THE HIGHWAYS AGENCY

TD 41/95

THE SCOTTISH OFFICE DEVELOPMENT DEPARTMENT

THE WELSH OFFICE
Y SWYDDFA GYMREIG

THE DEPARTMENT OF THE ENVIRONMENT
FOR NORTHERN IRELAND

Vehicular Access to All-Purpose Trunk Roads

Summary: This Standard sets out mandatory standards for the geometric layout of connections for direct vehicular access to all-purpose trunk roads where the numbers using the connection are below 500 AADT. The Standard describes the effects of vehicular access to Trunk Roads and outlines the results of recent research on the safety implications.

REGISTRATION OF AMENDMENTS

Amend No	Page No	Signature & Date of incorporation of amendments	Amend No	Page No	Signature & Date of incorporation of amendments

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VOLUME 6 ROAD GEOMETRY
SECTION 2 JUNCTIONS

PART 7

TD 41/95

VEHICULAR ACCESS TO ALL PURPOSE TRUNK ROADS

Contents

1. INTRODUCTION

Scope

1.1 Where vehicular access has been approved this Standard sets out requirements to be met in providing or improving such access to an all-purpose trunk road, including geometric and visibility standards. It covers both single and dual carriageway all-purpose trunk roads in urban and rural areas. The Standard reviews the traffic and safety implications and stresses the need for only the minimum number of well engineered connections in safe positions.

General

1.2 This Standard replaces **TA 4/80 (DMRB 6.2)** Access to Highways - Safety Implications, which is withdrawn. For England, this Standard should be read in conjunction with **Circular Roads 4/88 and Planning Policy Guidance Note No. 13 on "Transport" (March 1994)**. In Wales, the circular is **Welsh Office Circular 42/88** and the **Planning Policy Guidance Note 13** is that published in **1988**. These documents do not apply to Northern Ireland, and Scotland. This Standard provides technical information related to access policy but does not set out such policy.

1.3 In the case of England and Wales, local planning authorities have the responsibility for making decisions on direct accesses and their spacings where the all purpose trunk road is subject to a 40 mph speed limit or less.

1.4 This Standard updates the previous advice and introduces geometric standards. It includes the results of recent research work in this country. It also draws upon overseas experience. The opportunity has been taken to include full mandatory geometric and visibility requirements which extend **TD 42 (DMRB. 6.2.6)**. Other changes include widening the scope of the Standard to consider the needs of all road users including pedestrians, cyclists and equestrians.

1.5 Connections for vehicular access to an all purpose trunk road range from a field gate with a verge crossing or a direct access serving a single dwelling or development up to a road designated as unclassified and serving a number of developments or a large single development. If the total amount of traffic forecast to use the connection exceeds 500 vehicles per day (AADT) then it should be designed according to the appropriate junction Standard. This would be for either a Major/Minor Priority Junction **(TD 42 DMRB 6.2.6)**, a Roundabout **(TD 16 DMRB 6.2.3)**, a Signalled **(TA 18 DMRB 6.2)** or Grade Separated Junction, **(TD 22 DMRB 6.2.1 or TD 40 DMRB 6.2.5)** depending on the level of use of the connection, the traffic flow on and the nature of the trunk road in terms of the general level of junction provision along the length. Where the flow likely to use the connection falls below 500 AADT, and the connection is a direct access as defined in para 1.11, then this Standard shall be used for the design of the geometric layout.

1.6 The figure of 500 AADT relates to continuous use. It may be that an access is used less regularly but when it is, the use on that occasion exceeds this figure by a considerable amount. The access may then require some form of specific traffic control. It is for Overseeing Organisations to decide what provision is appropriate based on this peak use and the frequency of it occurring. It is unlikely that a roundabout connection would be appropriate in this situation as this would impose geometric delay permanently on trunk road traffic.

1.7 The primary purpose of the trunk road network is to provide for the safe and expendious movement of long distance through traffic. That means strictly limiting the number of direct accesses to trunk roads. It means ensuring that the full implications for traffic and road safety are taken into account when proposals are made for new development in the vicinity of trunk roads. This is whether it involves new access or increased use of existing accesses, particularly onto dual carriageways where speeds are high. Limiting direct access remains a prime objective of the Overseeing Organisations.

1.8 It has been accepted for more than 50 years ever since the **1936 Restriction of Ribbon Development Act** that if trunk roads are to perform satisfactorily as channels for longer distance traffic, the number of connections for vehicular access must be limited. Access traffic has three effects, it adds to the traffic on the trunk road, it slows other traffic, and it can give rise to accidents. What the new research reported here shows is that connections for vehicular access are one of a number of features which figure in the safety risk on the trunk road network. The key to providing a safe connection is to ensure that it is sited correctly, has adequate visibility and that it is designed so that joining and leaving traffic can do so without impeding through traffic. There are likely to be few places on trunk roads where even these conditions can be met.

1.9 Accident records for all roads, as set out in **"The Casualty Report" (Road Accidents in Great Britain 1992)** show that in urban areas 70% of accidents now occur at junctions and accesses, and about 38% of accidents in rural areas. In 1980, when **TA 4/80 (DMRB 6.2)** was published, the figures in **Road Accidents in Great Britain 1980** for accidents at junctions and accesses showed 66% in urban areas and 33% in rural areas. In the intervening 12 years, accidents away from junctions have fallen 14% to just under 90,000 in the year. Accidents at junctions and accesses remain almost constant having reduced by only 2% to 143,000. But on trunk roads in rural areas in 1991 there was a higher proportion of accidents at junctions and accesses, 47% of accidents on dual carriageways and 51% on single carriageway occuring there. These figures are explored further in **Annexes A1 and A2**.

Implementation

1.10 This Standard shall be used forthwith on all schemes for the construction, improvement, and maintenance of all-purpose trunk roads, currently being prepared provided that, in the opinion of the Overseeing Organisation, this would not result in significant additional expenses or delay progress. Design organisations should confirm its application to particular schemes with the Overseeing Organisation.

Definitions

1.11 The terminology follows where possible the definitions contained in **BS 6100 : Subsection 2.4.1 1990**.

1.12 The following additional terms have been defined for use in this Standard.

Direct Access : a connection to an all-purpose trunk road for the use of road vehicles, serving or intended to serve, one or more properties, and linking directly to the site.

Junction : a meeting of two or more roads.

Minor Junction: a meeting of an unclassified road or a classified unnumbered road with the all-purpose trunk road

Major Road : is a road on which traffic has a priority of movement over that of other roads.

Minor Road : is a road on which traffic concedes priority to the traffic on the major road.

Roads : Urban and Rural : as defined in **TD 20(DMRB 5.1)**, namely that an urban road is a road in a built up area which has either a single carriageway with a speed limit of 40 mph or less or is a dual carriageway or is a motorway with a speed limit of 60 mph or less. All other roads are rural roads.

Mandatory Sections

1.13 Sections of this document are highlighted by being in boxes. These contain standards which the Overseeing Organisation expects in design. These are the sections with which the Design Organisation must comply or must have agreed a suitable Departure from Standard with the relevant Overseeing Organisation. The remainder of the document contains advice and enlargement which is commended to designers for their consideration.

Relaxations Within Standard

1.14 In difficult circumstances the Design Organisation may relax a standard set out in this document to that relating to the next lowest design speed step, unless this document specifically excludes it. However, in using any such relaxation, the Design Organisation shall give special attention to the effect this relaxation may have on the overall performance of the access. This is particularly important in the situation where two or more Relaxations are incorporated into different components of the access design. In all instances of Relaxation, the Design Organisation shall record the fact that a Relaxation has been used in the design and the corresponding reasons for its use. On completion of the design, the Design Organisation shall report all such decisions to the Overseeing Organisation.

Departures from Standard

1.15 In exceptional situations, Overseeing Organisations may be prepared to agree to a Departure from Standard where the standard including permitted relaxations is not realistically achievable. Design Organisations faced by such situations and wishing to consider pursuing this course shall discuss any such options at an early stage in design with the relevant Overseeing Organisation. Proposals to adopt Departures from Standard must be submitted by the Design Organisation to the Overseeing Organisation and formal approval received BEFORE incorporation into a design layout.

2. GEOMETRIC STANDARDS FOR DIRECT ACCESS

General

2.1 There is a potential saving in accidents where there is a reduction in the number of lightly trafficked direct accesses and minor junctions made directly on to each trunk road. Such accesses can be joined together with a link or service road before they join the main carriageway of the trunk road. Options for such indirect connections should always be explored, as should providing the access from the local road network.

2.2 Direct vehicular access on to trunk roads shall be avoided as far as practicable. Where feasible, access should be to a local road. Where a direct access to an all purpose trunk road has been agreed by the Overseeing Organisation, the traffic flow and safety can be assisted by good design of the connection, meeting the requirements of the relevant junction standard. Large scale development proposals may merit the consideration of special traffic measures and road works to accommodate them in the existing network. Details for the design of such is set out in the Standards quoted in **para 1.5**. The geometric standards given in this chapter are only relevant to direct accesses where use is forecast to be less than 500 AADT in the design year.

2.3 The type of direct access provided shall correspond to the type of all-purpose trunk road involved and the volume and character of traffic likely to use it. It is unreasonable to require costly access designs when an access is readily apparent to drivers and only a few vehicle movements are expected from and to it each day on a road which does not carry high speed traffic. This therefore refers to roads having a design speed of 85 kph or below.

2.4 It is inadvisable to agree to a new access facing an existing one across a single carriageway as this may lead to vehicles crossing the trunk road. Cross road situations are undesirable and it would be better to ensure accesses are staggered. The implications and accident risk for right turning traffic into and out of the access shall always be taken into account. This may indicate that it would be desirable to prevent the right turning movements. If preventing them is not a practical option, vehicles waiting in the centre of the road to turn right can sometimes be protected by islands.

Existing Direct Access

2.5 Where an existing direct access is likely to cause, or has caused, danger to road users, action can be taken by the Highway Authority or Roads Authority to stop it up under the provisions of highways or roads legislation. Generally an alternative access has to be provided.

2.6 Owners of existing accesses are expected to use them safely and if necessary the Highway Authority or Roads Authority also has powers under highways or roads legislation to see that improvements are made to them to increase safety.

2.7 Where significant obstructions to visibility lie within the highway then propriety should be given to their removal. Cutting of grass verges and trimming bushes etc. at accesses to prevent obstruction to visibility should be part of routine maintenance. Maintenance of visibility splays has sometimes been made the subject of conditions imposed on the developer at the time of granting of a direct access.

New or Altered Direct Accesses

2.8 The geometric layout of new and altered direct vehicular accesses on to existing all-purpose trunk roads shall be determined in **TD 9 (DMRB 6.1.1)** and the size of vehicles using the access. The access shall be designed for the largest vehicle expected to use it. The selection access layout will be dependent upon carriageway widths, geometric constraints, local traffic flows, other site specific features, and environmental considerations.

2.9 Conditions under planning legislation can be applied to planning applications in order to enhance the safety of direct access to and from the site of proposed development and to minimise the detrimental effect on passing traffic. This is also set out in Chapter 9 of **TA 57 (DMRB 6.3)** on "Roadside Features".

2.10 Any application which results in a material increase in the volume of traffic or a material change in the type of traffic entering or leaving a trunk road shall be carefully considered. Generally, a material increase is considered to be if the turning traffic flows, as a result of the new development, would increase by 5% or more, although there may be cases when it is important to consider smaller increases. For England, this is discussed more fully in Annex B of **Planning Policy Guidance Note 13 (1994)**, and for Wales in Appendix A of **Planning Policy Guidance Note 13 (1988).**

2.11 New or altered direct accesses shall not normally be sited on a bend unless the desirable minimum stopping distance can be achieved. If the Overseeing Organisation agrees to the provision of a direct access as a Relaxation, the preferred location is on the outside of the bend to maximise the available sight lines. The provision of direct vehicular accesses on the inside of such a bend shall be refused. Direct accesses shall also not be sited in the overtaking section of single carriageway roads as defined in Highway Link Design as set out in **TD 9 (DMRB 6.1.1)**.

2.12 New or altered direct accesses onto trunk roads shall wherever possible be on level ground or in sags where there is visibility as set out in **para 2.15** to **2.27**. They shall not be at or near crests where the shape of the connection would not be immediately apparent to the driver on the trunk road, or where there are double white lines (indicating restricted forward visibility). At driver's eye level there shall be a clear view from the direct access over the immediate area of the access and its connection to the trunk road. New direct accesses shall only be sited where they do not encroach on the visibility requirements of adjoining direct accesses or junctions in regular use. This determines the minimum spacing of new accesses. Where the all-purpose trunk road is an Urban Road as defined in **para 1.11** the Overseeing Organisation may concur to a closer spacing as a Relaxation of standard, depending on the local road safety record on that particular stretch. In England and Wales, decisions on direct accesses and their spacing on trunk roads subject to a speed limit of 40 mph or less are for the local planning authority **(see para 1.2)**.

