when children are present. Many motorists only come across a stopped school bus on rare occasions.

On the other hand 20km/h is the legal speed limit for this situation. The ‘40’ LED sign was larger than the other signs tested and may be difficult to fit on some buses because of its size. A smaller ‘20’ is to be evaluated soon as part of a follow up project.

3 Safety of children while on school buses

3.1 Bus occupant restraints

This section discusses the effectiveness of safety belts and other forms of bus occupant restraint and protection systems.

3.1.1 Safety belts

Safety belts are a direct method of retaining passengers within a seating compartment. Safety belts provide occupant crash protection when high levels of deceleration are involved such as a head-on crash, and help to prevent ejection in the case of a rollover. Table 3.1 summarises the safety belt installation and use regulations in Australia, Canada, New Zealand, the United Kingdom and the USA. The summary of safety belt installation and use regulations in New Zealand was sourced from the Land Transport Rule: Seats and Seat Anchorages 2002 – Rule 32004, and the Land Transport (Road User) Rule 2004 – Rule 61001. The summary of regulations for the remaining jurisdictions was sourced from Swadling and Newman (2001). Further information is provided in appendix C.

Table 3.1 Summary of regulations regarding safety belt installation and use

Jurisdiction	Safety belt	Description
Australia	Required	Omnibuses up to 3.5 tonnes. Omnibuses over 3.5 tonnes that have more than 17 seats and seatback reference heights of more than 1m.
	Not required	School buses
	Use	Persons 16 years or older must wear a safety belt. In buses with 12 seats or less. The bus driver is responsible for ensuring passengers under 16 years wear a safety belt.
Canada	Required	Small buses weighing less than 4.5 tonnes.
	Not required	Large buses weighing 4.5 tonnes or more.
	Use	
New Zealand	Required	A front middle lap safety belt and three-point safety belt with emergency locking retractor for driver and front outer passenger on a passenger service vehicle with a gross vehicle mass not exceeding 3.5 tonnes first registered in NZ on or after 1 October 2002 (or 2003 if retrofitted): with more than 9 seats but no more than 12 seats including the driver's seat (class MD1); with more than 12 seats (class MD2) and is of a monocoque construction. Rear middle lap safety belt and lap safety belts on sideways-facing seating positions fitted to all MD1 and MD2 passenger service vehicles first registered in NZ on or after 1 October 2002.
	Not required	An omnibus with a gross vehicle mass exceeding 3.5 tonnes (classes MD3, MD4 and ME)
	Use	Persons 15 years or older must wear a safety belt if fitted. The bus driver must not permit passengers under 15 years to sit in the front seat without a child restraint or safety belt unless all sitting positions behind the driver's seat are occupied by passengers under 15 years. The bus driver must ensure passengers under 5 years use a child restraint unless no appropriate child restraint is available.
United Kingdom	Required	Minibuses carrying 9–16 people. Coaches carrying more than 16 people, GVM more than 7.5 tonnes, maximum speed of more than 60mph.

Jurisdiction	Safety belt	Description
	Not required	Coaches with GVM of 7.5 tonnes or less or, maximum speed of less than 60mph.
	Use	Persons 14 years or older must wear a safety belt. The bus driver is responsible for passengers under 14 years of age wearing a safety belt.
United States of America	Required	School buses weighing less than 4.5 tonnes
	Not required	Large school buses weighing 4.5 tonnes or more (other safety standards apply)
	Use	Voluntary compliance, no policy to mandate safety belt use.

The National Transportation Safety Board in Washington commissioned a safety study into the crashworthiness of large post-standard school buses (National Transportation Safety Board 1987). The study investigated 44 school buses involved in 43 accidents, in which 13 passengers were killed and 119 injured. It was concluded that of the 13 total school bus passenger fatalities, lap-belt use would have probably prevented two deaths, made no difference in 10 deaths, and could not be determined for one death. It was also established that lap-belt use would have caused death to three surviving passengers. This inference is based on the opinion of experts who believe that because children have a small and yet to develop bone structure, lap belts can cause fracturing of the spine and intra-abdominal injuries that lead to a worse outcome than an absence of wearing a lap belt (School Bus Fleet 1999). Thus, the probable net effect of wearing lap belts was zero. It was recommended that the federal safety standards should not be amended to require lap belts for passengers in all new large school buses. It should be noted that this study did not relate to the use of lap-sash safety belts (National Transportation Safety Board 1987).

Hatfield and Womack (1986) conducted a study for the Texas Transportation Institute about safety belts on school buses. School bus accident data was obtained from Texas police reports between 1975 and 1984. During this period, 12,669 crashes involved school buses, resulting in 19 fatalities. It was determined that safety belts could have saved 12 lives, an additional four could also have been saved given better supervision of students during travel (three deaths resulted from children leaning their heads out of windows), and three deaths were deemed inconclusive. It was concluded that lap belts were not cost effective and that improved vehicle maintenance, bus driver training and rider training could be more effective in terms or reduced accident numbers and severity reduction over time (Centre of Transportation Studies and Research 1989).

A study by Henderson and Paine (1994) focused on the fitment, effectiveness and cost of mandating safety belts on school buses in New South Wales. The study highlighted that in Australia, unlike the USA, very few buses are used exclusively as a school bus, but rather for the transportation of a varied range of passengers. Therefore many of the constructional and safety features that are found in a dedicated school bus fleet cannot be simply applied to Australia. Eliminating child standees on school buses poses a problem because 70% to 80% of Australian students travel on normal route buses, and it would be very difficult for drivers to insist adults vacate their seats for children. The cost impact of eliminating both standees and the three-for-two policy by requiring safety belts on all buses, could be as high as 55% (Johnson 1993).

Henderson and Paine (1994) noted that the effectiveness of safety belts depended on a number of other vehicle design features. For example, the type of seat fitted, the type of belt used (lap sash or lap belt) and the extent to which all passengers used belts and adhered to vehicle policies. They noted that the requirements allowing standees and three-for-two seating passengers would need to be revised. It was concluded that modification to the seat design in Australian buses might be a more effective method of preventing injury and more cost than the fitment of safety belts.

3.1.2 Compartmentalisation

The approach used by dedicated school bus fleets in the USA and Canada is called compartmentalisation. Compartmentalisation is a passive safety measure that absorbs crash energy through the use of high-back seats, increased seat padding, and restraining barriers in front of seats.

A study undertaken by the Centre of Transportation Studies and Research concluded that compartmentalisation worked well to protect school bus passengers from injuries in all manner of accidents (Centre of Transportation Studies and Research 1989). Similarly, an earlier study by Farr (1984) concluded that compartmentalisation gave ample protection for frontal collisions. The study scrutinised the effects of safety restraints in school buses by performing full-scale crash testing. The use of lap belts was cautioned in this study for their potential to result in more serious injuries to the neck and head of restrained occupants.

Transport Research Board in the USA released its Special Report 222 into 'Improving school bus safety' (TRB 1989). The study investigated the cost effectiveness, and injury reduction and life-saving potential of nine safety measures. It was determined that the measures offering the greatest potential safety improvement (per dollar invested) were higher seat backs (for reducing fatalities and especially reducing injuries) and pupil education programmes. The least effective measures for reducing fatalities or injuries (per dollar invested) were deemed to be safety belts and school bus monitors.

3.1.3 Cost-benefit analysis of safety belts on school buses

This section analyses the benefit and cost of fitting safety belts to New Zealand's school bus fleet. The social benefit of having safety belts fitted is based on historical school bus crash and injury data.

Table 3.2 gives the circumstances surrounding school bus crashes, the injury severity suffered by the bus occupants, and the social cost attributable to those injuries for all reported school bus crashes. The injury data for occupants aged between 5 and 15 years old (including bus drivers) was extracted from NZTA's crash analysis system (CAS). These school bus crashes involved all bus crashes that happened on school days between the hours of 6am and 9am, and 2pm and 5pm from 1987 to 2008 inclusive (or 22 years). The social costs per reported injury (rural and urban areas) are based on June 2008 prices in NZ dollars – ie $3,374,000 per fatal injury, $591,000 per serious injury and $62,000 per minor injury (Ministry of Transport 2008).

Table 3.2 School bus crashes in NZ: circumstances, injury severity and social cost

Circumstance	Injury severity of bus occupants			Social cost	
	Fatal	Serious	Minor	Total	Per year
Bus leaves road and hits bridge	0	2	2	$1,306,000	$59.364
Bus leaves road and hits ditch/fence/ embankment	0	7	45	$6,927,000	$314,864
Bus leaves road and went over cliff (note 1)	5	22	14	$30,740,000	$1,397,273
Bus rear-ends another vehicle	0	2	0	$1,182,000	$53,727
Bus crashes head-on with another vehicle	0	2	28	$2,918,000	$132,636
Bus T-bones another	0	0	16	$992,000	$45,091

Circumstance	Injury severity of bus occupants			Social cost	
	Fatal	Serious	Minor	Total	Per year
vehicle					
Another vehicle T-bones bus	1	0	7	$3,808,000	$173,091
Total	**6**	**35**	**112**	**$47,873,000**	**$2,176,045**

(Note 1: one of these crashes resulted in five fatalities, two serious and one minor injuries)

One school bus crash accounted for nearly 38% of the total social cost of all school bus crashes during the 22-year period. That crash occurred on 17 February 1987. The bus lost control on a right-hand bend and went over a cliff killing five bus occupants, seriously injuring two occupants, and inflicting minor injuries on one bus occupant. All other crashes of a similar nature (bus left road and went over a cliff) combined resulted in 0 fatalities, 20 serious injuries and 13 minor injuries. Most of the fatalities in the February 1987 crash were due to the bus structure failing which resulted in the occupants being ejected from the bus and crushed when it rolled on top of them. That incident resulted in the introduction of bus and coach structural strength requirements. These requirements are contained in Land Transport Rule, Passenger Service Vehicles 1999, Rule 31001. The Rule stipulates that: 'the structural strength of a passenger service vehicle must be sufficient to provide reasonable protection for the occupants in the event of roof or wall deformation resulting from the vehicle rolling over'.

Most of the other crashes that resulted in injuries to bus occupants involved a hard braking event and/or a frontal collision with another vehicle or stationary object. Had lap-sash safety belts been worn by the occupants of those crashes, some injuries might have been less severe. Crashes where safety belts would probably not have reduced the injury severity suffered by bus occupants were those involved in side impacts or where another vehicle T-boned the school bus.

However, what can be said about these crashes is that, had safety belts been worn by every school bus occupant, this would have impacted to some degree on 92% of the total social cost of injuries or about $2.0 million per year (excluding the cost of injuries that resulted from other vehicles T-boning the school bus).

The number and size of buses that would need to be fitted with safety belts was estimated by using Ministry of Education data on the number of students allocated to each school bus route (Ministry of Education 2009a). It was assumed that 15% of the school bus services were undertaken by city buses that would not be required to fit safety belts because it would be impractical or even unnecessary to remove standees and three-for-two seating from city buses.

In cases where more than 50 students were allocated to a given rural school bus route, one 50-seat bus was allocated to this route and the remaining students were placed on either a 15- or 20- or even another 50-seat bus until every student was accounted for.

Assuming every school bus in the 8–11 size category has safety belts fitted, that all larger bus size categories require safety belts, and that the retrofitting cost per seated passenger will be $1250[2], the total

[2] In 2004, the cost to retrofit a Ministry of Education school bus was the equivalent of NZ$45,000+ GST (pers comm 2004). Assuming that a typical Ministry of Education school bus seats 40 passengers, the cost per seated passenger would have been $1125 plus GST in that same year. These costs are comparable with those used in Swadling and Newman (2001) which include modifications to walls, floors, replacement of seats and fitting of safety belts and all required anchorages.

cost to fit safety belts to the entire fleet of school buses will be $81.3 million. An extension of fitting safety belts on school buses is the removal of all standees and occupied three-for-two seating positions. In 2009, an estimated 95,000 students (excluding those who were SESTA-funded or used public transport) travelled to school by bus at an estimated cost of $121 million ($150 million less SESTA funding and travel allowance costs). Thus the cost per student is approximately $1274 annually. Assuming that there are 10% standees on 10% of the large school buses (bus sizes 15–20 and larger), the equivalent of 950 additional seats will be required. Hence the cost to provide additional school bus services to eliminate standees will be approximately $1.21 million annually. For the school bus industry, this may mean operating more buses and larger buses.

Applying a discount rate of 8% on the social benefit of $2 million dollars summed over a period of nine years[3] results in an estimated benefit of $12.1 million. From above, the cost of fitting safety belts is estimated to be $81.3 million. Today's cost of providing additional bus services to eliminate standees over a nine-year period is $7.3 million, giving a total cost of $88.6 million. The resulting benefit-cost ratio is 0.14.

3.1.4 Discussion

It is difficult to justify the mandatory retrofitting of safety belts on school buses given that the estimated benefit-cost ratio is 0.14. Even targeting the highest-risk bus routes is very unlikely to produce a benefit-cost ratio approaching one. Bus structural strength requirements, aimed at ensuring bus occupants have sufficient survival space and are not ejected when a bus rolls over, have been introduced since the rollover crash that killed five children in 1987. Those requirements reduce the need, and hence the benefits of safety belts in school buses. The USA Transport Research Board recommended higher seat backs (for reducing fatalities and especially reducing injuries) and pupil education programmes as the most cost effective options for reducing school bus occupant fatalities.

3.2 School bus management standards

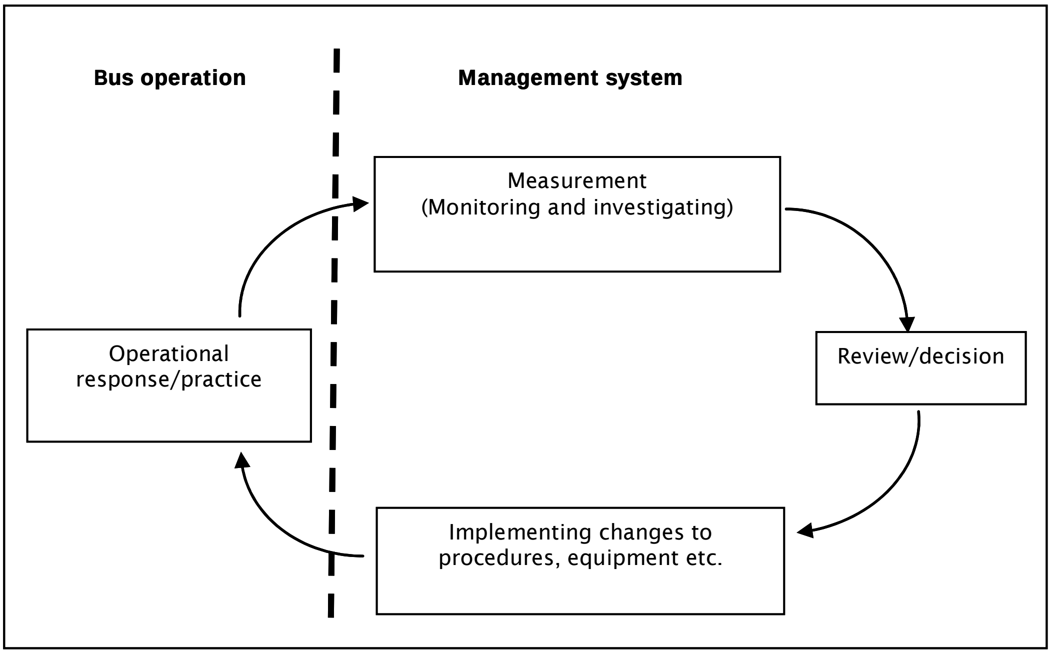
A number of studies have found that transport operators have a major influence on on-road safety. Baas and Taramoeroa (2008) evaluated the effectiveness of the Australian industry TruckSafe heavy vehicle accreditation scheme and the Australian government National Heavy Vehicle Accreditation (NHVA) schemes. These schemes are voluntary and provide formal recognition of operators who have good safety and other management systems in place. In order to become accredited operators need to demonstrate, through independent audits, that they have effective management systems. Baas and Taramoeroa (2008) determined the safety benefits of accreditation by comparing Police reported crash rates over a three-year period of accredited and non-accredited vehicles in Victoria, Queensland and NSW. Approximately half of the 48,000 articulated heavy vehicles registered in these States belonged to operators who were accredited to TruckSafe or NHVAS. It was found that vehicles belonging to operators accredited to TruckSafe or NHVAS were, on average, significantly safer than vehicles that were not accredited. The calculated difference in average crash rates (crashes per vehicle) was substantial with vehicles accredited to the schemes having between 50% and 75% fewer crashes on average than non-accredited vehicles. The analysis also found that operators improved through the process of becoming accredited with reductions on crash rates of approximately 50% in the two years after accreditation compared with the two years before.