2.13 On dual carriageway roads, it is important to keep crossings in the central reserve to an absolute minimum to maintain safety, and hence to confine traffic to more major road junctions. Only in exceptional circumstances, therefore, should movements across the central reserve be permitted to and from direct vehicular accesses. It is up to the Overseeing Organisation to determine whether the circumstances are exceptional in any particular instance. Crossings of the central reserve shall not be provided on dual three lane carriageways and wider.

2.14 New direct accesses shall not normally be provided at locations where the major road gradient is greater than 4%. It is recognised that in hilly terrain, particularly where major road traffic flows are in the bottom half of the range set out in **TD 20 (DMRB 5.1)**, direct accesses at locations with steeper gradients may be acceptable and the accident risk should be assessed before approval is given.

Visibility

2.15 For safety, drivers both on the major road and on the minor road or direct access shall be able to see any potential hazard in time to slow down or stop comfortably before reaching it. It is necessary therefore to consider the driver's line of vision in both the vertical and horizontal planes and the stopping sight distance for the vehicle at the relevant design speed. It is also essential that other road users can equally see oncoming vehicles, particularly where vehicles cross the footway in front of pedestrians at the same level and the crossing may not be so obvious. The Design Organisation shall comply with these requirements.

2.16 It is also important that any driver wishing to turn right across the opposing traffic stream into the access shall be able to see oncoming vehicles for the Desirable Minimum Stopping Distance as set out in **TD9 (DMRB 6.1.1)** for the design speed of the road. **TD9** also sets down the visibility requirements on approaching a junction and the same values shall be taken for drivers approaching where vehicles are turning right into a direct access **(see also 2.24)**.

2.17 Visibility splays shall be provided to enable emerging drivers using the direct access to have adequate visibility in each direction to see oncoming traffic in sufficient time to make their manoeuvre safely without influencing the major road traffic speed. Drivers of vehicles on the major road shall also have forward visibility equivalent to the desirable minimum stopping sight distance to be aware of the presence of the access.

2.18 Dangerous conditions arise if vehicles obstruct visibility by parking within visibility splays. Where necessary, parking and access shall be controlled to prevent this. The Design Organisation shall ensure that the positioning of lay-bys, bus stops, traffic signs and other street furniture does not interfere with the drivers' visibility requirements and that the obstructive effect for all road users is minimised.

2.19 The visibility standards given below are expressed in terms of "X" and "Y" distances. **Figure 2.1** below illustrates these distances in a typical access.

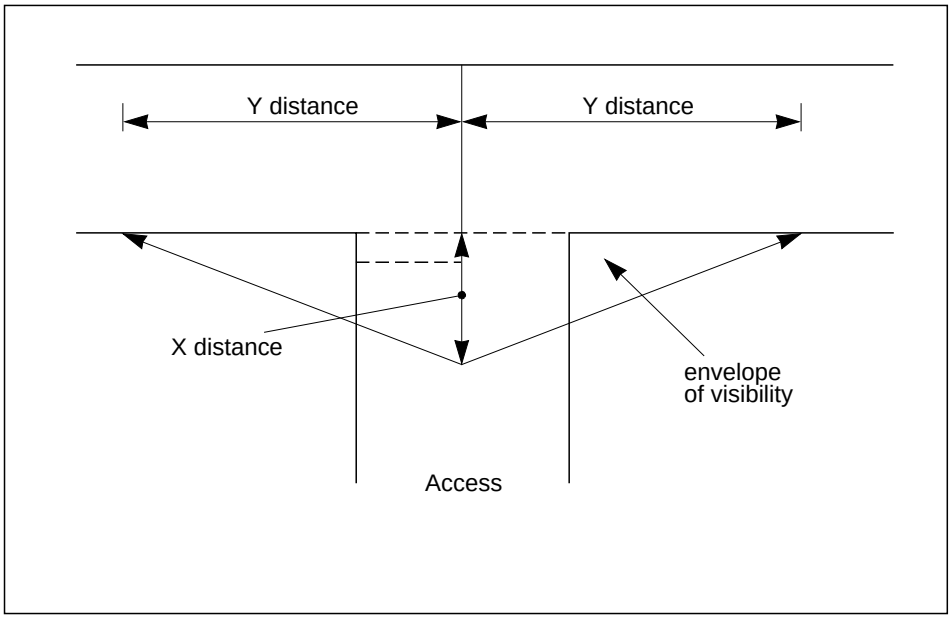


Figure 2/1 : Definition of “X” and “Y” Distances

2.20 The "X" distance is referred to as the 'set-back' distance and shall be measured from the continuation of the nearer edge of the major road running lane (not from the continuation of the main road 1m hardstrip if this is present) along the centre line of the direct access. The "Y" distance shall be measured from a point on the nearer edge of the main road running lane to its intersection with the centre line of the access.

2.21 Normally, an "X" distance of 4.5m shall be provided for a direct access where use in the design year is forecast not to exceed 500 AADT. The choice of set back distance is related to the forecast traffic using the access. For lightly used accesses, for example those serving a single dwelling or a small cul-de-sac of a half a dozen dwellings, the set back "X" may be reduced to 2.4m. The 2.4m set back relates to normally only one vehicle wishing to join the trunk road at one time. The 4.5m covers the situation where two light vehicles may want to accept the same gap in the trunk road traffic. Where in the case of lightly used accesses the site conditions are particularly difficult, then the set back "X" may be reduced to 2.0m as a Relaxation. Any further reduction would be a Departure from Standard under para 1.15.

2.22 The "Y" distance along the major road, the all purpose trunk road, shall be determined from Table 2/1:

Design speed of major road (kph)	120	100	85	70	60	50
"Y" Distance (m)	295	215	160	120	90	70

Table 2/1: Value of "Y" Distance

Note, these figures correspond to the Desirable Minimum Stopping Sight Distances set out in Table 3 in **TD9 (DMRB 6.1.1)**. Relaxations are not available on these figures.

2.23 Design speed on the all-purpose trunk road required for determining the "Y" distance shall be as given in **TD 9 (DMRB 6.1.1)** for existing and proposed roads and can be based upon measurement, speed limits or design speed principles.

2.24 In calculating sightlines it is important to ensure that the trunk road traffic shall have at least Desirable Minimum Stopping Sight Distances (SSD) on the approached to the access **TD9 (DMRB 6.1.1)**. Relaxations below Desirable Minimum are not permitted under **TD9** on the immediate approaches to junctions and this shall apply to direct accesses.

2.25 The same principles of sightlines in the vertical plane apply to direct accesses as given in **TD9 (DMRB 6.1.1)** for stopping sight distances. Thus, visibility in the vertical plane shall be measured from a driver's eye height 1.05m to 2.00m positioned at the set back distance in the direct access to an object height of between 0.26m ad 1.05m. This will ensure that a vehicle approaching on the trunk road is easily identified at night and that, for example, a child can be identified walking along an adjacent footway. **Figure 2/2** shows the construction required.

2.26 Where an emerging vehicle crosses a footway at a lightly used direct access - for example from the driveway of a single dwelling - pedestrians may not have sufficient warning of its approach. This relates to the situation where the vehicle crosses at the footway level and there is no clearly formed differentiation in the level between the footway and the crossing. Under these conditions, visibility splays to the back of the footway, 2m on either side of the centre of the access, shall be provided from 2m back in the access. The driver's eye height shall be taken as 1.05m and the object height at the back of footway shall be taken as 0.6m to make clear the presence of a small child. This is shown in **Figure 2/3.**

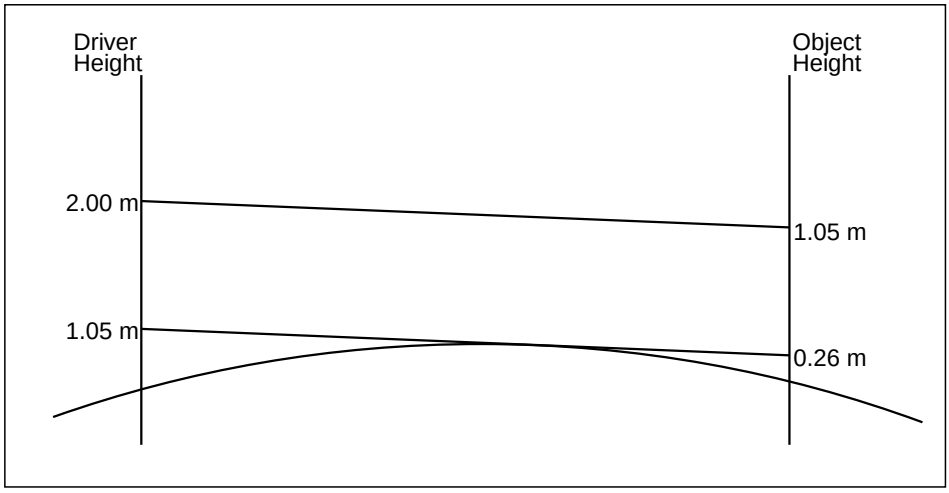


Figure 2/2 : Sightline Requirement in the Vertical Plane

Approach Gradients and Visibility

2.27 On direct accesses, gradients greater than 10% approaching the trunk road shall not be permitted other than in exceptional circumstances. The access gradient immediately next to the trunk road should be considerably less, and a "dwell" area of at least 15m shall be provided immediately adjacent to the trunk road carriageway. Where site conditions are particularly difficult this area may be 10m as a Relaxation. In the case of a single dwelling, it may be reduced to 5m as a Relaxation. The gradient for the dwell area shall lie between 0 and 2% approach downgrade. In difficult situations this may be increased to between plus and minus 4%. The intention here is to avoid the risk of vehicles stalling on a mild hill start when attempting to accept a gap in the trunk road traffic or inadvertently rolling out into the trunk road carriageway. The visibility requirement set out in the above paragraphs shall be met in full at locations with steep gradients.

Geometric Layouts

2.28 **Table 2/2** gives a umber of basic direct access layout types which should form the basis of local designs.

2.29 The following are layouts detailed in this chapter and for which diagrams appear at the end of the chapter.

Layout 1:	Field access
Layout 2:	Single dwelling
Layout 3:	A simple T layout for urban and rural situations
Layout 4	Left in/left out layout
Layout 5:	T layout with ghost island
Layout 6:	Rural access where long vehicles are predicted
Layout 7:	Rural access where long vehicles are predicted, no right turn from trunk road
Layout 8:	Typical gateway entry treatment
Layout 9:	Nearside diverge taper, as for example, entry to a Petrol Filling Station (PFS)
Layout 10:	Merge taper.

Layouts 3,4,5,6,7, allow for the provision of short merge tapers to enable Large Goods Vehicles (LGVs) to enter the trunk road without having to encroach on the adjacent traffic lane. Where possible these tapers should be provided, particularly if LGVs perform the turn regularly.

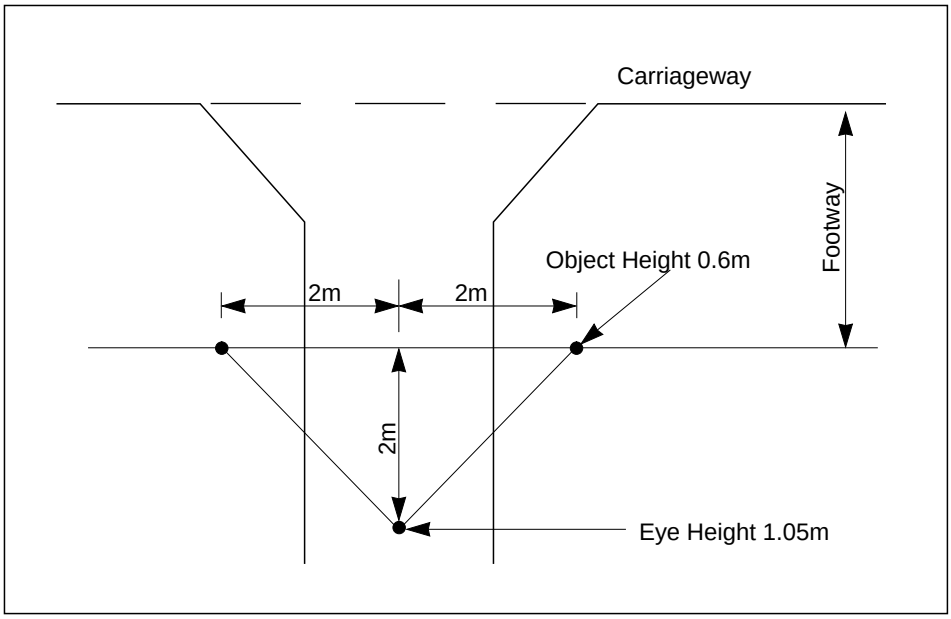


Figure 2/2 : Visibility at Back of Footway Crossing

	Field Access	Single Dwelling	Small Development eg up to 30 dwellings	Medium sized Development eg industrial estate	Larger sized Development eg housing development	Where Large Vehicle likely	"Gateway Entry"	Diverge Taper eg PFS entrance	Merge Taper eg PFS exit
Direct Access Layout	1	2	3	3,4,5	4,5	6,7	8	9	10
Traffic using the access AADT	Less than 10 movements a week	Less than 50 movements a week	0 - 300	3:0 - 300 4:0 - 500 5:300-500	300 - 500	6:0 - 300 7:0 - 500	0 - 300 para 2.30	Para 2.31	Para 2.34
Layout suitable for carriageway configuration:	Single Dual	Single Dual	Single	3 - Single 4 - Dual (Single as a relaxation) 5 - Single	4 - Dual (single as a relaxation) 5 - Single	6 - Single 7- Single	Single	Single Dual	Dual 2 and above

Notes:

1) These figures are recommendations and indicate the approximate level at which alternatives for connections should be considered. Design Organisations should look carefully at the safety implications involved in providing the alternative connection.