[3] Maximum school bus service life of 26 years less the average bus age of 17 years (Ministry of Education 2008).

3.2.1 Closing the loop

Successful management systems are dynamic, with continuous monitoring of vehicle condition and driver behaviour used to inform decision making and implementation as shown in figure 3.1.

Figure 3.1 Closing the loop



The measurement stage includes accident investigation, recording compliments and complaints, daily walk-around inspections of vehicles, monitoring driver hours, health, infringements, licence status etc, costs, fuel consumption and the other factors involved in operating a school bus.

The next stage is to review and decide on what can be done to reduce the risk of a crash occurring, reduce the level of complaints, improve fuel efficiency, reduce operating costs etc. This requires a deliberate management decision-making process with, for example, regular meetings and staff assigned to investigate different issues to ensure problems are not simply put in the too hard basket.

The third stage involves implementing the changes through, for example, driver training; eliminating hazards in the buses; changing repair procedures; meeting school staff to discuss passenger behaviour problems; and even buying a newer bus when the opportunity arises. These changes result in improving the operation of the buses, which are then monitored, thereby closing the loop.

3.2.2 Performance standards

A set of standards were to assist bus operators close the loop. The standards define the minimum level of performance operators should be aiming at to achieve to meet good management practices. Those operators who aspire to achieving outstanding levels of performance – and to receive the economic, commercial and safety benefits that that are likely to result – will be working to continuously improve their systems and procedures to achieve even higher standards of performance than those defined in these school bus standards. Implementation of the standards needs to take into account operator size. The experience in Australia has been that the systems do not have to be very complex and can be tailored to match the size of the bus operation.

The following set of performance standards is at the concept stage only and will need to be reviewed, refined and formally approved by all parties concerned before being implemented.

3.2.2.1 Standard modules

The school bus management system is divided into a number of modules as shown in table 3.3. At a high level each module is divided into three parts:

1 **Principles** that describe the expected outcome, for example, that the school bus is roadworthy all of the time it is in service.

2 **Indicator** that shows the operator is committed to and has in place the required management systems to close the loop, eg systems for undertaking daily bus checks by the driver.

3 **Evidence** sought during an audit that shows the management systems are being followed, eg that bus faults have been identified, recorded and rectified.

Table 3.3 The proposed standards modules

1 Safe workplace management system	To meet this core standard, operators must demonstrate they have a safe workplace (including in the vehicle) and good transport management systems. For example: • emergency procedures • exits and fire extinguishers • OSH requirements injury prevention and fatigue • basic monitoring, decision making and implementation procedures • internal and external audits • passenger behaviour • complements and complaints procedures • employment contracts.
2 Safe and fuel efficient bus operation	To meet this standard, operators must demonstrate that their bus operations are safe and fuel efficient. This could be through driver training, fuel use monitoring systems and management policies that support safe and fuel efficient on-road behaviour, eg, an on-road compliments and complaints system, bus stop and turning bay policies and incident investigation. For example: • passenger loading (seated, standing etc) • RUC compliance • driver licensing, infringements, endorsements • fatigue management • drugs and alcohol policies • medical screening • health and wellness promotion.
3 Maintenance management	To meet this standard, operators must be able to demonstrate that their vehicles are continually maintained to a minimum CoF standard between periodic inspections and are maintained to ensure efficient fuel use (see draft standard).

Further modules may be added over time, for example on:

1 **Eco verification.** Environmental sustainability (vehicle selection, monitoring and analysis of fuel use, fuel efficient driving, incentives to encourage energy efficient driving, improved engine and exhaust maintenance and tyre management, waste disposal, alternative fuels etc.)

2 **Passenger loading.** Standees, safety belts, three-for-two seating etc.

3 **Passenger behaviour.** Driver/parent/school responsibilities, strategies for avoiding problems, procedures for handling problems, disciplinary measures etc.

Each module would include the high-level standards for the module components. The following are examples of what these standard descriptors could look like (see tables 3.4, 3.5 and 3.6).

Table 3.4 Safety management system

Injury prevention		
Principles	**Indicators**	**Evidence**
The operator is fully committed to ensuring the workplace is healthy and safe.	The organisation is committed to the development of its health and safety systems. Continuous development of health and safety (H&S) procedures is occurring.	People can give examples of how the health and safety system has worked and their contribution to its ongoing development. An audit of the workplace in accordance with the H&S guide will identify no more than two minor hazards and no serious hazards in each workspace.

Table 3.5 Safe and fuel-efficient driving

Safe driving practices		
Principles	**Indicators**	**Evidence**
The operator is fully committed to safe driving by encouraging safe driving and ensuring drivers have the required skills.	The organisation is committed to driver training and views safe driving as paramount, over and above schedules and other operational constraints.	An audit of driver records shows that drivers are trained or are being trained for the tasks they perform. Drivers are able to give examples of the no-speeding policy of the operator. Complaints about drivers and on-road infringements are recorded and drivers counselled where appropriate.
Driver fatigue and wellness		
Principles	**Indicators**	**Evidence**
The operator is fully committed to promoting the wellbeing of drivers and ensuring that they are fit for duty.	The organisation is committed to maintaining and developing management systems that include drug and alcohol testing, medical screening, fatigue management and health and wellness promotion	The audit finds that the systems employed by the operator to promote and monitor driver health and fitness for duty are adequate. Drivers are able to give examples of driver health and fitness for duty (fatigue management and wellness initiatives that have been introduced by the operator.

Table 3.6 Maintenance management

Maintenance management		
Principles	**Indicators**	**Evidence**
The operator is fully committed to ensuring that all vehicles are in a roadworthy condition all the time while being operated as school buses.	The organisation is committed to the implementation and operation of its vehicle maintenance management systems that include daily checks, fault reporting, repair and scheduled maintenance.	An audit of vehicles being operated as school buses identifies no vehicle defects of a serious nature. The audit finds that faults are identified, recorded and rectified in a timely manner in accordance with the guide.

Below each of these standards descriptors would be guidance on what is best practice, sample forms, audit criteria etc. A draft maintenance management standard is included in appendix D as an example of what is proposed.

3.2.3 Ministry of Education school bus operator contract

The Ministry of Education has encouraged the adoption of fleet safety management practices based on the concept described above, by including in their contracts for school transport services (Ministry of Education 2009b) requirements for bus contractors to ensure that:

1. They deliver a reliable service with drivers and vehicles that comply with all licensing requirements and are well maintained, to ensure students arrive at school on time and are ready to learn.
2. Vehicles are within the maximum age criteria of 15 years for small passenger service vehicles (PSV) or 26 years for large PSVs.
3. Vehicles and their individual components are maintained within safe tolerances of the manufacturer's specifications, and certificate of fitness (CoF) standards, as issued by the NZTA, at all times while transporting students.
4. Vehicles comply with emissions regulations in force as at January 2009 and amendments to emissions regulations beyond that date.
5. Vehicles are always fit for purpose and presented in a clean and tidy condition.
6. Every vehicle used in the provision of services has an ongoing maintenance programme.
7. Every vehicle is subject to a daily pre-departure check before entering service. This pre-departure check is to incorporate all elements of the vehicle that affect the safety, performance, presentation and cleanliness of the vehicle.
8. Detailed vehicle maintenance records are maintained for every vehicle and are to be made available to service agents and/or the NZTA for inspection upon request.
9. All drivers have completed, or have an agreed programme to complete, the Tranzqual Limited Credit Programme for school bus drivers, within six months of their engagement by the contractor.
10. Drivers receive the equivalent of two half-days ongoing driver development per annum, on a range of generic topics such as defensive driving, first aid, advanced driver training, hazard identification, and stress and time management programmes. Ad hoc development activities are to be provided for individual driver-specific situations.
11. Drivers hold all relevant driver licences and endorsements at all times they are involved in providing the services.
12. Drivers comply with the Work Time and Logbooks Rule 2007, including working within all requirements of work time, secondary or other employment, retaining logbook records, and monitoring for signs of fatigue.

4 Recommendations

4.1 Improving the safety of children who have to cross the road to and from school buses

It is recommended that a nationally coordinated package of measures be introduced to improve the safety of children crossing the road to and from school buses.

4.1.1 Minimising the need for students to cross the road

- **Encourage caregivers to meet their children at the bus stop.** NZ Police, the NZTA, Ministry of Education, schools and community groups have been raising awareness of the need for caregivers to meet their children at the bus stop, including parking on the same side of the road as the bus. Reminding caregivers of their responsibilities is not sufficient on its own because, as many studies have found, convenience plays an important role with perceived risks weighed up against the time and effort required (Lobb 2006). Overcoming this barrier may be difficult and may require engineering measures such as improved parking facilities near bus stops.
- **Rearrange bus routes to reduce the number of children who have to cross the road.** The Ministry of Education and their service agents try to configure bus routes to minimise the number of children who have to cross the road. School bus routes are reviewed every two years. The limiting factors are extra running costs if the routes need to be extended and require students to stay on the bus longer, especially if the bus passes their house on the way out but they are not allowed off until the bus returns on their side of the road.
- **Improve bus stops.** Some road authorities have been improving school bus stops as the opportunity arises. A draft bus stop guide has been developed (see appendix A) to assist road authorities with upgrading bus stops, especially on major roads in rural areas. An important feature of rural bus stops is the provision of parking for caregivers who are waiting for a bus to arrive. Providing parking at the bus stops will reduce the number of children who have to cross the road. It is recommended that the draft guide be adopted by the NZTA and that priority be given to upgrading bus stops on state highways and major local roads as the opportunities arise.

4.1.2 Preventing children from running heedlessly across the road:

- Caregivers, bus drivers, schools and other stakeholders have a shared responsibility to do what they can to make sure children cross the road safely. While there have been some questions about the effectiveness of educational and awareness-raising interventions, there are things that can be done that are not difficult or expensive. For example caregivers can be reminded regularly what safe road crossing is and that they need to model it to the children they are looking after. School community based initiatives, such as bus wardens and neighbours taking turns to meet the bus, should be encouraged. Children should be reminded of the need to take care. The Ministry of Education has produced a fact sheet that explains the responsibilities of all parties, including caregivers, bus drivers and schools.
- **Road safety education in schools.** Improving attitudes to and knowledge of how to cross safely is taught by the NZ Police as part of their road safety education programme. The Ministry of Transport is currently reviewing young person road safety education and the effectiveness of what is currently taught should be included in that review.

4.1.3 Minimising the consequences by slowing down the traffic when children are crossing:

The greatest gains will come from changes in bus routes, better bus stops and other measures that remove the need for children to cross the road. However, funding for engineering solutions and longer bus routes is limited and so these will take time to implement. In the absence of these measures, the next most effective approach is to slow down the traffic when children need to cross. This is because children of primary school age, in particular, are poor judges of vehicle speed, are impulsive and caregivers cannot always be present when children need to cross the road. In order to be able to slow down the traffic, it is recommended that:

- **The Land Transport Road User Rule should be amended to enable effective enforcement.** It is currently difficult for the NZ Police to enforce the 20km/h speed limit when passing school buses that have stopped for the purpose of discharging or embarking school children – although it is less difficult as the result of a recent Rule change, prior to which the Police had to show that a child was entering or alighting at the time when a speeding motorist passed. However, the difficulty has meant that there have been virtually no prosecutions of motorists speeding past school buses despite the very high level of non-compliance. A number of studies have found that punishment can be more effective than awareness raising campaigns and education in changing behaviour (Lobb 2006). It is recommended that Land Transport (Road User) Rule 2004 (SR2004/427) section 5.6 be amended to enable effective enforcement of the speed limit. When considering amendments to the Rule it is recommended that:
  - the speed limit be reviewed. The research suggests that the speed limit around school buses should be the same as that in other high-risk areas such as outside the school gate, in shared main street spaces and near and at road works. This uniformity will increase driver awareness and the level of compliance
  - the speed limit should apply whenever approved active warning lights are activated, including when the bus is moving to or away from a bus stop
  - the sign should only be activated when students are very likely to cross.
- **Active speed signs should be installed on school buses that display the speed limit when the sign is activated.** A new active sign should be developed based on the findings of the trial undertaken for this project. Cost, ease of installation and effectiveness need to be considered. Ideally the new sign should be implemented in conjunction with a law change as proposed above, but if that is not possible, a '20' sign would help to slow motorists on its own. Some community groups have indicated that they may be able to fund the installation of a limited number of signs until their use can be included as a requirement in the Ministry of Education school bus services contracts.
- **Driver awareness campaigns should be reviewed.** A number of organisations, such as Rural Women New Zealand, SafeKids New Zealand, NZ School Trustees Association, the NZTA, ACC and local authority road safety coordinators have put a lot of thought and effort into trying to slow down the traffic with billboards and other awareness raising measures that remind drivers what the legal speed limit is when passing a school bus.
- If funds are limited, priority should be given to improving bus stops, installing the new active signs on school buses and enforcement of the speed limit rather than driver awareness campaigns. Active speed signs are of direct relevance to motorists in that if they ignore them, there is a risk they will be prosecuted or, worse, could kill a child. Billboards and other passive measures rely on motorists remembering the message the next time they come across a school bus.

4.2 Reducing the risk of injury while travelling on school buses

The following options were investigated to improve the safety of school bus passengers.

- **School bus management standards.** Since this research project started, the Ministry of Education has written into their school bus contracts more stringent requirements for the construction and maintenance of school buses. This appears to have been effective as a recent NZ Police sting operation in the Coromandel Peninsula found that none of the 39 school buses inspected had vehicle safety faults (BCANZ 2010). It is recommended that the Ministry of Education and NZTA continue to encourage bus fleet operators to adopt best practice.

- **Occupant protection**. The bus structural strength requirements appear to have been effective in reducing the risk to injury during bus crashes. Further improvements in occupant protection would result from having higher seat backs. However, retrofitting older buses with these seats is probably not justified because of the cost.

- **Safety belts.** While the mandatory use of safety belts would improve safety, reducing the number of children killed while crossing the road from school buses will produce greater benefits at lower cost, and hence should be given priority. The estimated safety benefits from retrofitting safety belts on school buses are estimated to be approximately 14% of the cost of fitting them.

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Appendix A: Draft school bus stop and turning point safety guide

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Definitions

School bus stop: A place on or near the roadside or carriageway, or in school grounds or another nearby place, where school buses stop to pick up or set down school pupils.

Road side school bus stop: A school bus stop located on or near the roadside or carriageway in an urban or rural area.

School located bus stop: A school bus stop, located within school grounds or near a school, used primarily to pick up or set down school pupils, including a school bus interchange where pupils may change from one bus to another.

Contents

A1 Introduction **50**
A1.1 Background 50
A1.1.1 Crash data 50
A1.1.2 Resource material 50
A1.2 Guide outline 51
A2 Review of traffic engineering and general road safety principles **51**
A2.1 General road safety principles 51
A2.2 General guidance for the provision of school bus stops 52
A3 Guidelines for good practice **53**
A3.1 Highway environment 54
A3.1.1 Speed zone 54
A3.1.2 Sight and stopping distances 54
A3.1.3 Proximity to side roads 55
A3.1.4 Traffic volume and composition 56
A3.1.5 Crash data 56
A3.1.6 Lane and shoulder widths 56
A3.1.7 Type and condition of road surface 57
A3.1.8 Car parking facilities and modal separation 57
A3.2 Passenger waiting environment 58
A3.3 Operating conditions 58
A4 Hierarchy of potential treatments **59**
A4.1 Roadside school bus stops 59
A4.1.1 Traffic safety considerations for roadside school bus stops 59
A4.1.2 School bus passenger considerations at roadside school bus stops 61
A4.2 School-located bus stops 62
A4.2.1 Traffic safety considerations for school-located bus stops 62
A5 Typical treatments **63**
A5.1 Typical midblock treatment 64
A5.2 Typical midblock treatment with constraints 66
A5.3 Typical intersection treatment 68
A5.4 Typical treatment for school-located bus stops 70
A5.4.1 Island layout 70
A5.4.2 Perimeter layout 72
A5.4.3 Concourse layout 74
A6 Costs **76**
A6.1 Costs for roadside school bus stop treatments 76
A6.2 Costs for school-located school bus stop treatments 76
A7 Case studies **77**
A8 Bibliography **77**

A1 Introduction

This draft guide has been prepared as part of the school bus safety project funded by the NZ Transport Agency (NZTA). Its purpose is to improve safety at the point where students are picked up and dropped off.

In November 2004, the Land Transport Safety Authority (LTSA) (now the NZTA) published *Guidelines for the safe siting of school bus stops* (LTSA 2004). This brief document covers the main principles that should be considered when locating school bus stops. It provides basic technical advice including check lists for considering single school bus stops and school bus routes.

The aim of this school bus stop and turning point safety guide is to provide more comprehensive information about the principles, technical and safety considerations involved in the location and design of school bus stops and turning points, on rural and urban roads and at schools. This draft, when approved, will form the basis of a code of practice or guideline for use by local government and other road providers, road safety coordinators, school authorities, education agencies, school bus operators, parents and communities.

The guide is intended to cover school bus stops at or near schools and on roads in both urban and rural areas. However, in urban areas, school buses generally use bus stops already provided for route and other bus or coach services. The guide will apply to school bus stops where signage and facilities for other bus services are not required – these are generally on rural roads and at or near schools.

The guide aims to encourage the use of good traffic engineering and risk management practice.

A1.1 Background

A1.1.1 Crash data

In the 21 years from 1987 to 2007 inclusive, 22 children were killed, 45 were seriously injured and 91 received minor injuries when crossing the road to or from a school bus. This equates to, on average, one fatal, 2.1 serious and 4.3 minor injuries that are reported to the Police each year.

Of the reported crashes:

- 85% occurred in the afternoon on the way home from school
- 86% of the fatal incidents but only 39% of all incidents (fatal and injury) occurred in speed zones greater than 50km/h
- a similar number of children appeared from the front or rear of the bus
- there were no reported crashes on unsealed roads. As the number of children who travel by bus on unsealed roads is not known, it is not possible to say whether travelling on sealed roads is any more dangerous than unsealed roads and vice versa.

A1.1.2 Resource material

With the exception of the NZTA guideline (LTSA 2004), a search of the internet revealed very little published information about the design and safe operation of school bus stops and turning points which could be relevant to the type of school bus services that operate in New Zealand. However, an unpublished report prepared in 2006 by ARUP consultants for the Ministry of Transport in Victoria, Australia, (previously the Department of Infrastructure (DOI)), was identified and sourced. This report is entitled

'Rural school bus stop and school interchanges – safety guidelines and typical treatments' (ARUP 2006). It covers rural roadside school bus stops and school located interchanges in Victoria. The report provides guidance on principles, guidelines for good practice, hierarchy of potential treatments, typical treatments and costs together with case studies.

Due to the comprehensiveness and completeness of the Victorian report, its use of technical traffic engineering standards which are also used in New Zealand (*Guide to traffic engineering practice* (Austroads 2005)), and the presentation of solutions which could also apply under New Zealand conditions, a decision was made to use the relevant content, together with the existing NZTA guidelines (LTSA 2004), as the basis for the recommendations of this draft guide.

A1.2 Guide outline

This draft guide commences with a brief summary of road safety practice and some general guidance on bus stop design. These are applied to the development of good practice and a hierarchy of potential treatments for both roadside and school-located school bus stops, considering traffic safety and passenger requirements. Typical treatments for school bus stops at midblock, intersection and school locations are illustrated, with a summary of case studies and indicative information on unit costs for the treatment options. Checklists to assist review and audit of roadside and school-located school bus stops are provided.

A2 Review of traffic engineering and general road safety principles

The Victorian report (ARUP 2006) provides a convenient summary of the relevant road safety principles. These are summarised below and are then applied as guiding principles for the provision of safe school bus stops.

A2.1 General road safety principles

National guidelines for road safety audits and traffic engineering good practice identify that a safe road environment should:

- **warn** the driver of any substandard or unusual features
- **inform** the driver of conditions ahead
- **guide** the driver
- **control** the driver's passage through conflict points or sections
- **be designed to be forgiving of** driver errors, errant or inappropriate behaviour.

The guidelines indicate the need for consistency when treating similar situations and state that the following should be avoided:

- inadequate treatment – not treating a situation to an appropriate level
- inappropriate treatment – using the wrong treatment for the situation

- excessive treatment – using more treatment for more safety thereby masking other similar situations, which have already been treated to the appropriate level.

A safe road environment provides:

- **no surprises** in road design or traffic control (design matches expectations)
- **a controlled release** of relevant information (not too much at once)
- **repeated information** where pertinent to emphasise danger.

Too much information can be counter-productive and result in drivers or riders overlooking or discarding essential information.

To assist with identifying safety issues, the road safety audit processes use a series of checklists. This approach was used in this study and is recommended to help identify safety issues. Annex E and Annex F are provided to prompt a reviewer responsible for identifying safety issues associated with roadside school bus stops and school-located bus stops respectively. However, final recommendations on the appropriate level of treatment should also be based on the experience and knowledge of the reviewer. The checklists are for assistance only.

General information on bus stop and interchange design is summarised in annex A.

Road side and school-located school bus stop issues which should be considered include:

- clear areas that provide enough space for passengers to boarding and alight
- well drained hard areas where passenger can wait
- bus passenger shelters
- bus stop kerbing to provide a clear divide between where passengers wait and the bus stops
- well defined bus stop areas
- kerbside bus stops in urban areas
- the use of the adjacent road space
- bus stop bays to allow the bus to pull off the road
- disability access.

A2.2 General guidance for the provision of school bus stops

When considering the provision of roadside bus stops and turning points, or when making improvements, the following factors are important:

- traffic volumes
- student numbers
- the availability of alternative sites within a reasonable distance of students' homes
- the need for appropriate signage when the local topography is constrained
- the minimum spacing of bus stops to maintain efficiency and to reduce conflict with other road users
- the need to consider, where appropriate, allocating space for parents' car parking and secure student cycle storage

- route selection to minimise, where possible, the use of higher-risk manoeuvres and locations, such as u-turns, turns at locations with restricted vision, and narrow roads.

At school-located bus stops the main principles to consider, in addition to those above, are:

- separation of vehicles, pedestrians and cyclists
- elimination of reversing
- safety fencing
- safe loading
- shelters
- supervision.

Draft guidelines used by VicRoads include:

- sight distances for vehicles travelling at different speeds, based on desirable safe intersection sight distances, for example, 255m at 100km/h
- a clearance width of 3m is recommended between a parked bus and the centre of the road
- a vehicle is permitted to stop in the entrance to a driveway to drop off or pick up passengers
- a vehicle, including a bus, is not generally permitted to stop within an intersection
- where written approval is given by the road authority, the bus may stop within the intersection provided traffic volume on the side road is less than 500 vehicles per day and sight distance from the side road to a stopped bus is at least 120m
- required clearances at bus stops and sight distances should be maintained at all times by preparing standing areas for buses with a maximum side slope of 6% away from the road, and by removing or trimming trees (including regular maintenance)
- student waiting areas, parent parking areas and bus shelter locations should be provided where needed, but their location should take into account the above requirements
- school bus stop warning signs as set out in the *Manual of traffic signs and marking* (NZTA 2010) may be used if sight distances and parking requirements cannot be met. Examples of these signs are shown in annex 1.

A3 Guidelines for good practice

Good practice for the safety management of roadside school bus stops and school-located bus stops requires thorough consideration of the proposed/ existing location and the appropriate level of facilities to be provided. In general roadside school bus stops and school-located interchanges should be located and designed to:

- minimise the need for children to have to cross the road unassisted, especially primary aged children
- provide for the safety of school children and other road users
- minimise the interaction between different road users, where possible
- limit the interference to traffic flow on the road network.

Safety issues should be considered in terms of:

- road environment
- passenger waiting environment
- operating conditions.

The following addresses these issues in turn.

A3.1 Highway environment

Bus stops at or near schools should be accommodated within the school grounds if possible. This significantly reduces potential conflict between buses, students and other road users competing for space. School-located bus stops vary considerably in terms of the number of students and buses they need to accommodate. This will have a direct impact on the space required to accommodate vehicle movements and waiting areas.

If the bus stop must be located outside the school grounds then most of the highway environment aspects described below will need to be considered. The highway environment in which the school bus route operates will influence the most suitable bus stop treatment to use. Consideration should also be made when conducting site visits as to whether there is a more suitable site for locating the stop, if necessary by changing the school bus route.

A3.1.1 Speed zone

School bus stop and interchange treatments should not create excessive speed disparities between vehicles as speed disparities increase the possibility of crashes. Roadside school bus stops in higher-speed environments (over 80km/h) should be located off the carriageway or with sufficient provision for other vehicles to overtake safely. The number of stops provided along a route in high traffic volume, high-speed environments should be limited as much as possible.

Generally schools are located within much a lower-speed environment than highway-located school bus stops, and often reduced speed limits apply at school times. This lowers the potential for excessive speed disparities to occur at school-located bus stops.

A3.1.2 Sight and stopping distances

School bus stops should be located so all activities are conspicuous and visible to all road users in all weather conditions. Straight alignments at uniform grades would typically be suitable locations. Stops and interchanges should not be located in unexpected situations or where the topography of the area limits visibility. For instance locations near sharp bends, steep gradients, just over the crest of a hill or obstructed by vegetation or roadside objects should be avoided.

On the approach to the bus stop the appropriate sight distance in relation to the designated speed limits should be provided. This enables vehicle drivers to observe the school bus stop activities in sufficient time to react and stop if necessary. Tables A1 and A2 summarise the appropriate stopping sight distances. Where a school bus stops within the carriageway the approach sight distances detailed in table A1 should be adopted. Where buses pull off the carriageway to stop, the safe intersection site distances detailed in table A2 should be adopted.

Table A1 Stopping sight distances for school bus stops within the carriageway

Design speed (km/h)	Minimum stopping sight distance (m)								
	Upgrade				Flat	Downgrade			
	8%	6%	4%	2%	0%	2%	4%	6%	8%
80	105	110	110	115	115	120	120	125	130
90	130	130	135	140	140	145	150	155	160
100	155	160	165	165	170	180	185	190	200
110	185	190	195	200	205	215	225	230	245

Table A2 Intersection stopping sight distances for school bus stops located off the carriageway

Design speed (km/h)	Safe intersection Sight distance (m) - desirable
80	181
90	215
100	253
110	297

If school bus stops or interchanges must be located where visibility is impaired, safety may be compromised. Other measures such as signing, delineation, high-friction surfaces and vegetation clearance should be introduced to warn motorists of the potential hazards.

A3.1.3 Proximity to side roads

Locating school bus stops within close proximity to side roads/intersections should be avoided to ensure acceptable sight and stopping distances are not constrained by side road traffic, and to minimise conflict with other road users.

Where a school bus stop is needed close to an intersection, it should be on the departure side of the intersection. This ensures the sight and stopping distances for all intersection traffic is not constrained by the bus, and motorists have greater visibility of students or other pedestrians wishing to cross the road. It also reduces conflicts between buses and vehicles turning at the intersection.

It is recommended that a suitable distance for stops to be located on the departure side of an intersection is at least 50m to avoid misinterpretation of a bus driver’s intention to stop rather than turn left into the side road.

Where school-located bus stops cannot be accommodated within the school grounds, the issues of proximity to side roads and intersections described above are also relevant.

In some instances the only suitable location identified for buses to stop is within an intersection (refer figure A1). This may be acceptable where traffic volumes on the side road are very small (below 500 vehicles per day) and sight distances from the side road to a stationary bus are good.

Figure A1 A school bus stop located within an intersection

A3.1.4 Traffic volume and composition

The traffic volumes and composition along a school bus route are likely to influence the probability of crashes occurring. School bus stops and interchanges should be avoided where possible in high traffic volume environments and where heavy vehicles numbers are high. If stops or interchanges are needed in such environments all bus stopping activities should be located clear of the traffic lanes and consideration should be given to how children will be able to cross safely.

A3.1.5 Crash data

By examining the crash history of a location, contributing factors can be identified which help to determine its suitability as a school bus stop. Study of the factors causing crashes may also help to recommend appropriate remedial treatments. School bus stops should not generally be located in areas with a history of particular types of crashes that could place bus stop activities at risk. For example, a location with a high number of run off the road crashes would be a safety concern in relation to students waiting at the stop.

A3.1.6 Lane and shoulder widths

Except on narrow roads with low traffic flow where school buses may safely stop and block the road, roadside school bus stops need to be located with sufficient passing opportunities (at least 3m from the centre of the road) for following vehicles. The most appropriate arrangement is for buses to stop in the shoulder, fully clear of other traffic. Table A3 summarises ideal lane and shoulder widths. This highlights that at roadside school bus stop locations, typical shoulder widths may need to be increased to accommodate the 3m requirement. Traffic lanes and sealed widths may have already been increased where there are high levels of truck movements or where the crash history has warranted such treatment.

Table A3 Widths of rural carriageways

Classification	Average annual daily traffic	Lane widths (m)	Shoulder widths (m)	Sealed shoulder (m)
M	Any	Duplicated carriageway 2 x 3.5 each	LHS 3.0 RHS 1.0	LHS 3.0 RHS 1.0
A	<1500	2 x 3.1	2.0	1.5
	>1500	2 x 3.5	2.5	1.5
B	<1500	2 x 3.1	2.0	0
	>1500	2 x 3.5	2.0	0
C	<1500	2 x 3.1	1.5	0
	>1500	2 x 3.5	2.0	0
Local access	51 – 150	1 x 4	1.5	n/a
Private access	1 – 50	1 x 3	2.0	n/a

A3.1.7 Type and condition of road surface

The road surface condition and drainage at the stop or interchange needs to be suitable for bus use in all weather conditions. Any irregularities or defects in the road surface could affect a driver's ability to control the vehicle and increase the potential for crashes to occur in the vicinity of the bus stop. A poor road surface also reduces comfort for vehicle occupants and increases maintenance requirements for both the road and the vehicles using it.

Statistically, unsealed roads are not a safety issue for school bus stops and it is not generally necessary for the road surface in the immediate vicinity of a school bus stop to be sealed. However, this should be considered if resealing work is being carried out in the vicinity or feedback from local bus operators indicates it is required.

A review of an existing school bus stop should identify whether there are kerbs or barriers for buses to pull up against. Stops should be designed to allow buses to pull up flush against the kerb line for ease of boarding and alighting. For roadside stops in rural areas it is unlikely that kerbs or barriers will be present at stops but buses should be able to pull up as close as possible to the student waiting area.

A3.1.8 Car parking facilities and modal separation

Provision should be made close to a school bus stop for parents' cars to safely drop children off in the morning and wait for the bus to arrive to collect their children in the afternoon. This facility should be located so it does not conflict with buses actually stopping and should have a safe walking connection of suitable standard along the verge for children travelling between the two locations.