2) The upper limit for the operation of the T layout with ghost island is also a function of the major road traffic flow and this needs to be checked using PICADY or a similar predictive computer program.

Table 2/2 : Recommended Standard Access layouts

Typical gateway entry treatment (Layout 8)

2.30 There may be occasions when developers would choose a "gateway" style connection for direct access as used on the **"Priority (Red) Routes"**. An example is shown in **Layout 8**. The access is normally slightly ramped as a footway crossing, which may be regarded as a road hump, and the surfacing used generally contrasts to indicate a change in the nature of the area. Design Organisations should consult the relevant Overseeing Organisation for the current requirements of the respective highways or road legislation in relation to road humps. Special authorisation may be required where the road hump falls within the highway boundary of the trunk road and where only a single road hump is installed a the entry treatment. Speed reducing features may be required on the minor road side of the entry treatment under specific legislation. The ramps should not be greater than 1:10 to limit grounding occurring. The entry need not be ramped, but if it is not, then the surfacing must contrast with both the road surface of the trunk road and the minor road at its rear. These gateway entries are not appropriate where regular use by even small numbers of Large Goods Vehicles (LGVs) is likely. The disturbance caused to trunk road traffic by an LGV turning into an entrance is considerable. This can be accommodated to a certain extent by the use of tapers on both sides of the entrance. Tapers should be considered where the traffic using the gateway entry exceeds 50 vehicles in the peak hour. A **Traffic Advisory Unit Leaflet (2/94) is available on entry treatments.**

Diverge Tapers (Layout 9)

2.31 Nearside diverge tapers allow left turning trunk road traffic to slow down and leave the trunk road without impeding following through traffic. This is important where the major road traffic is heavy and fast. They shall be provided at direct accesses where the trunk road design speed is 85 kph or above and the volume of left turning traffic is greater than 450 vehicles AADT and there is a high proportion (greater than 20%) of large or slow moving vehicles either turning or continuing on the trunk road, or the gradient of the trunk road is greater than 4%. Nearside diverge tapers may also be applicable where there is high seasonal use by large or slow moving vehicles. They may be omitted if there are difficult site constraints.

2.32 Diverge tapers shall be formed by a direct taper to a width of 3.5m at the corner into the direct access (preferably of radius 20m). The width round this corner will depend on the radius selected. These figures are given in **TD 42 (DMRB 6.2.6)**. Left turning traffic shall be signed to give way to traffic turning right from the major road. The diverge taper length is given on **Layout 9**.

2.33 They shall not be provided where an existing direct access is on the inside of a sharp curve **(see Para 2.11)** as traffic in the diverging lane could adversely affect visibility for drivers emerging from the access or access road.

Merge Taper (Layout 10)

2.34 Merge tapers shall only be used at direct accesses to dual carriageways of two lanes and wider where the Design Speed is 85 kph or above, the volume of left turning traffic exceeds 450 vehicles AADT and there is a large proportion of large or slow moving vehicles, either turning, or on the trunk road (over 20%), or the gradient of the trunk road is greater that 4%. Merge tapers may also be applicable where there is a high seasonal use by large or slow moving vehicles.

2.35 Merge tapers allow left turning traffic from the direct access to accelerate before joining the trunk road traffic. A separate turning lane, preferably of radius 25m minimum, shall be used to introduce the merging lane from the direct access. The initial width of the lane, which will depend upon the radius of the turning lane, shall be decreased at a constant taper which depends on the Design Speed. The width of the turning lane is as set out in **TD 42 (DMRB 6.2.6)** for various radii. The merge taper length is given in **Layout 10**. The length incorporates one design speed step reduction from the standard for the **Geometric Design of Major/Minor Priority Junctions TD 42, (DMRB 6.2)** having regard to the normally lower level of use of direct accesses compared to junctions.

Entrance Gates Across Direct Access

2.36 Entrance gates across a direct access shall be set back to accommodate one vehicle in the access, clear of the main running lane and preferably clear of the footway. The vehicle to be accommodated should be of the largest type to use the access on a regular basis, (which in the case of farm vehicles may include a trailer). Wherever possible, gates should open away from the highway and where this is not possible, the set back should be increased to allow for this. As a Relaxation, where entrance gates are permanently open while the development is in use and during the working day, the requirement for the set back may be omitted.

Signing and Marking

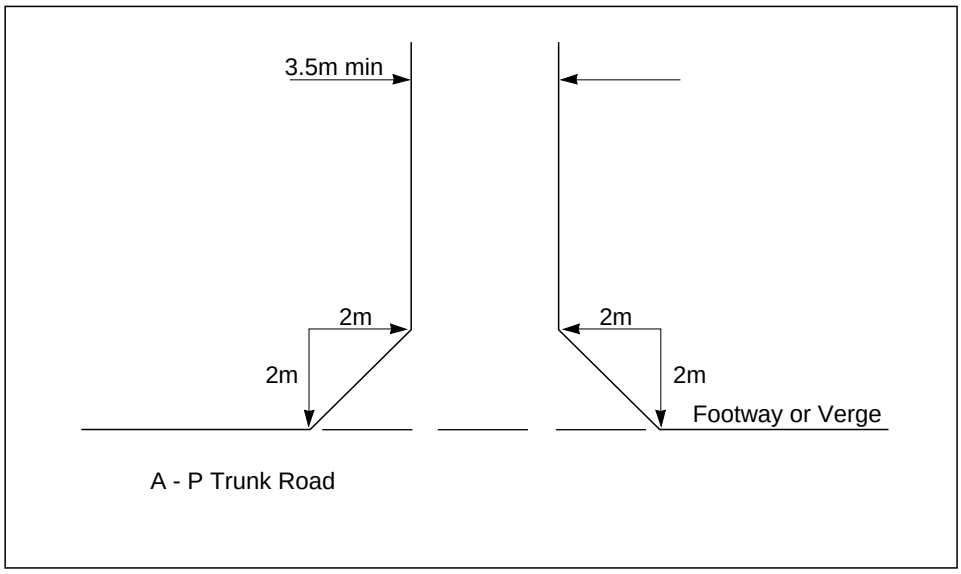
2.37 Statutory requirements for traffic signs and road markings are contained in the **Traffic Signs Regulations and General Directions**.

Farm Access

2.38 Further advice on the direct access to farms and the types of use to which they may be put is set out in chapter 9 of **TA 57 (DMRB 6.3)** on "Roadside Features".

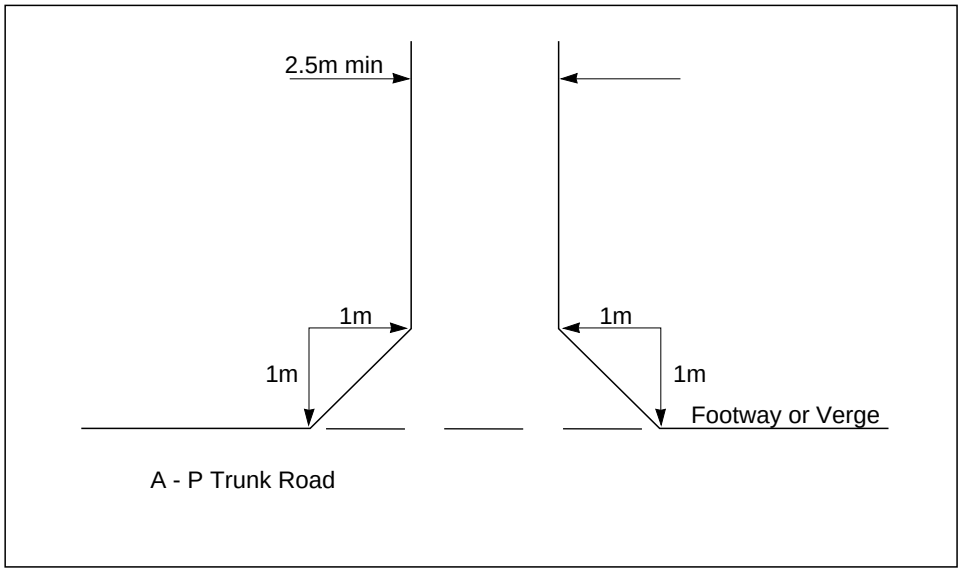
ACCESS LAYOUTS

Layout 1 - Field Access
(Use by Large Vehicles)

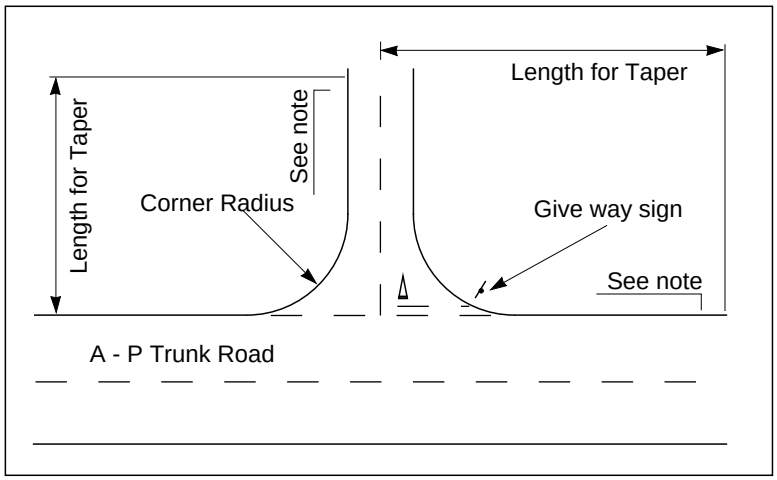


Where field accesses are frequently used by wheeled vehicles, consideration should be given to constructing a hardened approach strip to assist in the removal of mud from tyres and equipment prior to entering the trunk road.

Layout 2 - Access to Single Dwelling



Layout 3 - Simple Layout



without 1m hardstrip

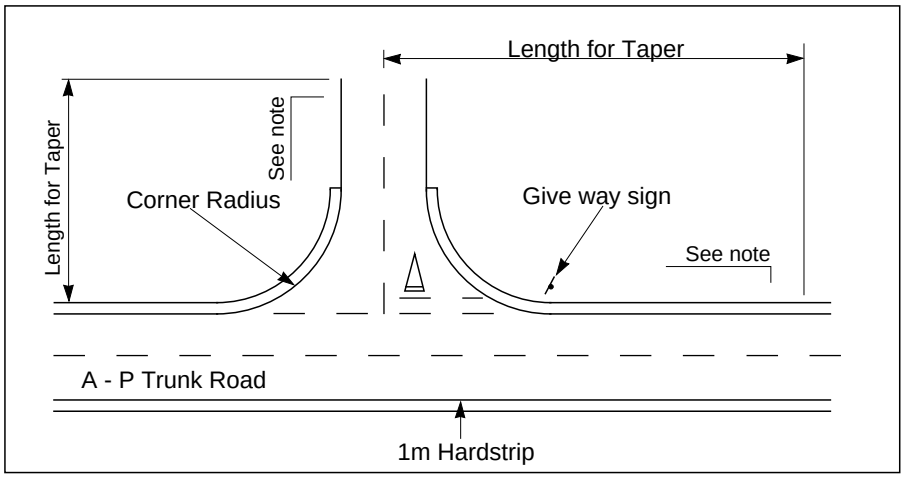
Corner Radius	with		No Large Goods Vehicles
Minimum Radius		-	urban roads 6m
		-	rural roads 10m

Provision for occasional Large Goods Vehicles (LGVs) (but see layout 6)
Minimum radius

Urban roads 10m (with taper over 30m of 1:5 exiting left turn in and out)

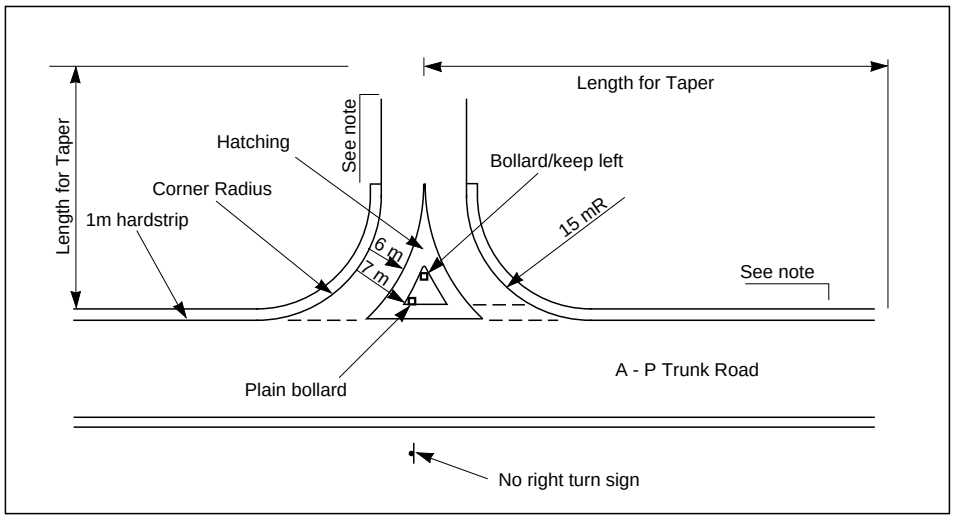
Rural roads 15m (with taper over 25m of 1:10 exiting left turn in and out)