If no bus stop signs exist, it is recommended that a suitable location approximately 10m before the school bus stop may be used for car parking. Where bus stop signs exist, according to the Land Transport (Road User) Rule 2004, Rule 6.8 (4), parking cannot occur within 6m of the bus stop, or within road markings indicating the extent of the bus stop. If a bus stop sign is not present, additional signage or markings may be required to prevent hazards due to parked vehicles.

At school located bus stops every effort should be made to separate bus activity from other road users. Parents' cars picking up or dropping off children generally cause the main delay to bus services at schools. Separating these activities also significantly reduces the risk of a crash occurring.

A3.2 Passenger waiting environment

At roadside school bus stops the appropriate level of facilities should be provided for school children to safely and comfortably wait for their bus. Ideally this should include:

- shelter
- seating
- hard standing area that is well drained and free from tripping hazards.

The appropriate level of facilities to provide will be determined by the number of children who use individual stops and the permanency of the route. As a general rule the following criteria may be considered as a guide in rural areas:

- shelter, with seating and a hard standing area for all stops used by six or more children
- hard standing surface for all other stops.

The waiting facilities at roadside stops should be located as far away from the traffic lanes as possible. Shelters should be located to avoid restricting sight distances for drivers on the road.

At set down stops there is no requirement for waiting facilities as children are expected to alight the bus and immediately continue to their destination.

At school-located bus stops, waiting facilities should comprise shelter, seating, lighting and litter bins. The waiting areas should also act as student marshalling areas. These areas should ensure students are segregated from bus movements by the use of guard rails/barrier fencing.

Where possible the waiting areas at school-located bus stops should be located close to school buildings to allow students to directly transfer to or from buses. This avoids the need for students to cross roads and minimises potential conflict with other road users.

Where it is not possible to locate school bus stops adjacent to school buildings the provision of clearly marked road crossing points should be considered where student numbers justify a treatment. The marshalling of students across roads should be appropriately supervised.

A3.3 Operating conditions

The usage of roadside school bus stops in rural areas can vary significantly. Student numbers will influence the most suitable stop treatment. Stops used by the members of a single family are more likely to be transient in nature compared with stops catering for the needs of more than one family. The permanency of the route and the number of students will particularly impact on the appropriate level of waiting facilities and highway works that should be undertaken.

At school-located bus stops it is important to identify the number of students actually transferring between buses. Clearly marked pedestrian routes that are designed to save time and effort should be introduced where appropriate

The vehicle type and frequency of the school bus service using a stop should be considered when determining the level of treatment to introduce at a roadside stop. Where larger vehicles or more than one vehicle use the same stop, typical treatments may require additional space to accommodate all bus stopping activity.

Consideration must also be given to bus turning requirements. These areas should be located away from bus stops to avoid conflict with children waiting to catch the service or those who have recently alighted vehicles and are travelling to their final destination.

A4 Hierarchy of potential treatments

In this section safety treatment criteria are identified and defined, together with the appropriate extent and types of treatments for roadside and school located school bus stops.

A4.1 Roadside school bus stops

A4.1.1 Traffic safety considerations for roadside school bus stops

The key criteria affecting the safety requirements for the location of roadside school bus stops are shown below. For each of these a range of three risk conditions (eg low, medium, high) are defined in table A4.

- speed limit
- traffic volume
- traffic composition
- crash numbers
- sight distance
- the number of users of the bus stop
- user age profile
- the permanency of the stop
- the frequency of services.

Table A4 Key safety criteria that influence treatment type

Criteria	Definition of conditions		
Speed zone	Low – up to 40km/h	Medium – 40–60km/h	High – over 60km/h
Traffic volumes	Low	Medium	High
Traffic composition	Low proportions of large vehicles – less than 10% of traffic class 3 or above	Medium proportions of large vehicles – 10% – 25% of traffic class 3 or above	High proportions of large vehicles – over 25% of traffic class 3 or above
Crash statistics	Low – less than 3 casualty crashes over last 5 years	Medium – 3 – 6 casualty crashes over last 5 years	High – over 6 casualty crashes over last 5 years
Sight distances	Good – at least 90% of the standard for the speed environment	Medium 70% - 90% of the standard for the speed environment	Below 70% of the standard for the speed environment
Student numbers(roadside bus stops)	Low – under 3 students	Medium – 4-10 students	High – over 10 students

Criteria	Definition of conditions		
Age profile of students	Predominantly primary school age	Mix of primary and high school ages	Predominantly high school age
Permanency of stop	Transient – expected to operate for 1 year or less	Semi permanent – expected to operate for 1–5 years	Permanent – expected to operate for over 5 years
Frequency of service at roadside bus stops	Low – 1 bus a day	Medium – 1–5 buses per day arriving at different times	High – more than one bus a day arriving at same time or more than 5 buses per day

Consideration should also be given to where parents can safely drop children off in the morning and wait for the bus to arrive to collect their children in the afternoon. Depending on the extent of this activity (which will be directly associated with the student numbers using each stop) a drop-off or pick-up facility should be located so it does not conflict with buses actually stopping, ie not within 20m on the approach side and 10m on the departure side of a signed bus stop. In addition there should be a safe walking connection of suitable standard along the verge for children travelling between the two locations.

A hierarchy of four treatment levels for school bus stops were identified:

- no treatment
- minor treatment
- middle level treatment
- major treatment.

Physical road conditions, as indicated below, affect the extent of works required at a particular location. Levels of these conditions are defined in table A5.

- presence of vegetation
- lane width
- shoulder width
- type of shoulder surface
- condition of the road surface.

Table A5 Design criteria used to determine the extent of required treatment

Criteria		Definition	
		Good ↔ Poor	
Physical impact of vegetation	No Impact – no overhanging vegetation	Some impact – some overhanging vegetation	High Impact – extensive overhanging vegetation
Lane width	Meet/exceed standard for road classification	0-0.5m below standard for road classification	Below 70% of the standard for road classification
Shoulder width	Meet/exceed standard for road classification	0-0.5m below standard for road classification	Over 0.5m below standard for road classification
Type of shoulder surface	Sealed	Unsealed	None
Condition of road surface	Good –no pot holes/ cracks in surface, drains wells, recently resurfaced	Adequate – some pot holes/ cracks in surface, adequate drainage, slightly	Poor – many pot holes/cracks, poor drainage, uneven surface

Criteria		Definition	
		uneven	
Condition of shoulder surface	Good –no pot holes/ cracks in surface, drains wells, recently resurfaced	Adequate – some pot holes/ cracks in surface, adequate drainage, slightly uneven	Poor – many pot holes/cracks, poor drainage, uneven surface
Verge or footpath width	Good – over 2m	Adequate – 2m	Poor – below 2m
Condition of verge	Good – clear from vegetation, drains well	Medium – some vegetation clearance required, adequate drainage	Poor – extensive vegetation clearance required, poor drainage
Condition of footpath	Good – no cracks, drains well, clear of obstructions	Medium – some cracks, adequate drainage, some obstructions, slightly uneven	Poor – many cracks, poor drainage, many obstructions, uneven surface

Annex B identifies the level of treatment and type of works required for the criteria and road condition identified above, for midblock or intersection locations.

A4.1.2 School bus passenger considerations at roadside school bus stops

Requirements for passenger waiting facilities are largely determined by the following criteria as shown in table A4:

- School bus passenger numbers who use the stop:
  low – under 3 passengers
  medium – 4–10 passengers
  high – more than 10 passengers.
- Age profile of the student passengers who use the stop:
  mostly primary
  primary and secondary
  secondary
- Permanency of the stop
  short term – 1 year or less
  medium term – 1 to 5 year
  long term – over 5 years.
- Frequency of service
  low – 1 bus per day
  medium – 1 to 5 buses per day
  high – more than 5 per day, or more than 1 at any time.

The following criteria affect the extent of the treatment required in order to provide of waiting facilities as shown in table A5:

- Verge or footpath width
  good – over 2 metres
  adequate – 2 metres
  poor below – 2 metre**s**
- Condition of verge
  good – free of vegetation, well drained

medium – vegetation clearance required ,drainage ok
poor – extensive vegetation, poor drainage.

- Condition of footpath
  good – no obstructions
  medium – slightly uneven, some obstructions
  poor – uneven with obstructions.

Treatments for passenger waiting facilities can be classified as:

- no treatment
- minor treatment
- major treatment.

Annex C identifies the recommended treatment and possible type of works required for each of the above criteria and treatment levels. These include (depending on the recommended treatment level) the clearance of vegetation, provision of a hard stand waiting area, provision of shelter, car parking, and provision of connecting walkways.

A4.2 School-located bus stops

A4.2.1 Traffic safety considerations for school-located bus stops

The safety requirements for school-located school bus stops are generally the same as for roadside school bus stops as listed in sections 4.1.1 and 4.1.2.

If located within the school grounds the frequency of services will primarily influence suitable treatments for school located interchanges. If the facility is not within the school grounds (figure A2) then all of the criteria listed above will determine which treatment is most appropriate.

Figure A2 A school-located school bus stop not within the school grounds

To determine the most appropriate type of treatment for school-located bus stops a further three key criteria need to be assessed:

- modal conflict
- space constraints
- the level of interchange activity between buses.

The space available will predominantly govern the design options. The extent of works will then be determined by the road surface and footpath condition of the proposed interchange site. If located near, but outside school grounds then all of the criteria listed above apply.

Within the school grounds the most suitable treatments for school located bus stops will be determined by:

- the frequency of services
- the presence of modal conflict
- space constraints
- the level of interchange activity between buses.

Where a school-located interchange is outside the school grounds then the assessment to determine the most suitable treatment should primarily follow the process for reviewing roadside bus stops.

For sites within school grounds a hierarchy of three treatments were identified:

- minor treatment
- middle-level treatment
- major treatment.

Annex D identifies the conditions and design criteria associated with each treatment. The extent of works for each treatment is determined by a review of the individual site against the design criteria. This should also serve to verify the right level of treatment is chosen. A distinction is made within the typical treatments identified as to which layout option is most appropriate.

A5 Typical treatments

A range of constraints exist throughout the rural road network, therefore it may not be possible to implement the ideal bus stop treatments everywhere. The typical treatments described in this guide should be used as a starting point and adapted to suit each particular circumstance.

For illustrative purposes three typical layouts for treatments are shown in figures A3, A4 and A5Figure . These are:

- midblock location – no safety constraints
- midblock location – safety constraints exist
- intersection location.

The typical layouts were developed to represent a high level of safety provision for schoolchildren and other road users to limit the interference to traffic flow on the road network. Smaller scale treatments should be determined using the typical layouts as a base but the extent of work required would be significantly less.

A distinction was made between recommended treatments for bus stops used in the morning by children waiting to go to school (AM stops) and those used in the afternoons as a drop-off point only (PM stops). AM stop locations may include the provision of a shelter, provided because students wait at the stop for the bus, whereas in the PM students tend to leave the stop immediately. PM stop locations may include an area for vehicles to remain in while waiting for the bus to arrive and drop off the students.

Under certain conditions kerbside stops may be acceptable in lower speed environments (below 60km/h) and lower demand locations with good visibility. This may require little or no treatment to improve the location before a school bus stop can be provided.

Minor treatment of the stop in these locations is likely to include improvements to the passenger waiting environment (AM stops) and identifying connections between the stop and the child’s final destination (PM stops). There should also be sufficient warning in the form of signage provided prior to the stop.

All the treatments described in this section were designed to accommodate one vehicle per stop. Where a stop is used by more than one service additional space may be required to accommodate more vehicles and more waiting children.

A5.1 Typical midblock treatment

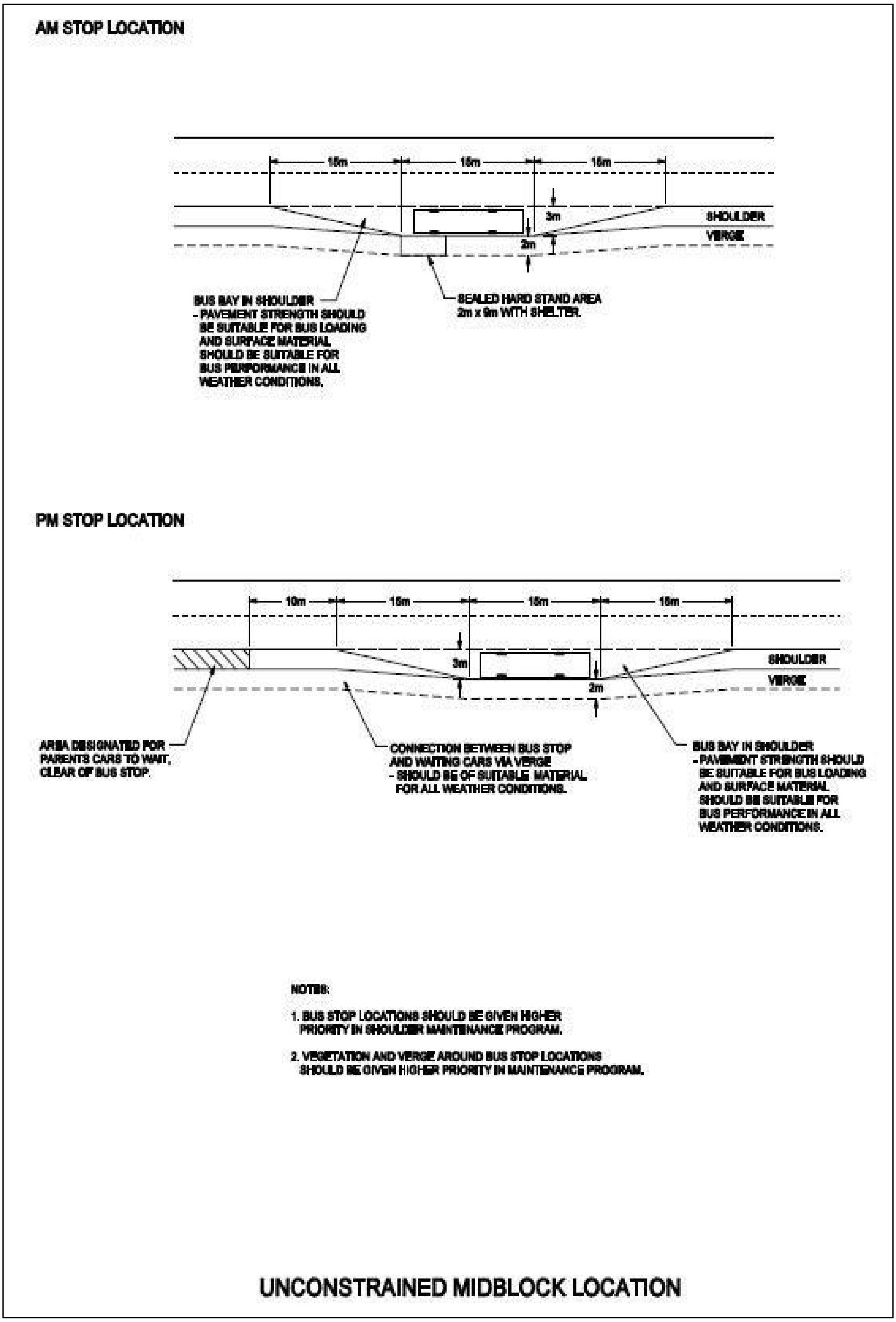
Based on site visits to a sample of roadside stops, and good practice, it is recommended that bus stops should typically be located out of the main traffic flow. In general the traffic volumes, composition and speed zone on school bus routes and the number of students using existing roadside school bus stops suggest that bus bay stopping arrangements are the most appropriate to meet safety concerns.

Where there are no safety constraints the most suitable location for roadside school bus stops is generally midblock (ie not adjacent to an intersection). Characteristics of an unconstrained location are:

- road alignments with appropriate visibility for the designated speed limit
- uniform grade
- wide carriageway shoulders and verges
- adequate traffic lane widths.