Where the trunk road has a 1m strip and LGVs comprise a significant proportion of the turning movements then the compound curve shown in TD42 (DMRB 6.2.6) shall be used



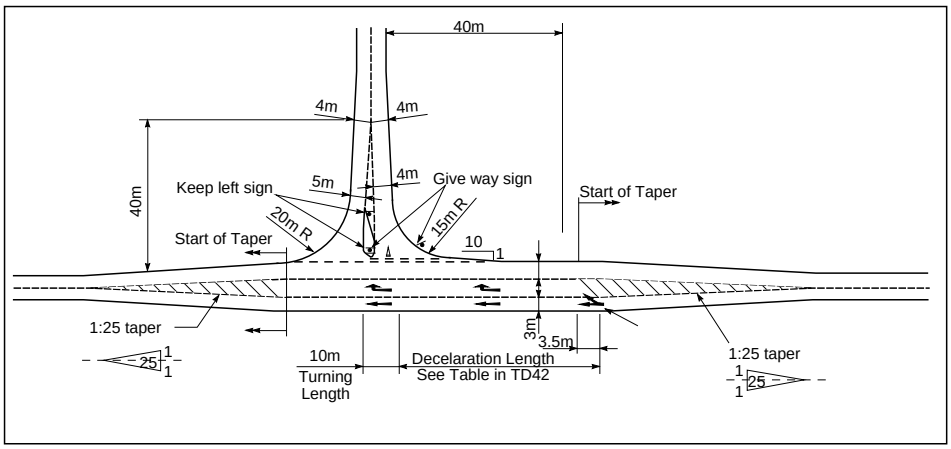
with 1m harstrip

Layout 4 - Direct Access with Left In / Left Out



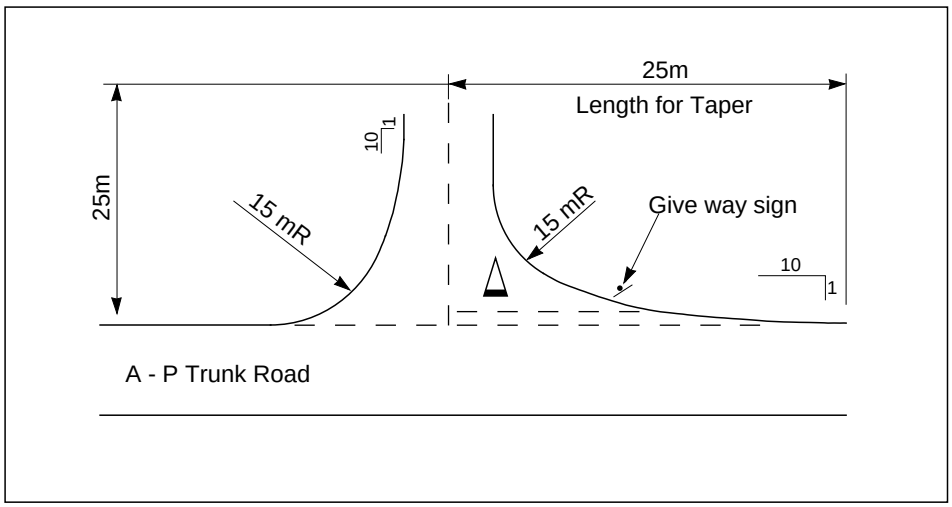
Corner Radius and Tapers
See note on Layout 3

Layout 5 - Ghost Island Turning Lane
Widening on both sides of Trunk Road



Dimensions as in **TD 42 (DMRB 6.2.6)**

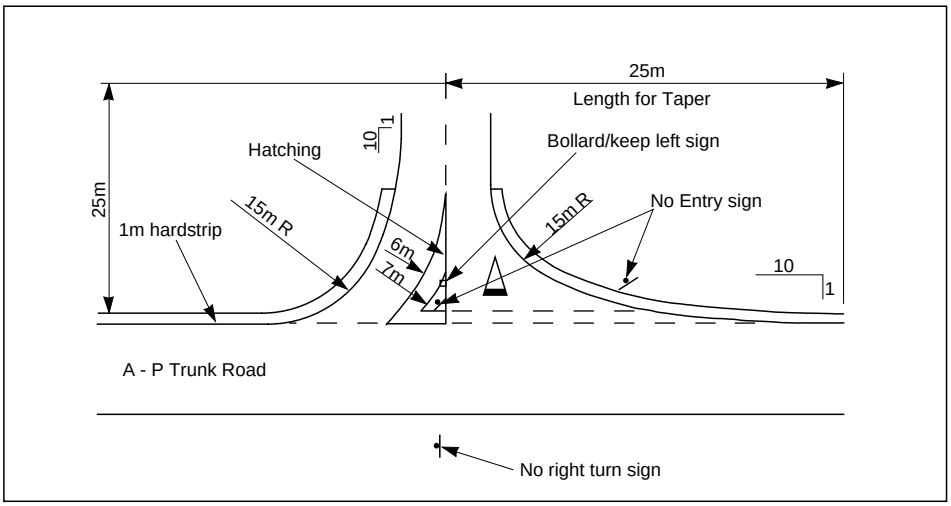
Layout 6 - Rural Access where long vehicles are predicted



Corner Radius

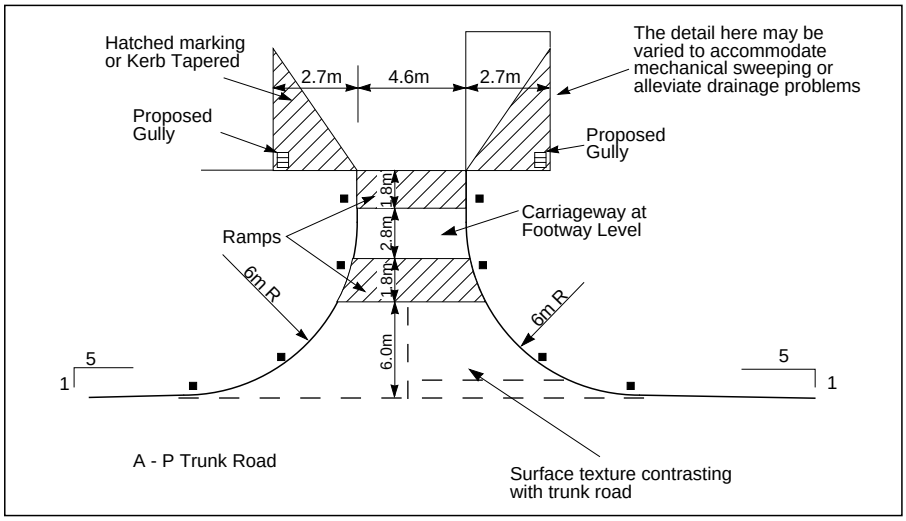
Alternatively, the compound curve for the corner, shown in TD 42 (DMRB 6.2.6) may be used.

Layout 7 - Rural Access where long vehicles are predicted
No Right Turn from Trunk Road

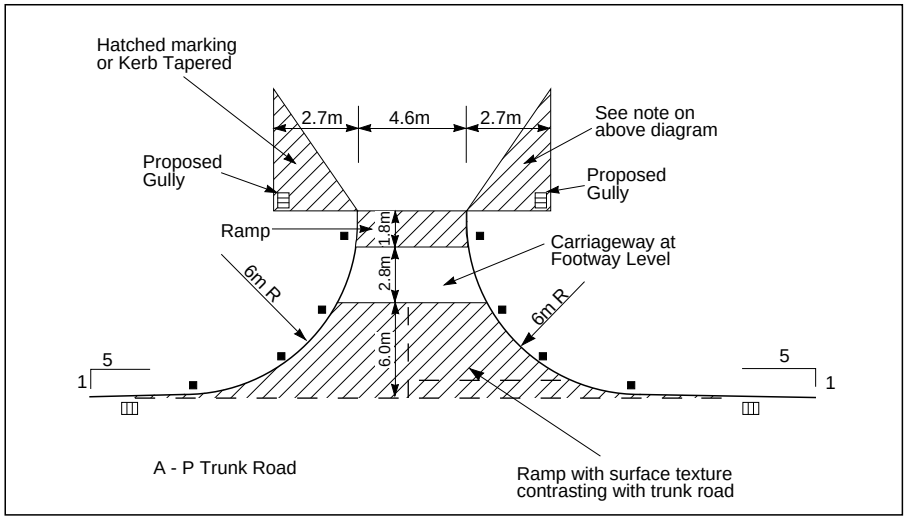


Corner Radius - See note to Layout 6

Layout 8 - Typical "Gateway" Entry Treatment

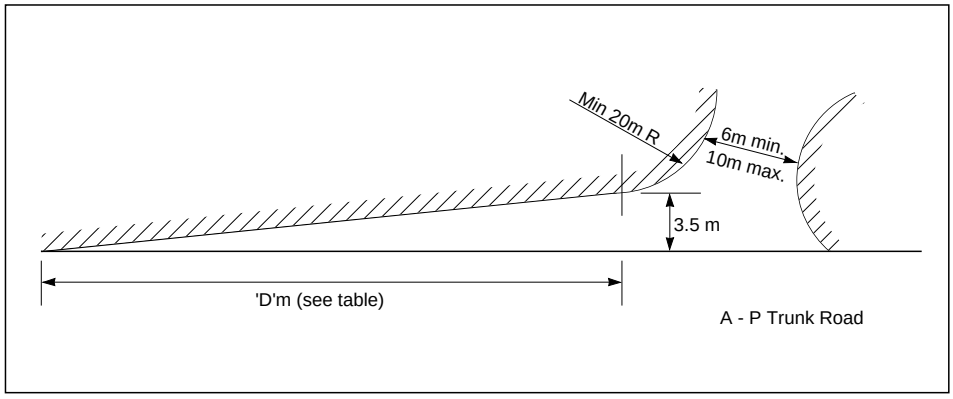


Alternative Layout :



Note: On both of these layouts, where the use exceeds 50 vehicles per hour in the peak, or there is occasional use by LGVs tapers may be considered to be added on both sides of the access on the trunk road. The tapers should be 1:5 and should start and finish 15m from the centre line of the direct access. Where site conditions are difficult, entry radii may be reduced to 4m as a Relaxation.

Layout 9 - Nearside Diverge Taper



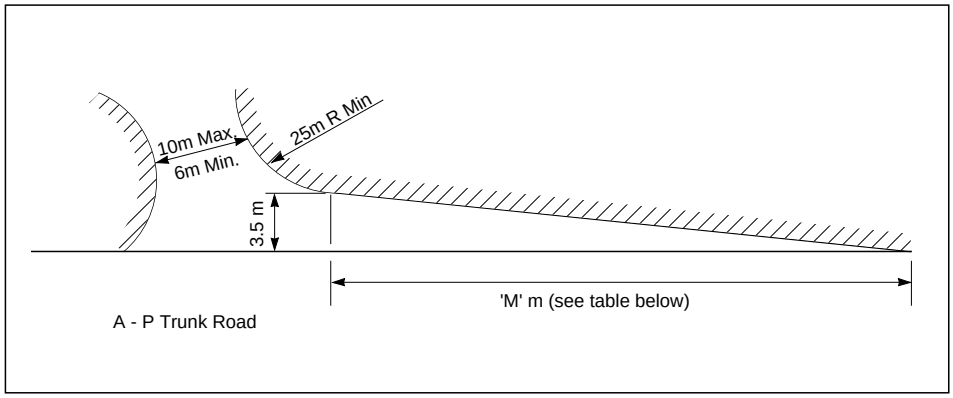
Design Speed (kph)	On Up Gradient		On Down Gradient	
	0 - 4 %	Over 4 %	0 - 4%	Over 4%
120	110	80	110	150 (110)
100	80	55	80	110 (80)
85	55	40	55	80 (55)
70	40	25	40	55 (40)
60	25	25	25	40 (25)
50	25	25	25	25

Figures in brackets may be used where the all purpose trunk road is a single carriageway

Diverge Taper Length ‘D’ Metres

The length may be reduced as a Relaxation by one design speed step where there are difficult site constraints.

Layout 10 - Merge Taper



Design Speed (kph)	Merge Taper Length M (m)
120	110
100	90
85	70
[70]	50

Merge Tapers shall only be used on dual carriageways of 2 lanes or wider where the design speed is 85 kph or above.

The lengths given above represent one design speed step reduction from the figures given for merge tapers at major - minor proximity junctions in **TD 42 (DMRB 6.2.6)** (See para. 2.35).

The length may be reduced as a Relaxation by one furthur design speed step where there are difficult site constraints.

3. ROAD USERS SPECIFIC REQUIREMENTS

3.1 In designing a direct access, it is important to take account of specific requirements of road users.

Pedestrian Facilities

3.2 The type of facility selected will depend upon the volumes and movements expected of both pedestrians and traffic and should be designed in accordance with current recommendations and requirements.

3.3 Separate pedestrian routes crossing the direct access away from the bell mouth are preferable. Only rarely may they be practical. If the crossing has to be in the bellmouth then an unmarked crossing place provided with dropped kerbs and a central refuge should be considered. Central refuges are covered by **TD42 (DMRB 6.2.6)**. The use of tactile surfaces should be considered in the normal way.

3.4 In urban areas, where large numbers of pedestrians are present, guard rails may be used to prevent indiscriminate crossing of the carriageway. Where guard railing is provided, drivers visibility requirements shall still be met. Types of guard rails are available which are designed to maintain drivers' visibility of pedestrians through them and vice-versa.

Cyclist Facilities

3.5 Connections for vehicular access of all types are a particular hazard for pedal cyclists. Sometimes it may be necessary to consider the following facilities:

a) full grade separation, eg. by a combined pedestrian/cyclist subway system
b) a signposted alternative cycle route;
c) an alternative form of junction, such as traffic signals.

3.6 The provision of dedicated cyclist facilities is covered in **TA 57(DMRB 6.3)** and further recommendations are given in **Local Transport Notes**.

Equestrians

3.7 In some cases it may be necessary to consider the provision of dedicated crossing places where the number of crossings by ridden horses is relatively high. In such circumstances, **TA 57 (DMRB 6.3)** shall be consulted which gives advice on the design of at-grade equestrian crossings.

4. OTHER CONSIDERATIONS

Environment

4.1 The effects on the local environment shall be considered for any proposed direct access to a trunk road. Where an access is expected to have a significant effect the advice on environmental assessment contained in **DMRB Vol 11** shall be followed.

4.2 It is essential that visibility splays remain unobstructed by vegetation. Trees and shrubs shall not be planted within 3 m back from the edge of the visibility splay. This is to allow for future growth to take place which will not impede the required standards of visibility.

4.3 Exceptionally and providing visibility standards are not infringed, plants maintained as ground cover could be planted within the visibility splays but normally the splays should be grassed or paved. Any grass will require at least one cut per annum. The maintenance regime shall be discussed with the Overseeing Organisation.

4.4 In siting new or improved accesses Design Organisations shall wherever possible maintain the existing landscape character of the road, particularly where roadside trees, hedgerows, walls or other features of the built environment are important to this. In some cases trees may be protected by Tree Preservation Orders and walls or gateways etc may be Listed but it is not only protected features that are important. The character of the road can be altered by small changes which are not carried out sympathetically. Particular care needs to be taken where a direct access falls within a designated Conservation Area. When working close to existing trees, It is important to ensure that root systems are not damaged to the detriment of the health and safety of trees. Advice on working in the vicinity of trees is contained in **BS5837 "Trees in relation to Construction"**. Care shall also be taken to avoid adverse effects on features of ecological and archaeological value.

4.5 Landscape design can play an important part in assisting drivers to travel safely through an access. **The Good Roads Guide, DMRB Volume 10** gives more information.

Parking

4.6 It will be important to ensure that developments serviced by a new direct access do not lead to parking on the trunk road in the vicinity of the access to the detriment of the safe passage of vehicles on both the access and the trunk road.

5. REFERENCES

1. **DESIGN MANUAL FOR ROADS AND BRIDGES HMSO.**

a **TD 9 (DMRB 6.1.1)**
Highway Link Design

b **TD22 (DMRB 6.2.1)**
Layout of Grade Separated Junctions

c **TA48 (DMRB 6.2.2)**
Layout of Grade Separated Junctions

d **TD16 (DMRB 6.2.3)**
Geometric Design of Roundabouts

e **TD40 (DMRB 6.2.5)**
Layout of Compact Grade Separated Junctions

f **TD42 (DMRB 6.2.6)**
Geometric Design of Major/Minor Priority Junctions

g **TA18 (DMRB 6.2)**
Junction Layout for Control by Traffic Signals

h **TA57 (DMRB 6.3)**
Roadside Features

i **TD20 (DMRB 5.1)**
Traffic Flows and Carriageway Width Assessment.

2. **BRITISH STANDARDS**

a **BS 6100** Subsection 2.4.1 1990 - The British Standard Glossary of Building and Civil Engineering Terms - Part 2 Civil Engineering Terms - Section 2.4 Highway and Railway Engineering: British Standards Institution 1990 (UDC 001.4: (624+697))

3. **TRANSPORT RESEARCH LABORATORY (TRL) RESEARCH REPORTS**

a **LR 762** (Berkshire Study) Methodology of an In-Depth Accident Investigation Survey 1977.

b. **LF779** A Study of Speed/Flow Relations on Rural Motorways and All-Purpose Dual Carriageways 1979.

c. **LF780** Speed/Flow Formulae for Rural Motorway and All-Purpose Dual Carriageways 1979.

d. **LF923** A Study of Speed/Flow/Geometry Relations on Rural Single Carriageways 1980.

e. **LF925** Changes on Speeds on Rural Roads 1980.

4. **TRL JUNCTION ASSESSMENT PROGRAMS**

a. **ARCADY/3** Application Guide 17: 1990 (Assessment of Roundabout Capacity and Delay Version 3).

b. **OSCADY/3** Application Guide 22: 1993. (Optimised Signal Capacity and Delay)

c. **PICADY/3** Application Guide 18: 1990 (Priority Intersection Capacity and Delay Version 3).

5. **OTHER RESEARCH REPORTS**

a. **Interstate System Accident Research Study** - 1: USA Federal Highway Administration Washington DC: 1970.

b. **Effects of Road and Traffic Characteristics on Accidents on Main Rural Roads in Ireland**: An Foras Forbatha: Dublin, Ireland: 1976.

c. **Relationship of Private Entrances to Highway Efficiency**: Ontario Ministry of Transportation 1988.

6. **OTHER GOVERNMENT PUBLICATIONS**

a. **SI 1994 No. 1519** - The Traffic Signs Regulations and General Directions 1994 - HMSO: 1994 (England, Scotland, Wales)

SR 1979 No. 386 - Traffic Signs Regulations (Northern Ireland) 1979 (as amended).

b. **The Casualty Report**: Road Accidents in Great Britain 1992 HMSO.

c. **Road Accidents in Great Britain 1980**: HMSO.

d. **Tactile Surfaces Disability Unit Circular 1/92**.

e. **Cyclists at Road Crossings and Junctions - Local Transport Note 1/86** Traffic Advisory Unit 1986.

f. **Shared use by Cyclists and Pedestrians LTN 2/88** Traffic Advisory Unit 1988.

g. **Making way for Cyclists LTN** 1/89 Traffic Advisory Unit 1989.

h. **Providing for the Cyclist** - Cycling Advice Note 1/89, Scottish Office 1989.

i. **Making way for Cyclists** - Cycling Advice Note 1/90: Scottish Office 1990.

j. **Entry Treatments** - Traffic Advisory Leaflet 2/94. Traffic Advisory Unit 1994.

k. **Transport - Planning Policy Guidance Note 13 (PPG13)** - Department of the Environment/Department of Transport: March 1994 (England) HMSO 1994.

l. **Highways Considerations in Development Control Planning Policy Guidance Note 13 (PPG13)** - Department of the Environment/Welsh Office: November 1988 (Wales). HMSO 1988.

m. **The General Policy of the Department of Transport and the Welsh Office on the Control of Development on trunk roads - Guidance Note**. Issued under cover of Circular Roads 4/88; Welsh Office Circular 42/88. (1988).

6. ENQUIRIES

All technical enquiries or comments on this document should be sent in writing as appropriate to:

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THE EFFECTS OF PROVIDING VEHICULAR ACCESS

A1.1 As indicated in **para 1.8**, traffic joining the trunk road from an access has three effects. It increases the traffic load on the trunk road, it slows other traffic down and it can give rise to accidents. It is these three effects which should be considered when further accesses or increased use of existing accesses are being contemplated.

Increased Traffic

A1.2 Adding traffic from a new development or an increased use can have a disproportionate effect on the existing users of the trunk road. If the trunk road operates at or near its capacity for periods during the day, then a marginal increase during these periods could well give rise to significant extra delay.

A1.3 There may be occasions where the peak use of the new development does not coincide with the trunk road peak, or the trunk road is operating below capacity. The effect again can become significant in the future and could reduce the design life of the road, that is, shortening the time until delay does become significant.

A1.4 The way in which connections for vehicular access are made to trunk roads, particularly dual carriageways, can give rise to widely differing effects. If a new development is linked to a new roundabout, then all traffic is subjected to the geometric delay imposed by the presence of the roundabout even when the facility is closed. If a similar new development is connected part way along a dual carriageway between roundabouts, then extra distance is covered by traffic travelling onto the next roundabout either to return to the development or leaving the development to turn back in the desired direction to resume its journey elsewhere. In this case, other traffic will be inhibited by the presence of traffic covering the extra distance associated with the use of the new development.

A1.5 Overseeing Organisations do have options under planning legislation and using relevant roads or highways legislation to seek contributions to enable them to maintain conditions for other trunk road users where they are likely to be significantly impaired by increased traffic arising from the new development, in addition to contributions for the costs of the direct connection of the new development. Normally a design year horizon of 15 years is considered, within which both the existing trunk road traffic and that arising from the development has to be accommodated adequately. These matters are covered more fully for England in the March 1994 version of **PPG13**.

Slowing Other Traffic

A1.6 Frequent junctions or direct accesses reduce the speed of trunk road traffic and thus user benefits. Research was carried out by the **Transport Research Laboratory** on the effects of geometry on the speed and flow of traffic on rural single carriageways. The research showed that the addition of one T-junction or one direct commercial access in a kilometre will reduce the average speed of major road traffic by 0.7 kph on a single two lane carriageway and by 0.5 kph on a wide (10m) single carriageway. A staggered junction in place of the T-junction would double these figures.

A1.7 Thus frequent junctions and direct commercial accesses reduce the trunk road link user benefits and could have an adverse effect on the overall cost effectiveness of a road. This can be extrapolated to any direct access which has similar usage to the average direct commercial access.

A1.8. The trunk road can also be significantly affected where a new development connects to a local road close to its own junction with the trunk road. This is also a situation which may lead to operational difficulties.

The Accident Risk

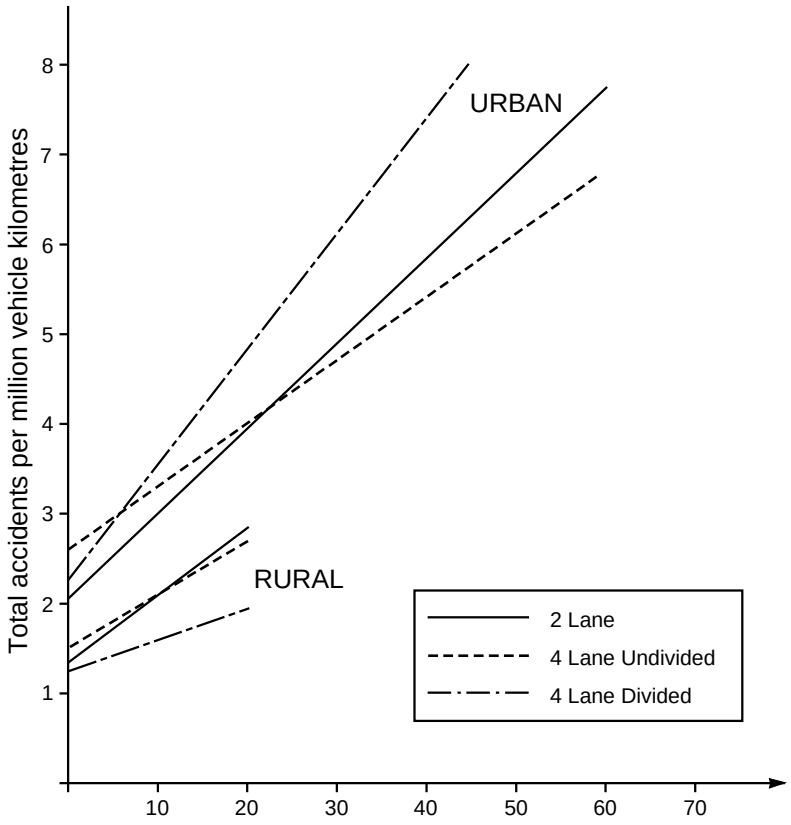
A1.9. Connections for vehicular access cover a wide range as mentioned in **para 1.4**, varying from the verge crossing from a field gate to a substantial roundabout for a superstore. The prediction of accident risk at the larger junctions - roundabout, traffic signals, or priority junction - can be made with the use of various computer programs such as those available from **TRL - ARCADY** (roundabouts), **OSCADY** (traffic signals) and **PICADY** (priority junctions).