Figure A3 shows a typical layout for a roadside school bus stop at an unconstrained midblock location. The AM stop arrangement shows the appropriate position of a hard standing area and shelter for children to wait for their bus.

Figure A3 Typical treatments for roadside school bus stop unconstrained midblock location



The PM stop arrangement identifies the need for a designated area for parents to park their cars away from all bus stop activity when waiting to collect children after school. A suitable distance would be around 10m (on the departure side of the stop) to prevent any conflict with buses. This treatment also includes the need for a designated connection from the bus stop drop-off to the area where parents are waiting.

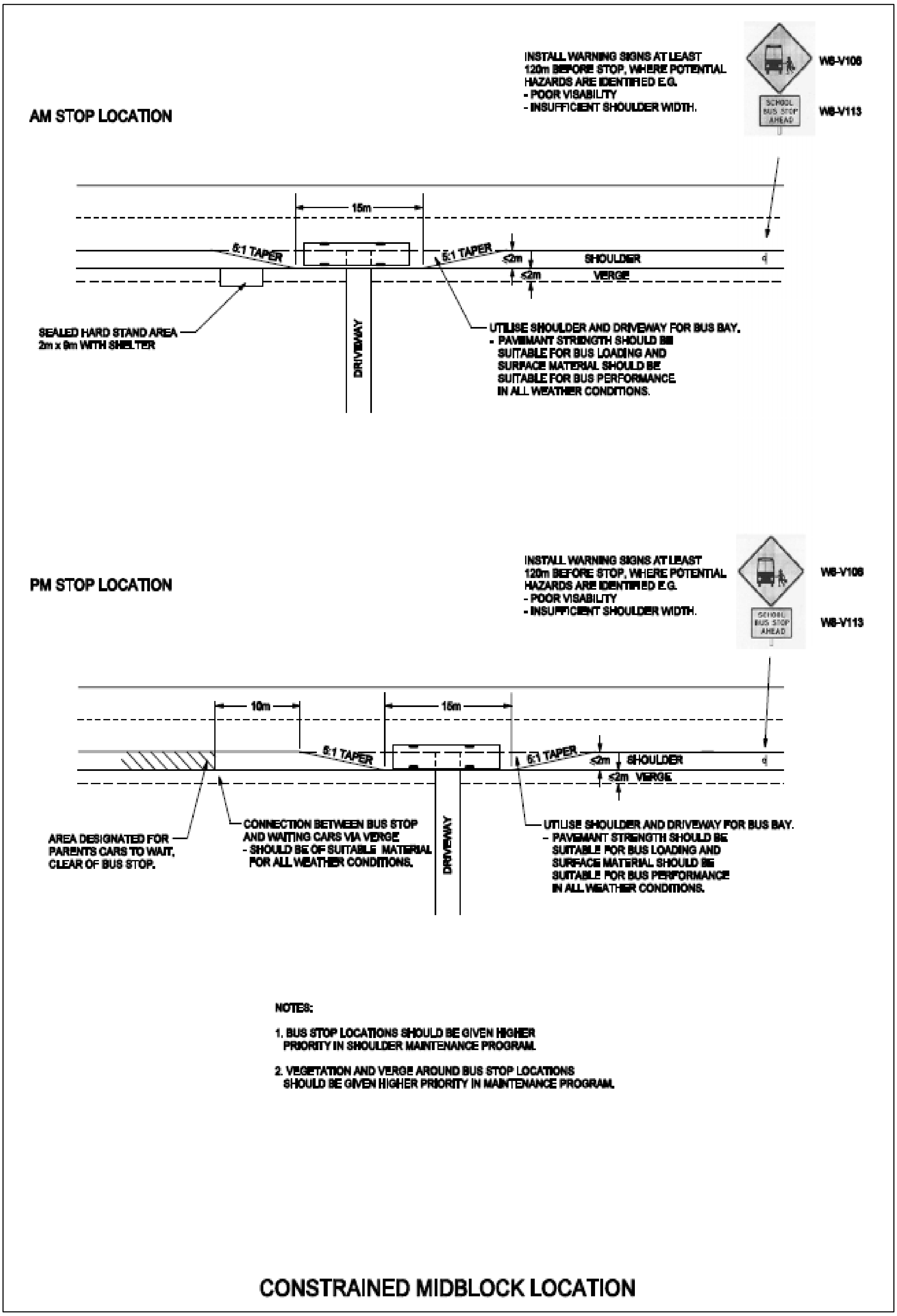
A5.2 Typical midblock treatment with constraints

Midblock locations may be constrained by certain characteristics of the highway or waiting environment. Typical constraints include:

- reduced visibility due to topography
- non-standard shoulder widths
- little or no carriageway verge.

A typical treatment for this environment is shown in figure A4 for an AM and PM stop. By utilising space already assigned to a driveway as the bus stop this potentially reduces interference to the traffic flow along the road network.

Figure A4 Typical treatment for roadside school bus stop at a constrained location



Additional constraints may exist at driveway locations such as culvert end walls, marker posts and letterboxes. These constraints need to be addressed within the design process.

This arrangement may still result in buses not being able to stop clear of the traffic lane. In such circumstances a school bus stop warning sign and school bus stop ahead plate should be erected at least 120m in advance of the stop. This allows motorists sufficient time to reduce speed and react to the hazard in front of them.

The AM stop arrangement again shows the appropriate position of the waiting area and the PM stop arrangement identifies appropriate arrangements for parents to park their cars away from all bus stop activity.

Where sight distances are restricted or the PM stop encroaches into the traffic lane it is also appropriate to erect a school bus stop warning sign and school bus stop ahead plate at the appropriate distance in front of the stop, according to the speed zone.

It is important to note that for roads with high traffic volumes (particularly heavy vehicles) high-speed limits warning signs may not be sufficient to mitigate the risk of buses encroaching on the traffic lane. In these circumstances, where no alternative location can be identified it may be necessary to undertake a treatment that removes buses completely from the traffic stream. This would be based on the unconstrained midblock treatment but involve a higher degree of construction works to widen carriageway shoulders and verges.

A5.3 Typical intersection treatment

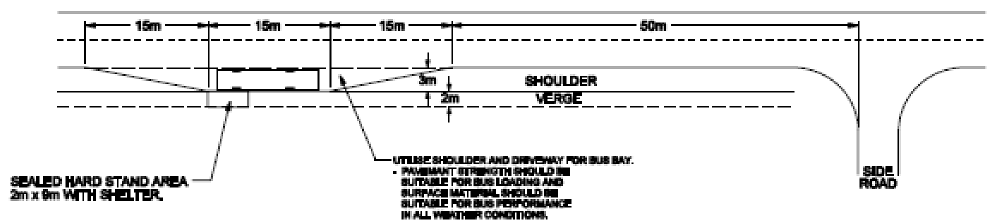
In rural communities, it may be appropriate for a roadside school bus stop to be located in close proximity to a side road intersection, particularly where this affords children much shorter journeys to and from the school bus stop. However, care must be taken to ensure that conflict between bus stopping activities and other road users is minimised.

Roadside school bus stops should be avoided at an intersection experiencing any safety-related constraints. For example, this includes intersections that have below standard sight and stopping distances, a history of crashes, below standard lane widths and/or a poor quality road surface.

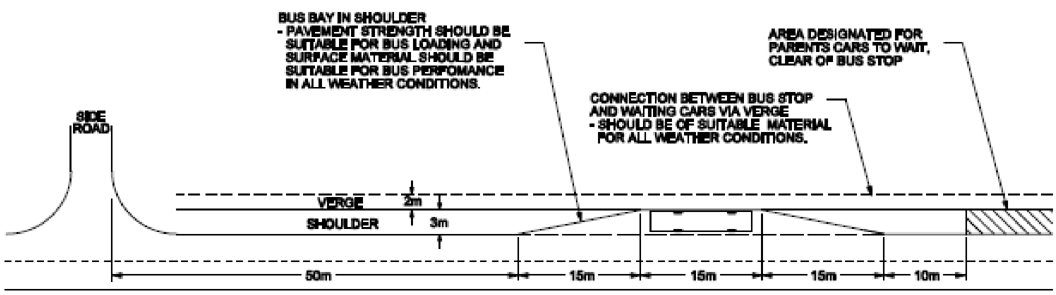
Figure A5 shows a typical treatment for this location for both an AM and PM stop. In general the safest location for a bus stop is the departure side of the intersection. This arrangement has the least impact on sight distances for all intersection traffic. It also reduces conflict between buses and vehicles turning left at the intersection. Pedestrian safety is better, as a motorist’s view of children or other pedestrians wanting to cross the intersection is less likely to be blocked by the bus.

Figure A5 Typical treatment for a school bus stop at an unconstrained intersection location

AM STOP LOCATION



PM STOP LOCATION



NOTES:

1. BUS STOP LOCATIONS SHOULD BE GIVEN HIGHER PRIORITY IN SHOULDER MAINTENANCE PROGRAM.
2. VEGETATION AND VERGE AROUND BUS STOP LOCATIONS SHOULD BE GIVEN HIGHER PRIORITY IN MAINTENANCE PROGRAM.
3. BUS STOPS SHOULD NOT BE LOCATED AT A CONSTRAINED INTERSECTION.

INTERSECTION - UNCONSTRAINED SITE

Where the bus stop is on the same side of the road as the intersecting side road, it is recommended that school bus stops are located at least 50m from the intersection. This will reduce the likelihood of other motorists misunderstanding a bus driver's intention to stop rather than turn left into the intersection.

The location and level of waiting facilities for AM and PM stops at intersections is in line with the recommendations for midblock sites.

Opportunities may also exist to locate school bus stops within an intersection where traffic volumes on the side road are very small (below 500 vehicles per day) and sight distances from the side road to a stationary bus are good (refer figure A1).

If stops are to be sited within an intersection, the passenger waiting facilities need to be located as far away from the road traffic lanes as possible but with clear visibility of approaching traffic .Children need to be issued with specific instructions not to move from the waiting area into the carriageway until the bus is stationary with the doors open.

A5.4 Typical treatment for school-located bus stops

School locations may require minor, medium or major treatments or the provision of bus stops. Minor treatments are similar to the minor treatments at roadside school bus stops where buses stop on the carriageway, at the kerb, or on the shoulder. For medium and major treatments there are generally three typical options:

- island layout
- concourse layout
- perimeter layout.

All three treatments are based on the assumption that sufficient land is available within or immediately outside the school grounds to develop for the purpose of a bus interchange. Where interchanges are located outside the school grounds, greater consideration needs to be given to the highway environment in which the interchange will be located. Consideration should be given to both the criteria for roadside school bus stops and school-located interchanges when these sites are developed.

The key distinction between whether a treatment is considered medium or major is the extent of works required at each location

For illustrative purposes each of the three interchange treatments is based on accommodating eight buses with a dimension of 12.5m x 2.5m. It is assumed that bus interchange activity is segregated from other vehicular activity to minimise conflict with parents' and teachers' cars. Signage should be erected to prevent other vehicles entering the bus interchange area. It is also recommended that the appropriate school staff member supervise all bus interchange activity.

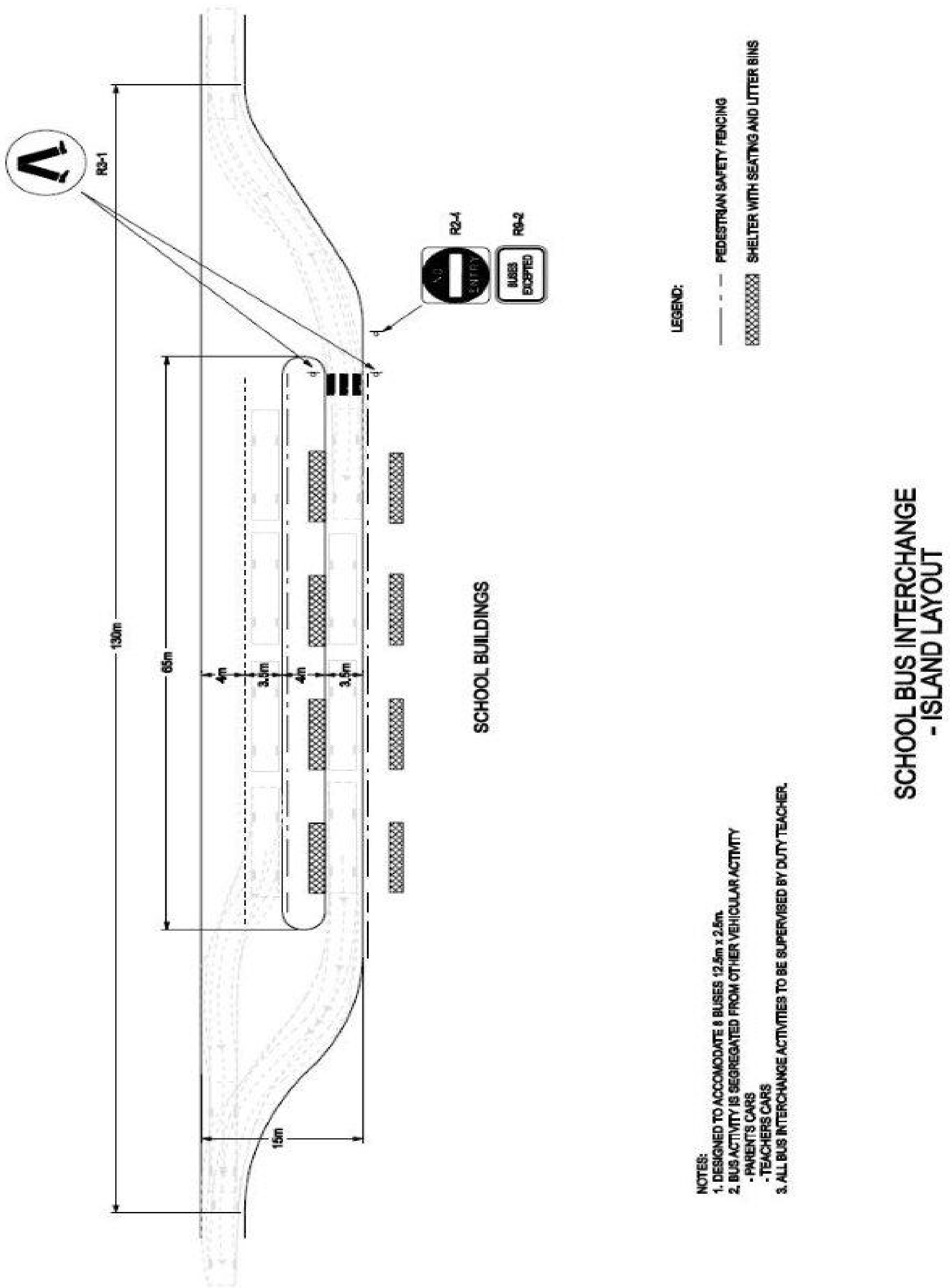
Each of the interchange treatments incorporates waiting facilities in the form of shelters with seating and litterbins. It is also recommended that safety fencing be erected to segregate bus movements from the student waiting/marshalling areas.

At all times it is essential that student marshalling activities are supervised.

A5.4.1 Island layout

The island layout treatment is shown in figure A6. This shows one boarding/alighting island between narrow single bus lanes. An additional boarding/alighting area is located directly adjacent to the school buildings. A pedestrian crossing connects the main school access to the island to minimise interaction between student marshalling and bus movements. In this arrangement buses are required to operate on a first in first out basis.