A1.10. Research has shown for a considerable time that minor junctions and direct accesses along a road give rise to an increased accident risk. **TA 4/80 (DMRB 6.2)**, which this Standard supersedes, reported the result of the **US Federal Highway Administration** study in 1970 and reproduced **Figure A1/1** from it. **TA 4/80**

went on to quote work by **TRL** in Berkshire (1977) which again showed that accidents at minor connections were significant and accounted for about 12% of the total accidents. Also mentioned was a study in **Ireland** which surveyed 2850 km of rural national routes and found that direct accesses were the next important factor after the volume of traffic itself. The study found that an increase of 5 major or 10 minor accesses along a 3.5 km section (1.4 major or 2.9 minor accesses per kilometre) increased the accidents rate by 15% at the mean fatal and injury accident level.

A1.11. Since the publication of **TA 4/80** research has continued. It showed that the nature and extent of roadside development and the degree of access allowed to the highway were clearly related to accidents. Having no direct access to a highway can cut the accident rate by two thirds. A partial reduction in the number of accesses represented a measurable improvement.

A1.12. Work for the **Ontario Ministry of Transportation (1988)** suggests that the accident risk along a highway can increase by around four times as the number of direct accesses is increased from 3 to 8 per kilometre **(Figure A1/2)**. After that, the nature of the road itself has probably changed, with significantly more frontage activity, and it has become more of a local route than a through route.



SOURCE - INTERSTATE SYSTEM ACCIDENT RESEARCH STUDY - 1

Figure A1/1 Total Accident Rate on Non-Interstate Highways for Selected Types of Highway by Number of Businesses per Km

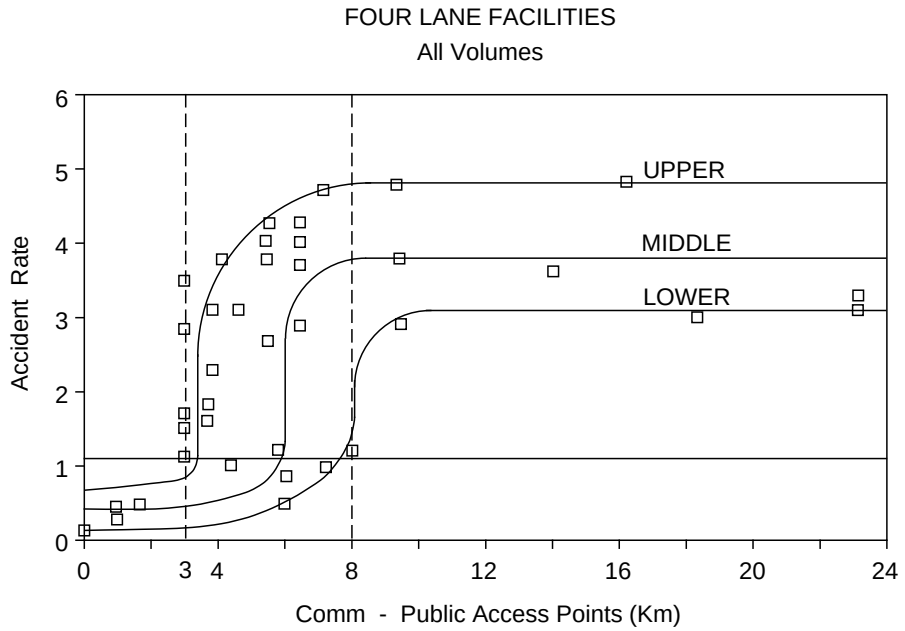


Figure A1/2 Relationships found between accidents and access by the Ontario Ministry of Transport (1988)

Trends in Accidents and their Distribution

A1.13. There was a reduction in personal injury accidents in Great Britain between 1980, when **TA 4/80 (DMRB 6.2)** was published and 1992 the latest year for which figures are available. As indicated in **para 1.8**, accidents associated with junctions and accesses have not fallen as fast as others. The figures are summarised in **Table A1/1**. Although accidents at junctions and direct accesses have only fallen by 2% there has been a significant reduction in severity with fatal and serious accidents falling by 36% in urban areas and by 11% and 31% respectively in rural areas. Slight accidents on the other hand increased by 4% in urban areas and soared by 49% in rural areas to just under 18,000

A1.14 Considering just those accidents reported as occurring at private drives or entrances, the least used of accesses, as set out in **Table A1/2**, these have risen by 15% between 1980 and 1992. On rural roads, fatal accidents have increased by 28%, but serious accidents, considerably more, have fallen by 32%. Slight accidents have increased by 42% to 2319. Overall, on rural roads, personal injury accidents increased by 16%.

	Junctions and Direct Access			Not at or within 20m of a Junction		
	1980	1992	% Change	1980	1992	% Change
Built-up (urban) roads:						
Fatal	1641	1048	-36%	1338	810	-39%
Serious	27913	17876	-36%	17080	10314	-40%
Slight	97862	101418	+4%	46280	41062	-11%
All	127416	120342	-6%	64698	52186	-20%
Non built-up (rural) roads:						
Fatal	589	522	-11%	1937	1479	-24%
Serious	6372	4379	-31%	14341	8886	-38%
Slight	12005	17847	+49%	23301	27293	+17%
All	18966	22784	+20%	39579	37658	-5%
Total	146382	143090	-2%	104277	89844	-14%
			All (1) Accidents	250940	233045	-7%
			All (1) Casualties	328600	310673	-5%

Note (1) These figures include some accidents which were not recorded as built up nor non built up.

Table A1/1 Personal Injury Accidents by Junction or Link - built up (urban) and non-built up (rural roads), 1980 and 1992.

	Built Up (Urban) Roads			Non Built Up (Rural) Roads		
	1980	1992	% Change	1980	1992	% Change
Fatal	50	46	-8%	47	60	+28%
Serious	1465	988	-33%	898	612	-32%
Slight	4979	6369	+28%	1631	2319	+42%
All	6494	7403	+14%	2576	2991	+16%
			Total	9070	10394	+15%

(Source: Road Accidents in Great Britain 1980 and 1992)

Table A1/2 Personal Injury Accidents at Private Drives or Entrances 1980 and 1992

A1.15 The research carried out as part of the review for **TA 4/80 (DMRB 6.2)** was based on a sample of all-purpose trunk roads in England. The overall accident figures for the period surveyed, 1989-91 are shown as annual average figures in **Table A1/3**. On all-purpose trunk roads in England, 57% of accidents occur at junctions and accesses and of these a quarter are at the more important junctions with other "A" and "B" roads. The remainder, 9000 accidents per year, occur at junctions with classified unnumbered and unclassified roads and at direct accesses.

A1.16 The 9000 accidents are shown broken down in **Table A1/4**. Overall, 10% of accidents on the all-purpose trunk roads are at a private drives and entrances. On the faster rural trunk roads the proportion rises to 13% and for fatalities, to 15%. Major direct vehicular accesses to developments built as various forms of road junctions are not separately identified in the statistics. It may be assumed as indicated in **paragraph A1.9** that they would exhibit the same characteristics as the other junctions of their type. Controlled junctions also do not form a separate classification but accounted for 14% of junction accidents in the 1992 overall figures for Great Britain.

A1.17 In dealing with the smaller direct accesses covered in detail by this Standard, it has to be recognised that conflicting traffic movements in and out of them are quite low and accidents are therefore sparsely distributed among numbers of these lightly trafficked accesses. Nonetheless they do constitute a very real risk.

The Results of Research

A1.18. The research undertaken as part of the review for this revised Standard examined accesses and accidents on 3000 kms of all-purpose trunk roads in England, both urban and rural, dual carriageway and single. The research is described in **Annex A2**. It showed that there is no simple relationship statistically between the number of accidents and the number of vehicular connections in the form of minor junctions and direct accesses. There is wide variation in the number of accidents for a given number of connections per kilometre. Over the whole range of connections per kilometre, the number of accidents shows a slight upward trend for both urban and rural roads, being more noticeable for rural roads. Detailed analysis using the statistical computer suite **GENSTAT** revealed that the major factors affecting the number of accidents on a link were the flow, the length of the link and the number of minor junctions and direct accesses.

	Total Accidents	Not at or within 20m of Junction	At all Junctions or Direct Accesses	At Junctions with A or B Roads	At Minor Junctions (with classified unnumbered or unclassified roads) or Direct Accesses
Built Up (Urban) Roads					
Fatal	155	69	86	13	73
Serious	1499	472	1027	232	795
Slight	6945	1745	5200	1279	3921
All	8599	2286	6313	1524	4789
Non Built Up (Rural) Roads					
Fatal	515	351	164	31	133
Serious	2677	1573	1104	240	864
Slight	8318	4428	3890	879	3011
All	11510	6352	5158	1150	4008
Total	20109	Links 8638 (43%)	Junctions 11471 (57%)	2674 (23%)	8797 (77%)

Table A1/3 All-Purpose Trunk Roads in England
Average Annual Personal Injury Accidents 1989-91

Junction Type	Built Up (Urban) Roads				Built Up (Rural) Road				
	Fatal	Serious	Slight	All	Fatal	Serious	Slight	All	Total
Roundabout	2	78	637	717	4	97	671	772	1489 17%
T or Staggered	42	426	1864	2332	58	338	989	1385	3717 41%
Y Junction	2	14	69	85	2	15	47	64	149 2%
Slip roads	2	16	95	113	21	102	353	476	589 7%
Cross Roads	17	174	804	995	22	137	394	553	1584 18%
Multiple Junctions	2	15	101	118	1	13	40	54	172 2%
Private Drive or Entrance	4	56	267	327	20	127	393	540	867 10%
Other	2	16	84	102	5	35	124	164	266 3%
All	73	795	3921	4789 54%	133	864	3011	4008 46%	8797 100%

Table A1/4 All-Purpose Trunk Roads in England

Average Annual Personal Injury Accidents 1989-91 occurring at minor junctions (with classified unnumbered and unclassified Roads) and Direct Accesses

A1.19 This analysis ignores the fact that at some level of connection per kilometre the nature of the major road changes from a through route to that serving local traffic using the connection. There is evidence to show this occurs at around 7-8 minor junctions and direct accesses per kilometre, as the Canadian research found as well. In essence this means that over this level the major road, although subject to rural standards and speed limits, has become essentially periurban or suburban. This appears to apply both to single and dual carriageways, particularly where there are crossings of the central reserve. Even then, each new connection adds to the accident risk but it is less marked.

A1.20 **Figure A1/3** shows the best fit line found for the breakpoints described in the previous paragraph, relative to rural roads. No breakpoint was found for urban roads and the best fit lines are shown on **Figure A1/4**.

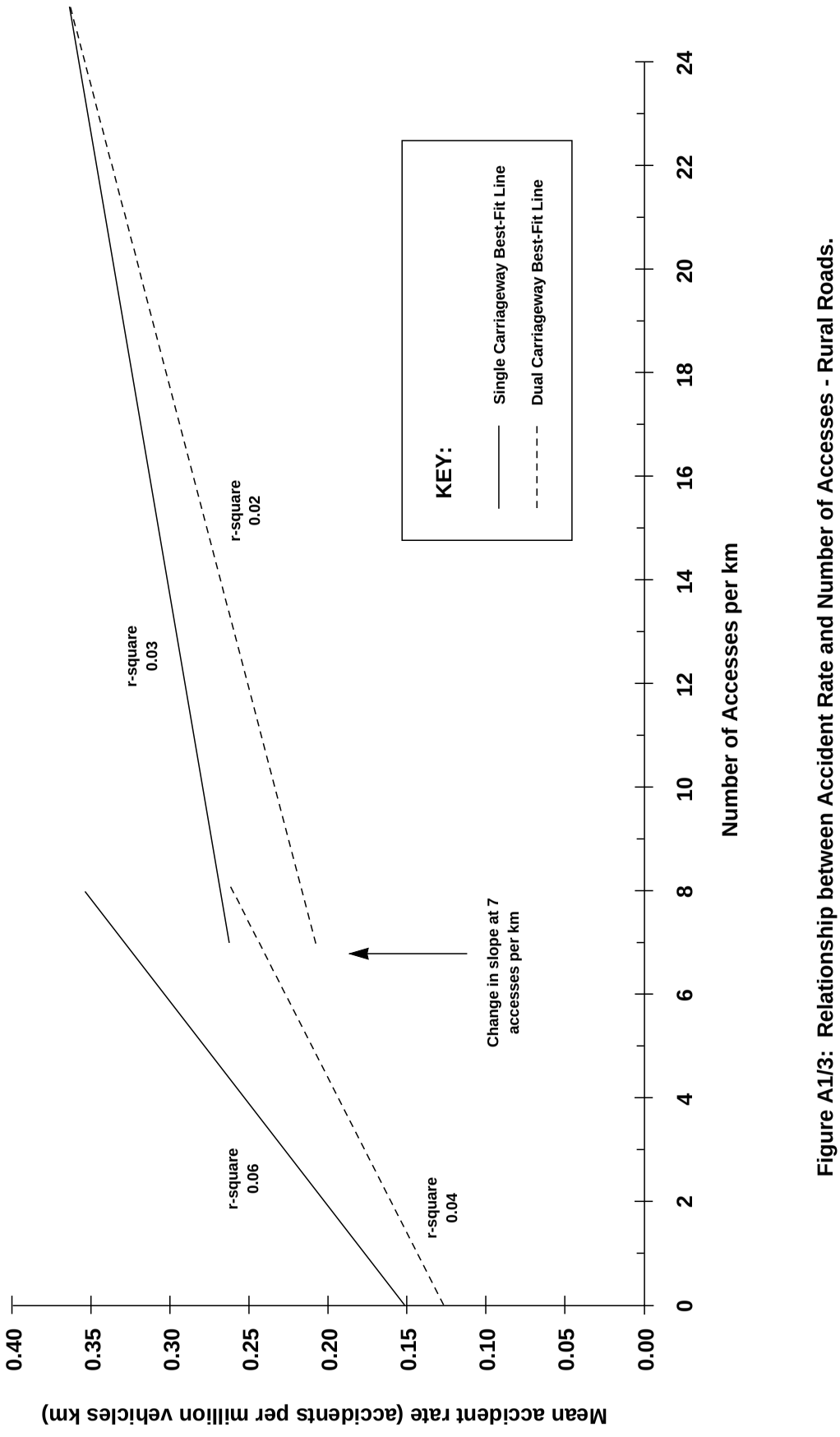


Figure A1/3: Relationship between Accident Rate and Number of Accesses - Rural Roads.