Figure A6 Island layout treatment



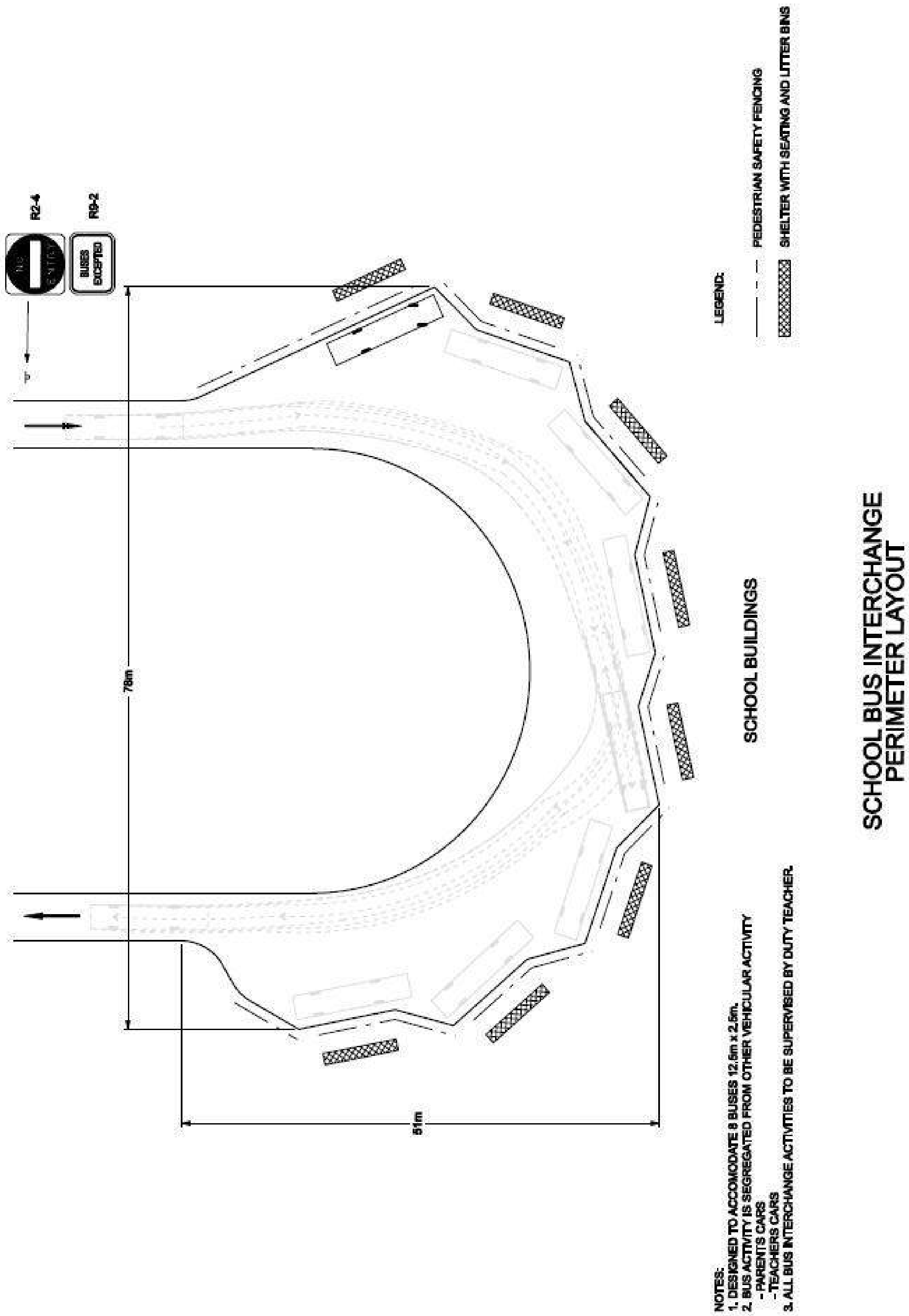
This arrangement is highly compact requiring just under 2000m2 to accommodate eight vehicles. To accommodate the installation of bus shelters and guard railing as well as queues of students, the island should be at least 4m wide. This should also be sufficient to accommodate wheelchair users if necessary. However, it may be possible to reduce the width of the island if students are able to wait for their buses on the area directly adjacent to the school building.

The marshalling of students to or from the island should be supervised at all times.

A5.4.2 Perimeter layout

The perimeter layout treatment is shown in figure A7. This arrangement allows for all boarding, alighting and waiting activity to occur on one edge, directly adjacent to the school buildings. Students are not required to cross any roadways minimising conflict between vehicle movements and student marshalling.

Figure A7 Perimeter layout treatment



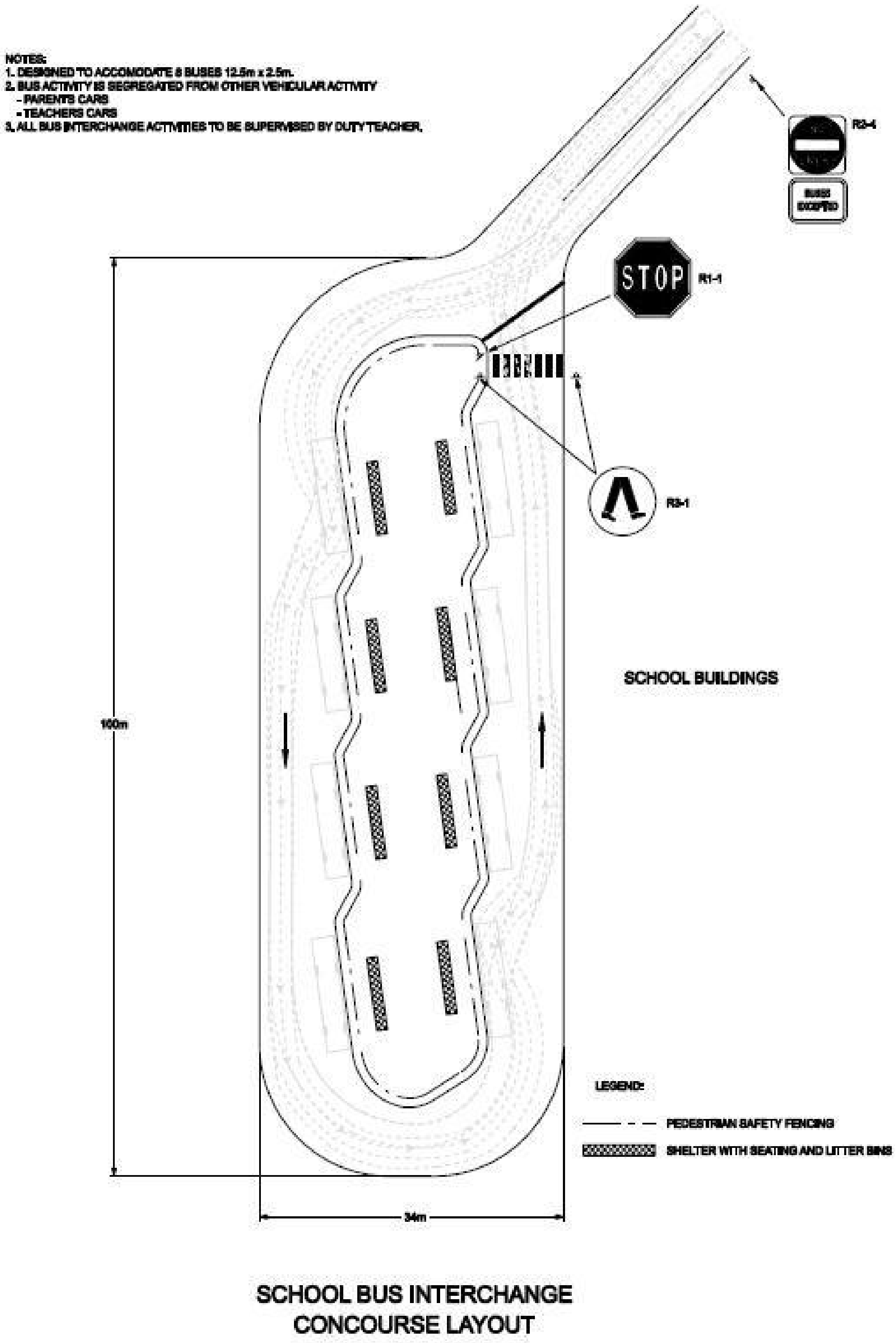
This arrangement requires an area of just under 4000m2 to accommodate eight vehicles. Bus shelters are provided adjacent to each allocated bus bay and guard railing erected along the length of the interchange with the appropriate size gaps for students to board or alight vehicles.

Buses are able to depart from the interchange independently although this would require certain vehicles to reverse out from some of the allocated bays.

A5.4.3 Concourse layout

The concourse layout treatment is shown in figure A8. This arrangement has all boarding and alighting activity occurring on one central concourse. Students wait for their buses on this central concourse, which would include shelters with seating and litter bins.

Figure A8 Concourse layout treatment



Students would access the concourse via a pedestrian crossing point located adjacent to the school buildings. To minimise conflict between bus movements and student marshalling or waiting, guard railing should be erected along the length of the concourse with the appropriate size gaps for students to board or alight vehicles.

This arrangement requires an area of approximately 3500m2 with all buses being able to operate independently. The space required for the interchange can be reduced if bus movements occur in a 'flighting motion', where all buses depart from the interchange at the same time.

A6 Costs

The costs of improving or establishing new school bus stops are highly variable, depending on the operational requirements and physical works required in each case.

A6.1 Costs for roadside school bus stop treatments

In urban areas, where existing bus stops would normally be used, there may be no additional cost for establishing roadside school bus stops.

At rural roadside school bus stops, costs will depend on the type and extent of the works required for shoulder treatment, the provision of waiting areas and shelter, and signage if required. The cost of providing these facilities varies significantly with the availability and price of materials, survey and design costs, alterations to utility services that may be encountered during construction and the extent of any drainage, major excavation or stabilisation works. Annex E provides indicative unit costs for the range of treatments that may be required.

A6.2 Costs for school-located school bus stop treatments

At school located bus stops, costs are affected by the same factors as for road side school bus stops, but the extent of the works may be larger and have additional requirements such as fencing, kerbing and islands and crossing provisions. Indicative unit cost estimates are provided in table A8.

Table A8 Indicative costs for school-located school bus stop treatments

Treatment type	Item	Area	Indicative unit cost (2005)
Island layout	Bus movement area	1700m2	$20–$40/m2 gravel pavement
	Large shelters	Dependent on student numbers	$10,000 per shelter
	Fencing	150–200m	$100–$140/m
	Boarding and alighting Island	2 x 65m	$65/m kerbing
		4 x 65m	$80/m2 concrete pavement
	School crossing	One	$450 per crossing
Perimeter layout	Bus movement area	2500m2	$20–$40/m2 gravel pavement
	Large shelter	Dependent on student numbers	$10,000 per shelter
	Fencing	150– 200m	$100–$140/m

Treatment type	Item	Area	Indicative unit cost (2005)
	Waiting area	175m	$65/m kerbing
		175m x 4m	$80/m2 concrete pavement
Concourse layout	Bus movement area	2800m2	$20–$40/m2 gravel pavement
	Large shelters	Dependent on student numbers	$10,000 per shelter
	Fencing	120–150m	$100–$140/m
	Central concourse	200m	$65/m kerbing
		15m x85m	$80/m2 concrete pavement
	School crossing	One	$450 per crossing

A7 Case studies

To support the development of the recommendations in these guidelines, they were tested by application to several rural roadside school bus stops and school located bus stops. The case studies are discussed in Annex H, showing suggested improvements resulting from these assessments together with the estimated costs of the recommended improvements.

Each case study consultation was undertaken with a representative from the school and the relevant bus operator to identify their safety issues and concerns.

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Annex A Guidance to bus stop related issues from the AUSTROADS *Guide to traffic engineering practice* [table 1, ARUP]

Part	Section	Requirements
5 Intersections at grade (2005)	2 Design procedures: 2.2 Basic data for design	Section 2.2.1 asks what function the intersection should fulfil; section 2.2.2 discusses intersection characteristic requirements, eg current traffic defined in terms of ...details of public transport, especially bus and taxi desire lines. Section 2.2.3 looks at future changes and consideration of 'planned route changes for trucks, buses and bicycles'. Section 2.2.4 – Output includes public transport requirements including movements, where services should stop, priority etc.
	7 Related facilities: 7.9 Bus stops	Location of bus stops in relation to the intersection should: • Prevent hazardous situations such as u-turns at the end of routes and right turns from the kerbside lane. • Minimise obstructions to other traffic bus zone activity should be limited at intersections to passenger pick up and drop off only. Bus stops at intersections require less space than midblock locations because parking restrictions at the intersections can be used for bus manoeuvres into or out of the bus zone. Far side stops may be preferable, especially at complicated intersections, as they may interfere less with through traffic. Far side stops are unsatisfactory if there is likely to be an accumulation of buses over the capacity of the zone. Bus stops at intersections will affect the sight distance requirements for other users. The visibility and location of pedestrian crossings should be considered.
11 Parking (1988)	7.2.3 Special use zones – bus stops	Bus stops should be located in relation to the land use they serve and to reduce pedestrian flow across roads. Midblock stops remove the run-in and run-out manoeuvres from the vicinity of intersection and cause less interference with traffic but may eliminate some kerbside parking. Where bus stops are required on both sides of undivided roads they should be staggered or fully indented. Typical layouts of kerbside bus stops and indented bus bays are described within the guidance. Bus route terminal stands or waiting areas should be located clear of through traffic lanes or at sites where disruption to traffic flows and parking provision is minimised.
16 On-road public transport (Austroads internal report 82-04)	5 Bus stops, tram stops and modal interchanges: 5.2 Bus stops	Detailed discussion including, design criteria, DDA requirements, parking and location issues and layout arrangements for different stops including for a basic kerbside stop; bus bay and sawtooth bays

Annex B Treatments for roadside bus stops

Conditions	Design criteria	Treatment type	Possible works required
Low speed zone Low traffic volumes Low proportion of large vehicles Low crash statistics Good sight distance Low student numbers Transient route Low service frequency	Lane and shoulder widths below or meet standards Sealed or unsealed shoulder Good condition of road and shoulder surface	No treatment required – buses stop in carriageway, located away from intersection	N/A
Medium – high speed zone Medium – high traffic volume Medium – high proportion of large vehicles Medium – high crash statistics Good sight distances Low student numbers Transient – semi permanent route Low service frequency	Lane and shoulder widths meet standards Sealed or unsealed shoulder Good condition of road and shoulder surface	No treatment required – buses stop in shoulder, located mid block or at least 50m from an intersection	N/A
Low – medium speed zones Low – medium traffic volumes Low – medium proportion of large vehicles Low crash statistics Medium sight distances Low student numbers Semi permanent – permanent route Low service frequency	Lane and shoulder widths below standard Sealed or unsealed shoulder surface Adequate – good road condition Adequate – good shoulder condition	Minor treatment required – buses stop in carriageway or partially in carriageway away from intersection	Minor upgrade to road and shoulder surface such as removing potholes and cracks Identify designated area for parents waiting in cars Small scale vegetation clearance Provide bus stop warning signage
Low speed zone Very low traffic volumes on side road/property driveway Low traffic volumes on main road Low proportion of large vehicles Low crash statistics Medium – good sight distances Low – medium student numbers Transient – permanent route Low service frequency	Lane widths meet standard Shoulder widths below standard Sealed or unsealed shoulder surface Adequate – good road surface condition Adequate – good shoulder condition	Minor treatment required – buses stop within side road or property driveway (refer figurse A1 and A4 for layout arrangements	Minor upgrade to road and shoulder surface such as removing potholes and cracks Identify designated area for parents waiting in cars Provide bus stop warning signage if sight distance restricted

Conditions	Design criteria	Treatment type	Possible works required
Medium – high speed environment Medium – high traffic volumes Medium – high proportion of large vehicles Medium – high crash statistics Medium – good sight distances Medium – high student numbers Transient – permanent route Low – medium service frequency	Lane widths below or meet standards Shoulder widths meet standards Sealed or unsealed shoulder surface Adequate – good road surface condition Adequate – good shoulder condition	Minor treatment required – buses stop in shoulder, located mid block or at least 50m from an intersection, (refer figure A3 and figure A5 for layout arrangements)	Minor upgrade to road and shoulder surface such as removing potholes and cracks Identify designated area for parents waiting in cars Small scale vegetation clearance Provide bus stop warning signage if sight distance restricted
Medium – high speed environment Medium – high traffic volumes Medium – high proportion of large vehicles Medium – high crash statistics Medium – poor sight distances Medium – high student numbers Semi permanent– permanent route Medium – high service frequency	Lane widths below or meet standards Shoulder widths below standards Unsealed shoulder surface Poor – adequate road surface condition Poor – adequate shoulder surface condition	Middle level treatment required – buses stop in shoulder located mid block or at least 50m from an intersection (refer figures A3 and A5 for layout arrangements	Medium upgrade to road and shoulder surface with suitable material for all weather conditions Widen shoulder if appropriate Provide designated area for parents waiting in cars Appropriate vegetation clearance Provide bus stop warning signage
Medium – high speed environment Medium – high traffic volumes Medium – high proportion of large vehicles Medium – high crash statistics Poor sight distances Medium – high student numbers Semi permanent– permanent route Medium – high service frequency	Lane and shoulder widths below standard Sealed or unsealed shoulder surface Poor road surface condition Poor shoulder surface condition	Major treatment required – buses stop in shoulder located mid-block or at least 50m from an intersection (refer figure A3 and figure A5 for layout arrangements)	Major upgrades required to: • - road surface • - shoulder surface • - width of roadway • - width of shoulder Appropriate drainage treatments Appropriate vegetation clearance Provide bus stop warning signage

Annex C Treatments for student waiting facilities at roadside school bus stops

Conditions	Design criteria	Treatment	Possible works required
Low student numbers Mainly high school age Transient stop	Adequate – good verge width Good verge condition	No treatment	N/A
	Adequate – good verge width Adequate verge condition	Minor treatment	Small scale vegetation clearance Identify location for student waiting area
Low student numbers Mix of primary and high school or mainly high school age Semi-permanent or permanent stop	Adequate – good verge width Adequate verge condition	Minor treatment	Small scale vegetation clearance Identify location for student waiting area
Medium student numbers Mix of primary and high school or mainly primary school age Transient or semi-permanent stop	Adequate – good verge width Adequate verge condition	Minor treatment	Small scale vegetation clearance Identify location for student waiting area Provide shelter for AM stop Identify designated walkway between PM stop and location for parents waiting in cars
Medium student numbers Mix of primary and high school or mainly primary school age Transient or semi-permanent stop	Poor – adequate verge width Poor – adequate verge condition	Major treatment	Large scale vegetation clearance Provide hard stand waiting area for AM stop of suitable material for all weather conditions Provide shelter for AM stop Provide designated walkway between PM stop and location for parents waiting in cars of suitable material for all weather conditions
Medium student numbers Mix of primary and high school ages Permanent stop	Adequate – good verge width Adequate verge condition	Minor treatment	Small scale vegetation clearance Identify location for student waiting area Provide shelter for AM stop Identify designated walkway between PM stop and location for parents waiting in cars
	Poor – adequate verge width Poor – adequate verge condition	Major treatment	Large scale vegetation clearance Provide hard stand waiting area for AM stop of suitable material for all weather conditions Provide shelter for AM stop Provide designated walkway between PM stop and location for parents waiting in cars of suitable material for all weather conditions

Conditions	Design criteria	Treatment	Possible works required
High student numbers Mainly high school age Transient stop	Adequate – good verge width Adequate verge condition	Minor treatment	Small scale vegetation clearance Identify location for student waiting area Provide extended shelter for AM stop Identify designated walkway between PM stop and location for parents waiting in cars
High student numbers Any age groups Transient – permanent stop	Poor – adequate verge width Poor verge condition	Major treatment	Large scale vegetation clearance Provide extended hard stand waiting area for AM stop of suitable material for all weather conditions Provide extended shelter for AM stop Provide designated walkway between PM stop and location for parents waiting in cars of suitable material for all weather conditions Extend verge width to at least 2m

Annex D Typical treatments for school-located bus stops

Condition	Design criteria	Treatment type	Possible works required
Low service frequency Limited modal conflict No space constraints Limited interchange between buses	Good road surface condition Good footpath width and condition Clear from vegetation	Minor treatment – in line with minor treatment types for roadside bus stops (refer table A2) where bus stops in carriageway (or kerbside) or in shoulder (or existing bus bay)	Provide shelter Protect student waiting area with guard fencing
Medium – high service frequency Modal conflict exists No space constraints Low – high levels of interchange between buses	Adequate - good road surface condition Adequate – good footpath width and condition Clear from vegetation	Middle level treatment – perimeter or concourse arrangement (refer figures A7 and A8)	Provide shelter Protect student waiting area with guard fencing For concourse arrangement provide school crossing and concrete pavement for student waiting area
Medium – high service frequency No modal conflict Limited space available Low – medium levels of interchange between buses	Adequate - good road surface condition Adequate – good footpath width and condition Clear from vegetation	Middle level treatment – island or perimeter arrangement (refer figures A6 and A8)	Provide shelter Protect student waiting area with guard fencing For island arrangement provide school crossing
Medium – high service frequency Modal conflict exists No space constraints Low – high levels of interchange between buses	Poor road surface condition Poor footpath width and condition Extensive vegetation	Major treatment – perimeter or concourse arrangement (refer figures A7 and A8)	Provide shelter Protect student waiting area with guard fencing For concourse arrangement provide school crossing Provide gravel pavement for bus stopping zone Provide concrete pavement and kerbing for student waiting area
Medium - high service frequency No modal conflict Limited space available Low – medium levels of interchange between buses	Poor road surface condition Poor footpath width and condition Extensive vegetation	Major treatment - perimeter or island arrangement (refer figures A6 and A8)	Provide shelter Protect student waiting area with guard fencing For island arrangement provide school crossing Provide gravel pavement for bus stopping zone Provide concrete pavement and kerbing for student waiting area

Annex E Indicative cost estimates for roadside school bus treatments

Treatment type	Item	Area	Indicative unit cost (2005)
Midblock AM stop, no constraints	Shoulder treatment	45m x 3m	$25 - $30/m2 asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Waiting area	2m x 9m	$80/m2 concrete pavement
	Shelter	1.5m x 4.5m	$5,000 per shelter
Midblock PM stop, no constraints	Shoulder treatment	45m x 3m	$25 - $30/m2 asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Walkway from stop to car parking area	10m x 2m	$20 - $40/m2 gravel pavement
Midblock AM stop, constraints exist	Shoulder treatment	45m x 3m	$25 - $30/m2 Asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Waiting area	2m x 9m	$80/m2 concrete pavement
	Shelter	1.5m x 4.5m	$5000 per shelter
	Warning signage	1 sign	$120 - $200 per sign
Midblock PM stop, constraints exist	Shoulder treatment	45m x 3m	$25 - $30/m2 asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Walkway from stop to car parking area	10m x 2m	$20 - $40/m2 gravel pavement
	Warning signage	1 sign	$120 - $200 per sign
Intersection AM stop	Shoulder treatment	45m x 3m	$25 - $30/m2 asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Waiting area	2m x 9m	$80/m2 concrete pavement
	Shelter	1.5m x 4.5m	$5000 per shelter
Intersection PM stop	Shoulder treatment	45m x 3m	$25 - $30/m2 asphalt
		45m x 3m	$20 - $40/m2 gravel pavement
	Walkway from stop to car parking area	10m x 2m	$20 – $40/m2 gravel pavement
All stop types	Vegetation clearing (excl maintenance)	As required	$50 - $500 per tree depending on size or $60 per hour for scrub clearance

Annex F Roadside school bus stops

Item	Observations required
Highway environment	
Speed zone	Specify zone, eg 60km/h
Traffic volumes	Volumes (vehicles per hour): high (>500 vph), medium (100 to 500 vph), low (< 100 vph)
Traffic composition	Cars/trucks (type/size – eg milk, log truck, semi trailers)
Crash statistics	Review NZTA crash data for past 10 years within close proximity to stop
Topography	Specify, eg hilly, winding road, steep/flat gradients, presence of overhanging trees
Sight distances	Record constraints to achieving recommended stopping sight distances and traffic clearance guidelines
Kerb alignments	Is there a kerb or barrier for buses to pull up against – yes or no; describe
Lane widths	Approximate width in metres and number of lanes, presence of shoulders
Type of road surface	Road and shoulder - asphalt, gravel, sealed, unsealed, existing line markings
Condition of road surface	Good, adequate or poor. Note if recently resurfaced
Drainage	Good, adequate, poor
Signage	Specify type of sign if present and approx location (eg school bus stop ahead/pedestrian crossing)
Proximity to side roads	At intersection, departure side, arrival side, midblock
Road crossings	Specify any concerns regarding crossing points for students from bus stop
Parking/kerb space	Sufficient space for parent's cars to wait and not cause conflict with buses
Alternative site locations	Specify if other locations potentially more appropriate within close proximity to existing
Bus waiting area	Surface type and condition, sufficient space off roadway
Waiting environment	
Seating	Yes, no, if yes quality of provision
Shelter	Yes, no, if yes quality of provision
Lighting	Yes, no, if yes quality of provision
Fencing	Yes, no, if yes quality of provision
Type of paving surface	Type and approximate width of verge or footpath
Operating conditions	
Student numbers	Confirm with school
Routing of service	Note whether bus serves both sides of road
Permanency of route	Transient, semi permanent, permanent
Frequency of services	Buses per day per stop and timing
Vehicle types on service	Specify different vehicle types that use stop
Bus turning arrangements	Reversing required, adequate turning circles and proximity to bus stop

Annex G School-located bus stops

Item	Observation required
Highway environment	
Location of interchange	Specify if school grounds or on-street
Speed zone	Specify zone
Traffic volumes	Volumes (vehicles per hour): high (>500 vph), medium (100 to 500 vph), low (< 100 vph)
Traffic composition	Cars/trucks (type/size – eg milk, log truck, semi trailers)
Crash statistics	Review NZTA crash data for past 10 years at locations
Topography	Specify, eg hilly, winding road, gradients
Sight lines	Record constraints to achieving recommended stopping sight distances and traffic clearance guidelines
Kerb alignments	Is there a kerb or barrier for buses to pull up against – yes or no; describe
Lane widths	Approximate width in metres and number of lanes, presence of shoulders
Signage	Specify type of sign if present (eg school bus stop ahead/peds crossing)
Type of road surface	Road and shoulder - asphalt, gravel, sealed, unsealed, existing line markings
Condition of road surface	Good, adequate or poor. Note if recently resurfaced
Alternative site locations	Specify if other locations potentially more appropriate within close proximity to existing
Drainage	Good, adequate, poor
Road crossings	Is there a marked crossing? If so is it patrolled?
Modal separation	Any potential conflict between cars, buses, children and other modes?
Proximity to side roads	At intersection, departure side, arrival side, midblock
Bus waiting facilities	Surface type and conditions, the number of stops, and kerb length
Waiting environment	
Seating	Yes, no, and quality of provision
Shelter	Yes, no, and quality of provision
Lighting	Yes, no, and quality of provision
Fencing	Yes, no, and quality of provision
Type of paving surface	Type and approximate width of footpath
Loading environment	Close to school buildings, direct transfer or are children required to cross roads
DDA considerations	Suitability of locations for DDA improvements if appropriate
Operating conditions	
Student numbers	Confirm with school/ DOI the number of students using interchange
Routing of service	Note whether bus serves both sides of road
Permanency of route	Transient, semi permanent, permanent
Frequency of services	Buses per day through the interchange and timing
Vehicle types on service	Specify different vehicle types that use interchange
Bus turning arrangements	Is reversing required, adequate turning circles
Supervision	Yes, no and by whom
Interchange	Number of students interchanging between buses

Annex H Case studies (to be completed when final guide produced)

Annex I Signage for school bus stops (to be completed when final guide produced)

Appendix B: Crashes during 1987 to 2007 involving students crossing the road to or from a school bus

Victim's gender	Count
Male	85
Female	77
Total	162

Age	No. of casualties
5	8
6	20
7	7
8	19
9	14
10	10
11	19
12	14
13	18
14	16
15	6
16	2
17	2
Unknown	6
Total	**162**

Injury	Count
Fatal	23
Serious	47
Minor	92
Total	**162**

Child from front or rear of school bus?	Count
Front	51
Rear	42
About to board the school bus	1
No mention	68
Total	**162**

Time of accident	Count
AM	22
PM	133
Total	155

Year	No of accidents
1987	8
1988	9
1989	7
1990	7
1991	10
1992	4
1993	5
1994	6
1995	10
1996	4
1997	4
1998	6
1999	13
2000	6
2001	7
2002	7
2003	10
2004	10
2005	4
2006	7
2007	8
Total	**155**

School bus status during the accident	Count
Stationary	62
Moving away	12
Left already	2
Making U-turn	1
Moving	0
No mention	78
Total	**155**

Road environment	
Terrain	**Count**
Flat	121
Hill	34
Total	**155**

Curvature	Count
Easy	15
Moderate	7
Straight	133
Total	**155**

Markings	Count
Centreline	116
Painted island	5
No pass line	8
Raised island	4
Pedestrian crossing	2
Nil	20
Total	**155**

Sealed?	Count
Yes	155
No	0
Total	**155**

Speed limit	Count
30	1
50	93
70	8
80	1
100	52
Total	**155**

Local body	2007 estimated population	No. of accidents (1987–2008)	% share of accidents to total accidents	Accidents per 100,000 population
Far North	57,800	2	1.29%	3.46
Whangarei	77,500	6	3.87%	7.74
Kaipara	18,600	0	0.00%	-
Rodney	94,700	8	5.16%	8.45
North Shore	220,200	7	4.52%	3.18
Waitakere	198,400	2	1.29%	1.01
Auckland	433,200	12	7.74%	2.77
Manukau	354,800	8	5.16%	2.25
Papakura	47,700	1	0.65%	2.10
Franklin	62,200	1	0.65%	1.61
Thames-Coromandel	26,800	1	0.65%	3.73
Hauraki	17,650	2	1.29%	11.33
Waikato	46,000	8	5.16%	17.39
Matamata-Piako	31,200	2	1.29%	6.41
Hamilton	136,600	0	0.00%	-
Waipa	44,200	4	2.58%	9.05
Otorohanga	9,250	2	1.29%	21.62
South Waikato	22,900	3	1.94%	13.10
Waitomo	9,600	0	0.00%	-
Taupo	33,500	2	1.29%	5.97
Western Bay Of Plenty	43,900	1	0.65%	2.28
Tauranga	108,800	2	1.29%	1.84
Rotorua	68,000	5	3.23%	7.35
Whakatane	34,400	5	3.23%	14.53
Kawerau	7,070	0	0.00%	-
Opotiki	9,140	1	0.65%	10.94
Gisborne	45,900	5	3.23%	10.89
Wairoa	8,580	0	0.00%	-
Hastings	73,600	3	1.94%	4.08
Napier	56,900	0	0.00%	-
Central Hawke's Bay	13,250	0	0.00%	-
New Plymouth	71,400	2	1.29%	2.80
Stratford	9,090	0	0.00%	-
South Taranaki	26,800	2	1.29%	7.46
Ruapehu	13,800	0	0.00%	-
Wanganui	43,600	0	0.00%	-
Rangitikei	15,050	0	0.00%	-
Manawatu	9,100	0	0.00%	-

Local body	**2007 estimated population**	**No. of accidents (1987–2008)**	**% share of accidents to total accidents**	**Accidents per 100,000 population**
Palmerston North	8,800	2	1.29%	2.54
Tararua	17,950	2	1.29%	11.14
Horowhenua	30,500	3	1.94%	9.84
Kapiti Coast	48,000	1	0.65%	2.08
Porirua	50,700	2	1.29%	3.94
Upper Hutt	40,000	5	3.23%	12.50
Lower Hutt	101,500	7	4.52%	6.90
Wellington	190,500	12	7.74%	6.30
Masterton	23,100	1	0.65%	4.33
Carterton	7,300	0	0.00%	-
South Wairarapa	9,140	0	0.00%	-
Tasman	46,100	3	1.94%	6.51
Nelson	44,400	1	0.65%	2.25
Marlborough	44,000	1	0.65%	2.27
Kaikoura	3,750	0	0.00%	-
Buller	9,960	0	0.00%	-
Grey	13,600	1	0.65%	7.35
Westland	8,690	0	0.00%	-
Hurunui	10,800	1	0.65%	9.26
Waimakariri	45,100	0	0.00%	-
Christchurch	365,700	1	0.65%	0.27
Selwyn	36,400	4	2.58%	10.99
Ashburton	28,400	4	2.58%	14.08
Timaru	43,900	0	0.00%	-
Mackenzie	3,920	0	0.00%	-
Waimate	7,420	0	0.00%	-
Chatham Islands	640	0	0.00%	-
Waitaki	20,700	1	0.65%	4.83
Central Otago	17,450	0	0.00%	-
Queenstown-Lakes	25,400	1	0.65%	3.94
Dunedin	122,500	2	1.29%	1.63
Clutha	17,200	1	0.65%	5.81
Southland	29,100	2	1.29%	6.87
Gore	12,300	0	0.00%	–
Invercargill	51,600	0	0.00%	–
Others	600	0	0.00%	-
Total	4,228,300	155	100.00%	3.67

Appendix C: Safety belt and occupant impact protection requirements

There are a number of regulations related to safety belt and occupant impact protection and containment. Table C1 provides a list of the primarily requirements in Australia (Australian Design Rule), Canada (Canadian Standards Association, Canada Motor Vehicle Safety Standards), New Zealand (Land Transport Rule), the United Kingdom (Economic Commission for Europe) and the United States of America (Federal Motor Vehicle Safety Standards).