Figure A1/3 : Relationship between Accident Rate and Number of Accesses - Rural Roads

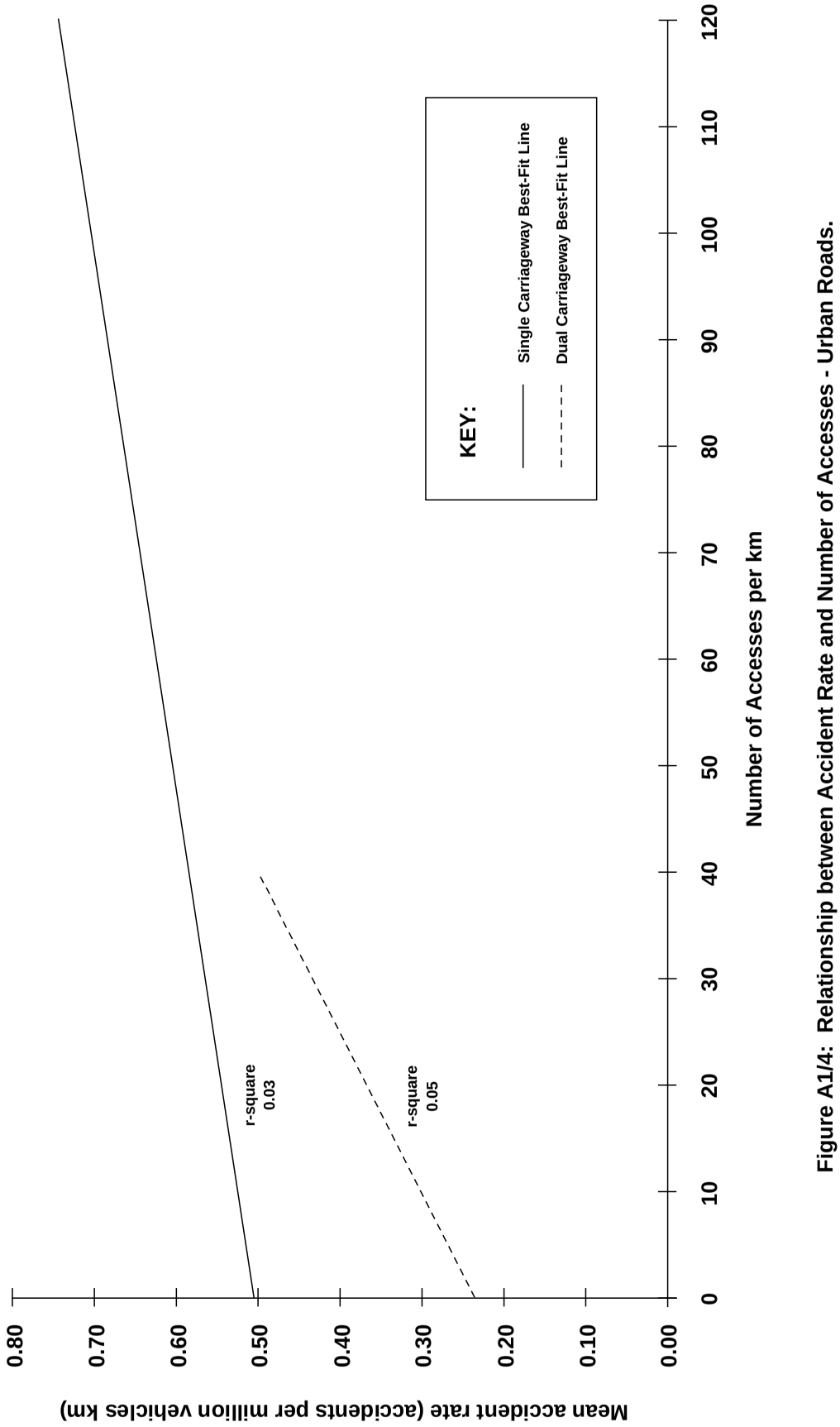


Figure A1/4: Relationship between Accident Rate and Number of Accesses - Urban Roads.

Figure A1/4 : Relationship between Accident Rate and Number of Accesses - Urban Roads

RESULTS OF NEW RESEARCH ON THE SAFETY IMPLICATIONS OF VEHICULAR ACCESS

Statistical Analysis

A2.1 New research was commissioned relating video analysis of a sample of the trunk road Network to accident statistics contained within the Network Information System (NIS).

A2.2 A total sample of 664 links, with a total length of approximately 3000 km of all purpose trunk road in England was studied using video collected between 1989 and 1990. The number and type of accesses were individually counted, noting the speed limit, number of lanes, road number, etc. of the trunk road. Accesses were classified into ten different categories, and assigned to a high medium or low usage dependent upon traffic flow. The accesses included all connections below that of "B" roads. 11,000 accidents occurred over the 3 years

A2.3 Initially, scatter diagrams were produced relating accident rate to the frequency of access provision for different types of road as follows : urban, rural single and rural dual. A simple multiple linear regression analysis was undertaken and the 'best fit' line is indicated on **Figures A2/1-3.** In each figure the coefficient of correlation (r^2) is given together with the kilometrage of road surveyed within that category. The coefficient of correlation is an indicator of the level of statistical reliance that can be placed upon the results. It is usual within accident analysis to achieve a r^2 value between 0.1 and 0.5.

A2.4 What these figures demonstrate is that a trend can be identified but that it is not a strong relationship. Further regression analysis was undertaken, this time with the dependent variable as accidents. This showed that there was a statistically significant relationship (at the 95% confidence level) between accidents and traffic flow, link length and the total number of all access connections (“accesses”) for rural single and rural dual carriageway all-purpose trunk roads. In the case of urban roads, only traffic flow had a significant effect on the number of accidents at this level of confidence.

A2.5 Further, more detailed examination of the relationship with the individual types of access showed statistically significant relationship for accidents on rural single carriageways with traffic flow, link length and farm accesses. On rural dual carriageways, the significant relationship extended to laybys, residential access and other types of access including petrol filling stations. On urban all-purpose trunk roads (which are only around 10% of the Total trunk roads) only traffic flow again had a similar effect. The r^2 figures for these studies were of the order of 0.33 to 0.55.

A2.6 The analysis demonstrates that even accesses with low usage can have a significant effect under certain circumstances.

A2.7 It is clear from these figures that the relationship between accident rate and access provision is not a simple one and that other factors affect the likelihood of an accident occurring. The graphs are a reflection of the success of access policy in providing safe access constructed to standard, in that in England accesses do not figure as strongly as a factor in accidents.

A2.8 It is often accepted by researchers that the number of accidents in a given period does not follow a normal distribution and, in particular, does not have a constant variance, and therefore the classical least squares regression is not entirely applicable. A further detailed regression analysis was undertaken using a generalised linear modelling technique with the **GENSTAT** computer program. This program allows accidents to be predicted from a Poisson distribution, and allows for transformation of the variables in order to reduce a more complicated model to a linear form.

A2.9 Regressions were carried out for the same road types as before and a mathematical model developed relating the number of accidents to flow, link length and access provision which were found to be the most important explanatory variables. The graphical representations of these models are shown in **Figures A2/4-6**. The model was of the general form

$$A=K\,Q^{a}L^{b}\exp\left(C_1 G_1 + C_2 G_2 + \right)$$

Where:
A is the accident frequency per year on a link
Q is a function of the traffic flow
L is a function of the link length
G are the explanatory variables and
K, a, b and C are the parameters to be estimated.

A2.10 As with the least squares regression analysis, the **GENSTAT** analysis demonstrates that in the rural situation there is evidence of an increasing trend between accident rates and access provision although the relationship is not simple. In the urban situation there is no direct relationship between access provision and accident occurrence.

A2.11 The **GENSTAT** analysis showed an amount of unexplained effect for accidents. Other factors may well be relevant such as the hilliness and bendiness of a route, or of the percentage of large vehicles possibly. Accidents invariably occur due to a multiplicity of factors and this analysis has demonstrated that accesses are an important factor alongside traffic flow and other variables.

A2.12 A further stage in the analysis is shown in **Figures A2/7 and A2/8**. Because the scatter diagrams are unclear as to the effective distribution of points since many observations overlaid others, the observations were grouped in bars and the means shown. In the case of rural roads, it becomes apparent on inspection that the perceived change in the nature or role of a road as the number of accesses increases, is reflected in the change in the trend in the mean accident rate at around 7-8 accesses per kilometre. Best fit lines are shown for the situation above and below the breakpoints. These represent a trend rather than a statistically significant relationship.

A2.13 The figure for urban roads, **Figure A2/8**, does not demonstrate a breakpoint. Again there is an increasing trend in the mean accident rate as the number of accesses increases. This trend is more marked for urban dual carriageway than for urban single carriageway all-purpose trunk roads. The relationship is not a strong one.

A2.14 It is difficult to generalise, even across a particular road type, as to whether the provision of a specific additional access will lead immediately to more accidents. Accidents are rare events and are also dependent on the level of usage both of the access and of the major road. What this analysis suggests is that the approach should always be to consider all the relevant factors relative to geometry, visibility and traffic flow as set out in **Chapters 2 and 3**. The trend is however that the mean accident risk (per million vehicle/kilometre) does increase with each added access.