Table C1 Safety belt and occupant impact protection and containment regulations

Jurisdiction	Regulation	
	Abbreviation	**Description**
Australia	ADR 3	Seats and seat anchorages
	ADR 4	Seat belts
	ADR 5	Anchorages for seat belts and child restraints
	ADR 66	Seat strength, seat anchorage and padding in omnibuses
	ADR 68	Occupant protection in buses
	ADR 69	Full frontal impact occupant protection
Canada	CSA D250-07	Includes requirements for doorways, aisle space, seating, emergency exits, seat belt for driver, fire safety equipment, advanced warning devices, safety crossing and bus stop arms, retro-reflective markings, lighting, mirrors, bus colour and body construction, and other bus component requirements
	CMVSS 220	School Bus Rollover Protection
	CMVSS 208	Occupant Restraint Systems in Frontal Impact
	CMVSS 210	Seat Belt Anchorages
	CMVSS 217	Bus Window Retention, Release and Emergency Exits
	CMVSS 221	School Bus Body Joint Strength
New Zealand	LTR 31001	Includes requirements for doorways, entry and exit ramps, aisle space, seating, emergency exits, fire hazards, rollover stability, structural strength, and special mobility requirements
	LTR 32002	Interior impact standards
	LTR 32004	Seats and seat anchorages
	LTR 32010	Head restraints
	LTR 32011	Seats and seatbelt anchorages
Europe	ECE 14	Safety-belt anchorages
	ECE 16	Safety-belts for occupants of power-driven vehicles
	ECE 36	Construction of public service vehicles
	ECE 52	Construction of small capacity public service vehicles
	ECE 66	Strength of superstructure
	ECE 80	Strength of seats and their anchorages
United States of	FMVSS 217	Bus emergency exits and window retention and release (Voluntary compliance on school buses)

America	FMVSS 208	Occupant crash protection
	FMVSS 209	Seat belt assemblies
	FMVSS 210	Seat belt assembly anchorages

Australia and Europe require safety belts on motorcoaches (ADR 68 and ECE R.80 Amendment 1). The major differences between ADR 68 and ECE 80 involve the crash pulse and loading scenarios. Table C2 summarises the impact criteria for the two regulations. The values for velocity change and peak acceleration show that ADR 68 imparts a more severe crash than ECE 80 when considering the strength of the seat and structure. Table C3 compares dummy injury criteria for the two standards.

Table C2 Comparison of ECE and ADR for bus safety belt regulation (National Highway Traffic Safety Administration 2007)

Parameter	ADR 68	ECE 80
Velocity change	49km/h	30–32km/h
Peak acceleration	20g, 0.05s	8–12g, 0.08–0.15s
Average acceleration	Not specified	6.5–8.5g

Table C3 Comparison of ECE and ADR for dummy injury criteria (National Highway Traffic Safety Administration 2007)

Parameter	ADR 68	ECE 80
Head Injury Criterion (HIC)	<1000	<500
Thorax Acceptability Criterion (ThAC)	<60g	<30g
Femur Acceptability Criterion (FAC)	<10kN	<10kN at any time, <8kN for durations of more than 20ms
Sternum Compression	<76mm	Not specified

Appendix D: Maintenance management

This standard is based on good maintenance management systems that are widely used in New Zealand and overseas. The benefits of adopting these practices include lower operating costs, improved safety, fewer breakdowns, reduced fuel use and less harm to the environment. The following are the high-level requirements of this standard.

Table D1 Maintenance management

Maintenance management		
Principles	**Indicators**	**Evidence**
The operator is fully committed to ensuring that all vehicles are in a roadworthy condition while being operated as school buses all of the time. Vehicles are considered to be roadworthy if they meet the CoF requirements.	The organisation is committed to the implementation and operation of its vehicle maintenance management systems that include daily checks, fault reporting, repair and scheduled maintenance.	An audit of vehicles being operated as school buses identifies no vehicle defects that are of a serious nature. The audit finds that faults are identified, recorded and rectified in a timely manner in accordance with the guide.

The following provides guidance on how these requirements can be met. Other methods of meeting the above requirements may be used.

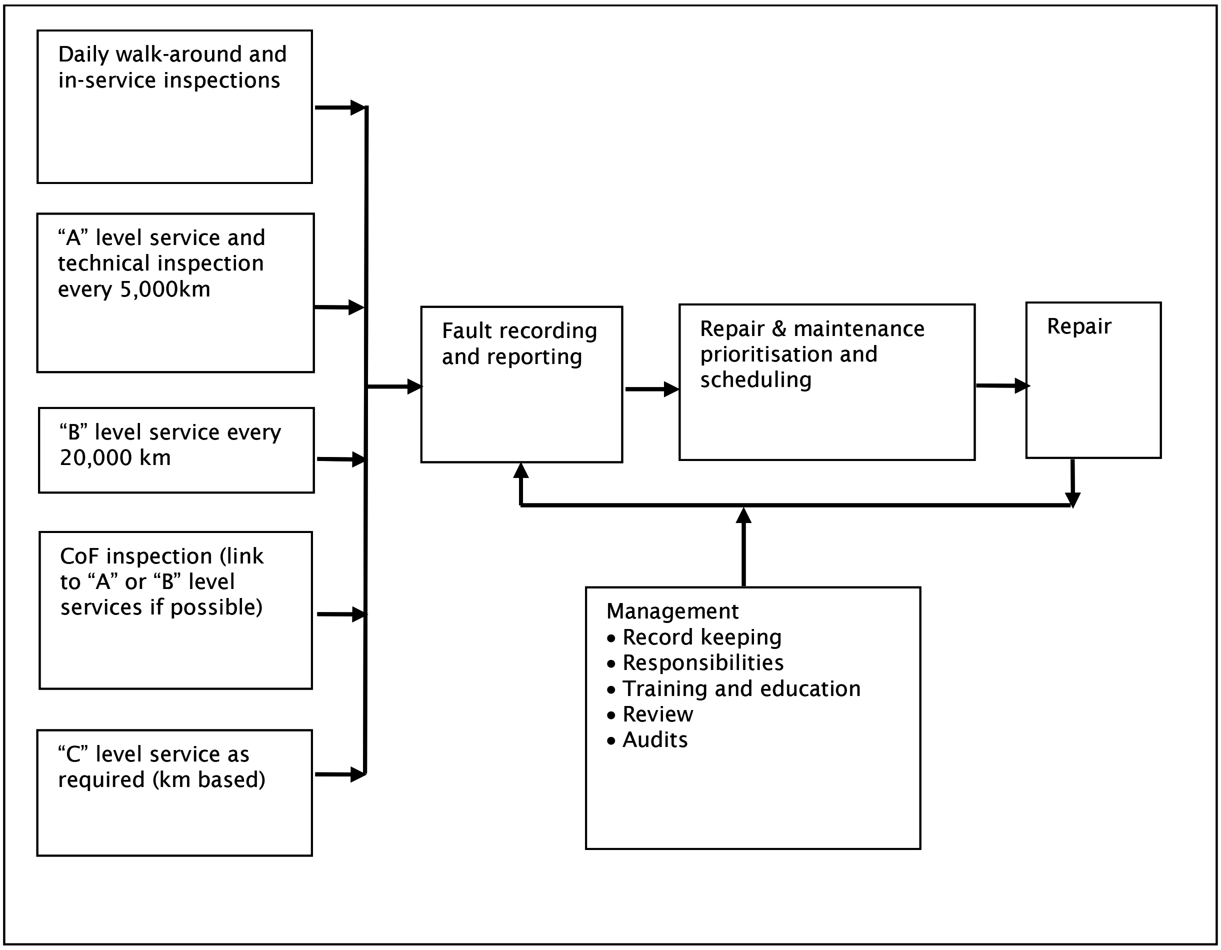
Background

Every school bus should be checked daily by the driver, receive an 'A' level service every 5000km and a 'B' level service every 20,000km, or at the intervals specified by the vehicle manufacturer. The normal A and B level services should be expanded to include the technical inspection of all parts of the bus that may affect safety, for example, the condition of the seats, chassis condition and the operation of the emergency exits. As school buses typically travel 20,000km to 30,000km per year, A services will be required every two to three months and B services approximately once a year. It makes sense to link the services in with pre-CoF inspections and to schedule them for the school holidays even if that means that the service or CoF inspections are slightly early.

As well as the inspections, there needs to be a formal recording, reporting and repairing system in place that ensures all faults are rectified in a timely manner. Repairing faults promptly not only ensures the vehicle is safe and in good condition but also reinforces to the driver the operator's commitment to safety.

Figure D1 summarises the steps of the maintenance management standard.

Figure D1 Maintenance management



Daily walk-around and in-service inspections

Daily checks are important to ensure that children have a safe and reliable trip to and from school.

The operator should establish, implement and maintain documented procedures for undertaking daily roadworthiness checks and have processes in place to rectify any faults that are identified. The checks are relatively simple and should ideally be undertaken by the first driver of the day for each bus. This helps ensure that drivers are fully involved in the process of inspection and reporting, and take an active share of the responsibility for maintaining roadworthiness standards. An alternative is for the inspections and reporting to be undertaken by another person who is familiar with the buses. In both cases, inspecting the buses before they are used for the first time each day ensures that serious faults previously reported have been fixed or at least left in a safe condition, and that the buses are in a roadworthy condition before going on the road. The person completing the inspection needs to acknowledge that the vehicle is roadworthy to the limits of the inspection. If they are unsure, they must report the fault to their supervisor who will decide whether the defect must be repaired before the bus enters service or can be scheduled for later repair as it does not pose an immediate threat to road safety. Faults detected during a trip need to be added to the daily vehicle check sheet below.

Each driver who subsequently uses a bus during the day should carry out a quick visual walk-around check of the outside and interior of the vehicle before using it. Buses should not be used if any serious faults are found.

The Land Transport NZ *Roadside inspection guidelines for heavy vehicles* is a good basis for the daily walk-around inspection. As well as the items listed, the inspection needs to include interior and exterior parts of the body such as fire extinguisher(s), seat condition, emergency exits, door function etc .

Fault recording, reporting and repair

An operator should establish, implement and maintain documented procedures for recording and reporting faults. A vehicle fault record should be kept in every vehicle to record faults and to note if repairs have been undertaken. Two examples of check sheets are attached to this standard.

Planned maintenance and safety inspections

An operator should establish, implement and maintain documented procedures for scheduling, performing and recording periodic maintenance and CoF inspections. Those inspections include:

'A' level inspection

This inspection needs to be undertaken by a technically qualified person and should include:

- items recommended by the vehicle manufacturer such as fluid levels
- safety items such as brakes, tyres, couplings and steering (these checks should include all of the CoF inspection items)
- a check on the items that should be inspected as part of the driver daily inspection.

'B' and 'C' level inspections

All items included in the A inspection and additional items recommended by the vehicle manufacturer and body builder.

Repair procedures

An operator should establish, implement and maintain documented procedures that provide for a reported fault to be assessed, the repair to be assigned a priority, and the repair to be undertaken. Repair procedures should include:

- At the end of each day, a review of the *daily bus inspection form* and *vehicle fault log* for each bus that has been in operation that day.
- Faults that cannot be repaired immediately, and are of a 'low risk' nature, should be entered into the workshop repair request system, which can be paper or computer-based. Each repair entry should record the date, the nature of the fault, who reported it, who undertook the repair and what parts were used and what work was done.
- If a fault is to be monitored instead of being immediately rectified, a record should be kept of what is being monitored, by whom and when. If, after a period of monitoring, it is decided that a repair is not required, this should be noted in the records along with who made that decision.
- Recording all repairs, services and other actions in the vehicle file. This can be linked to the workshop repair request system and can be paper or computer-based.
- Owner-drivers should decide on the urgency of the repair or check with their contract repairers.

Management

There should be clear management processes in place that include:

- Identification of the person with overall responsibility for the safe operation and roadworthiness condition of all buses operated as a school bus and for ensuring full compliance with the following management processes. This person should have the authority to commission repair work and to remove any bus they consider to be unroadworthy from service. A second person should be appointed to act as a *fall back* in emergency situations or to take overall responsibility when the first person is unavailable due to sickness, holidays etc.
- Ensuring periodic and CoF inspections are undertaken at, or before, the scheduled time, and that daily walk-around inspections are undertaken before buses are used each day.
- Ensuring good quality inspection and maintenance records are kept, and that these identify who made the entry and when.
- Ensuring all reported defects are assessed for risk and priority for repair or monitoring.
- Ensuring repairs are undertaken or, if a repair is not undertaken, why and who made the decision not to repair the fault.
- Ensuring responsibilities are clearly understood and acted on. If repairs are contracted out, the responsibilities of the repair shop and the vehicle owner/manager need to be clear.
- Ensuring repairs are undertaken to a standard that is acceptable to bus operator.
- Ensuring that all complaints about the condition of buses are recorded, investigated and that corrective action is taken where necessary. Corrective action should include rectification of the problem that led to the complaint, improvement of company systems (where investigation shows these to be inadequate) and employment related action in cases where company policies and procedures have not been followed.
- Undertaking internal audits to ensure procedures and processes are being followed. Audits of the repair shops could include inspections of a vehicle when returned from the workshop to ensure the repairs and services have been undertaken correctly.

Training and education

The bus operator has a responsibility to ensure appropriate training is provided for all of the people involved. This includes drivers, managers and maintenance personnel.

Fuel efficiency

How well a vehicle is maintained and how it is driven can make a large difference in the amount of fuel used, the amount of harmful exhaust emissions produced, global warming and safety. The difference in fuel consumption between a good and a poor driver can be as much as 35%. This difference is largely due to differences in road speed, gear selection, the engine speeds at which gears are changed, aggressiveness of accelerator use, and the amount of time the driver leaves the vehicle idling. Poorly-tuned engines can use up to 50% more fuel than well-tuned ones. Clogged air filters increase fuel consumption by up to 10%. Under-inflation increases fuel consumption, reduces tyre life and is a major contributor to flat tyres and blowouts. There is also a strong link between safety and fuel efficiency as how well a vehicle is maintained, speed and aggressive driving affect both.

It is recommended that operators focus on fuel saving by monitor fuel consumption and encouraging drivers to drive carefully and to inspect their vehicles thoroughly.