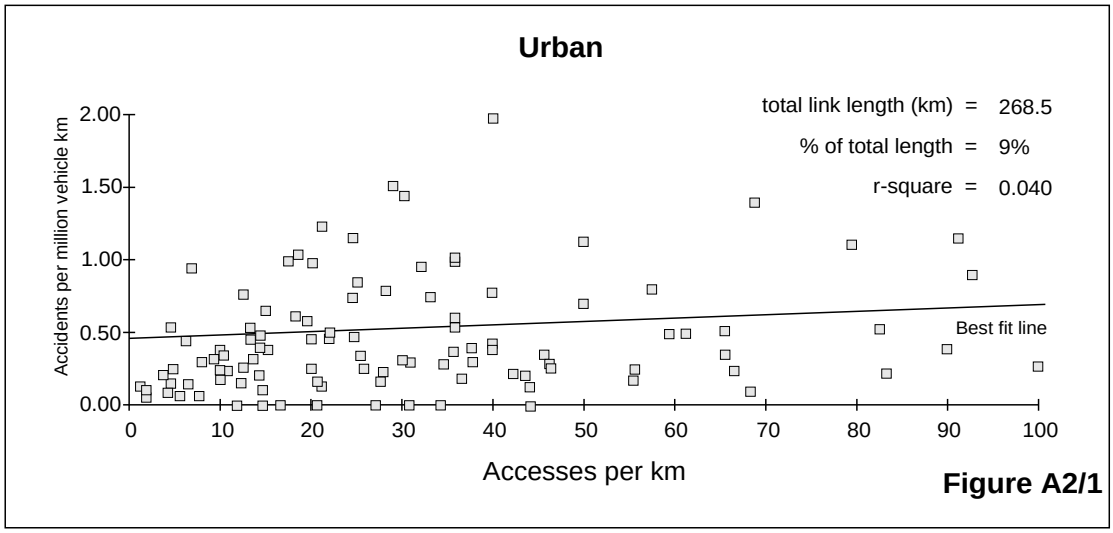


Figure A2/1

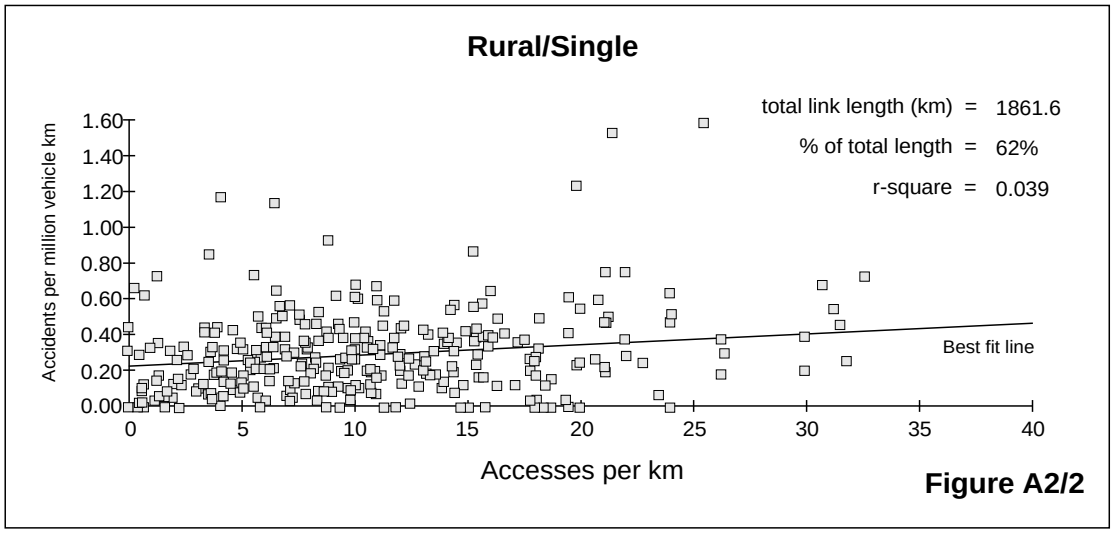


Figure A2/2

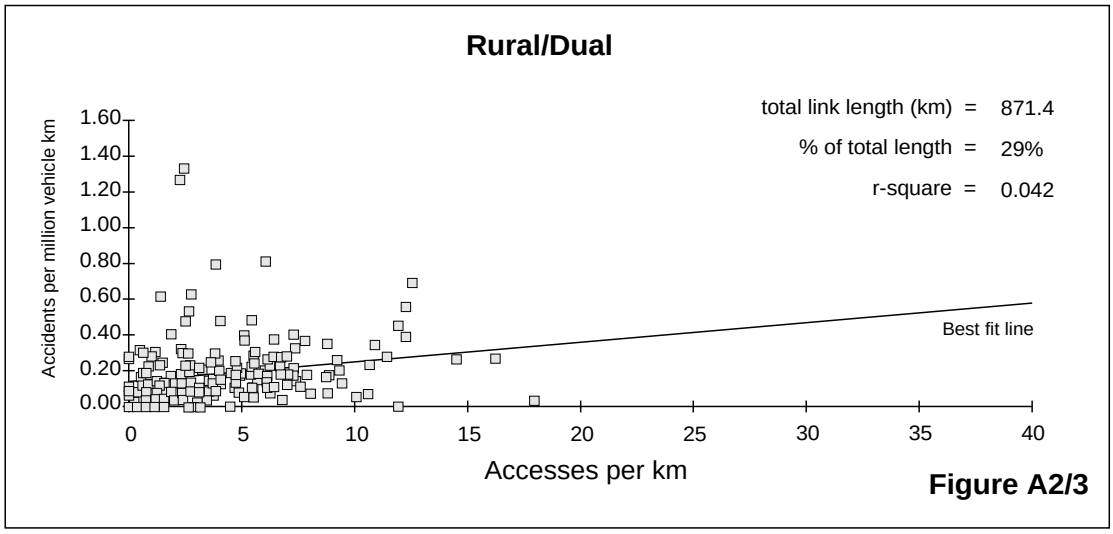


Figure A2/3

Scatter Plots of Accident Rate vs Accesses per km.

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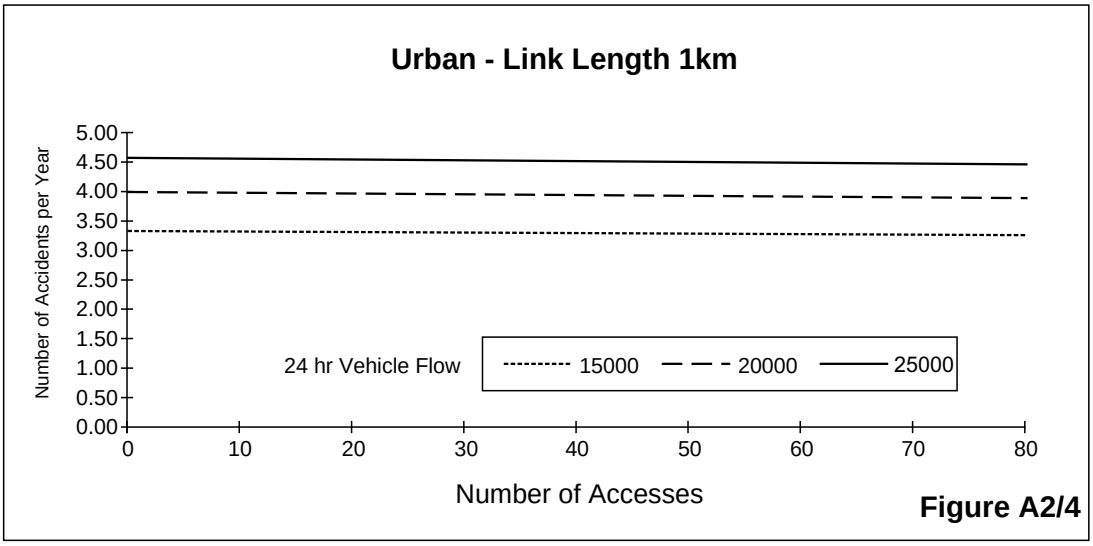


Figure A2/4

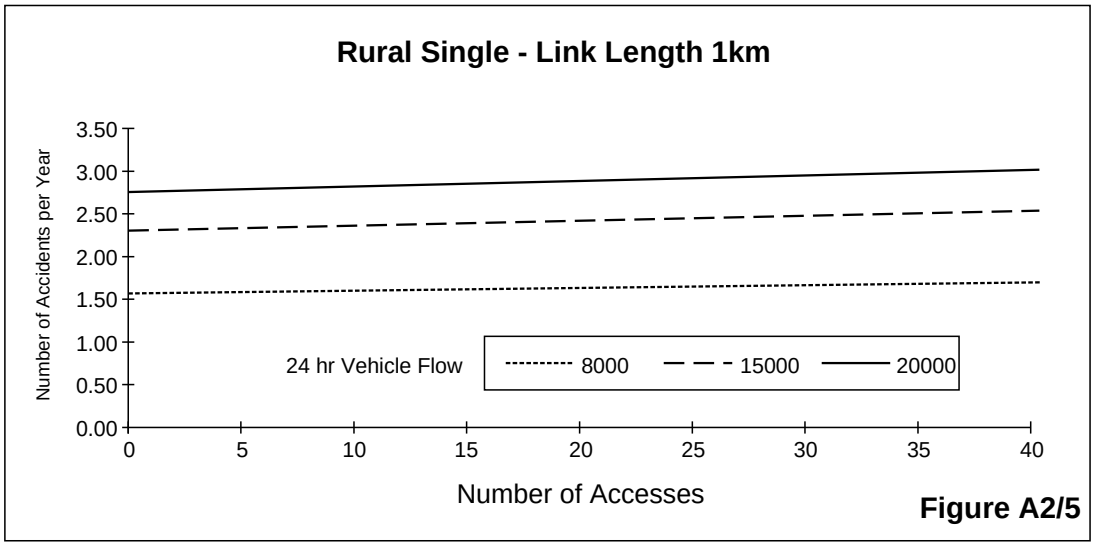


Figure A2/5

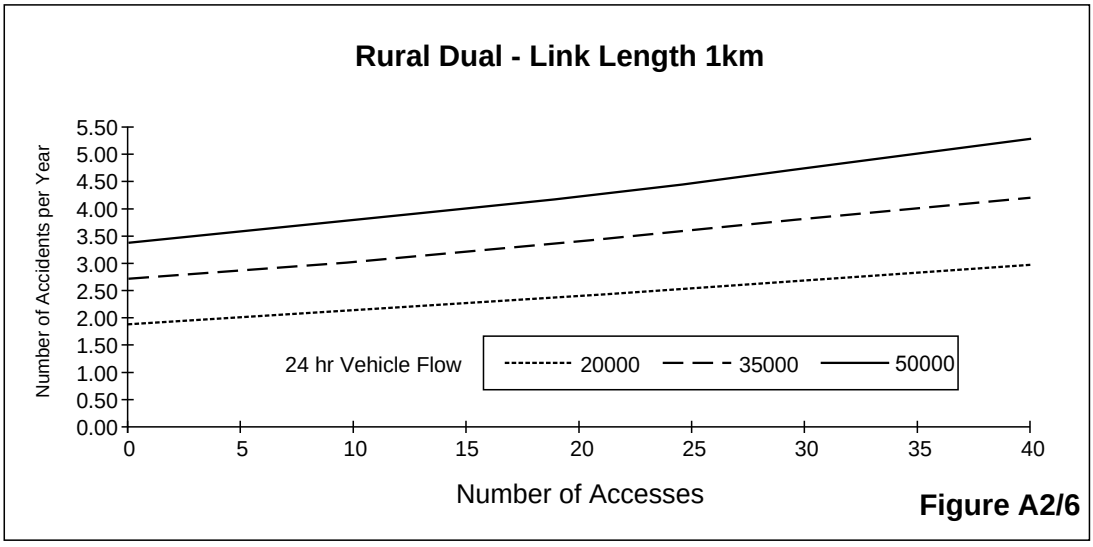


Figure A2/6

Results of GENSTAT Analysis

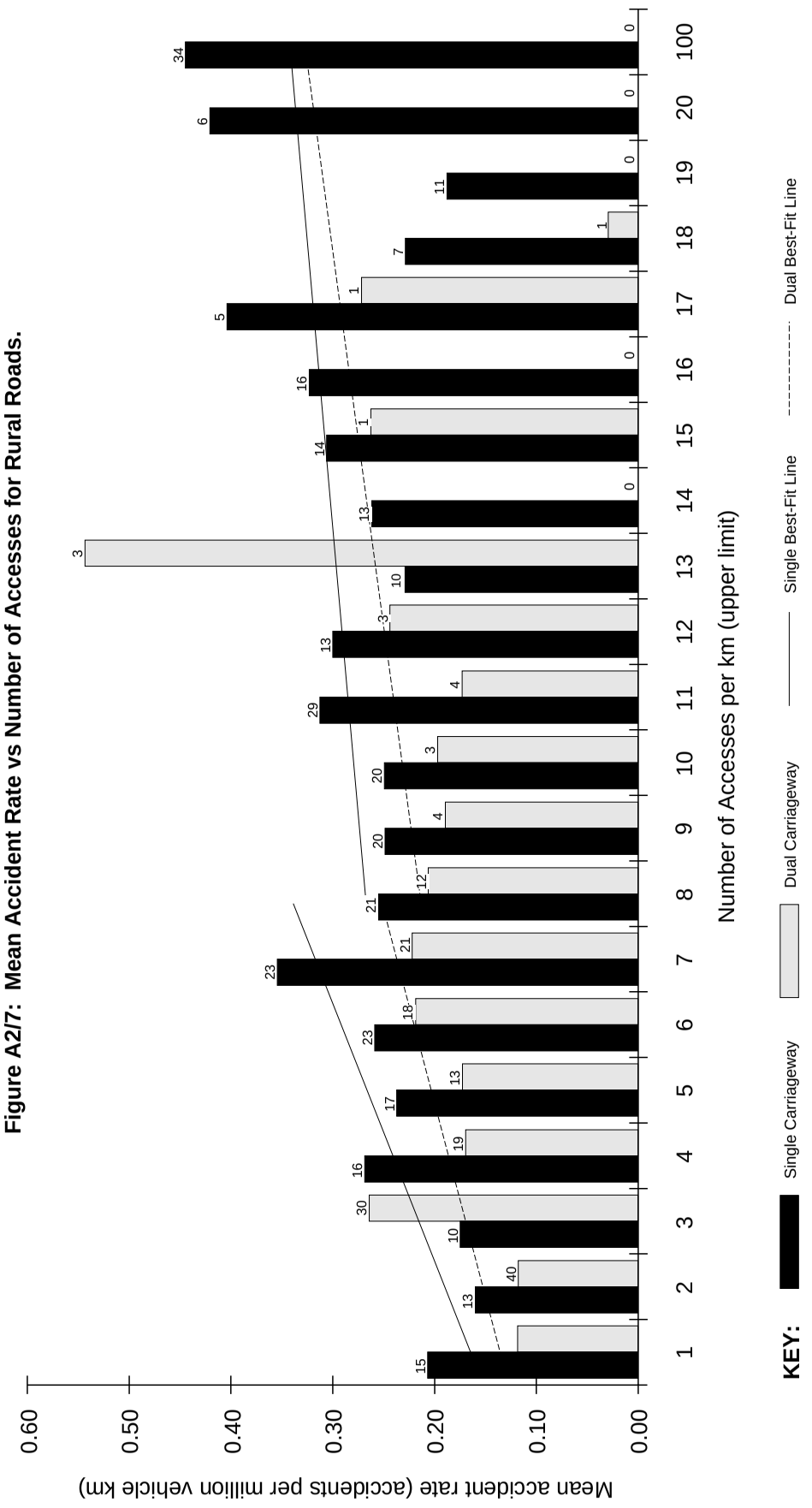
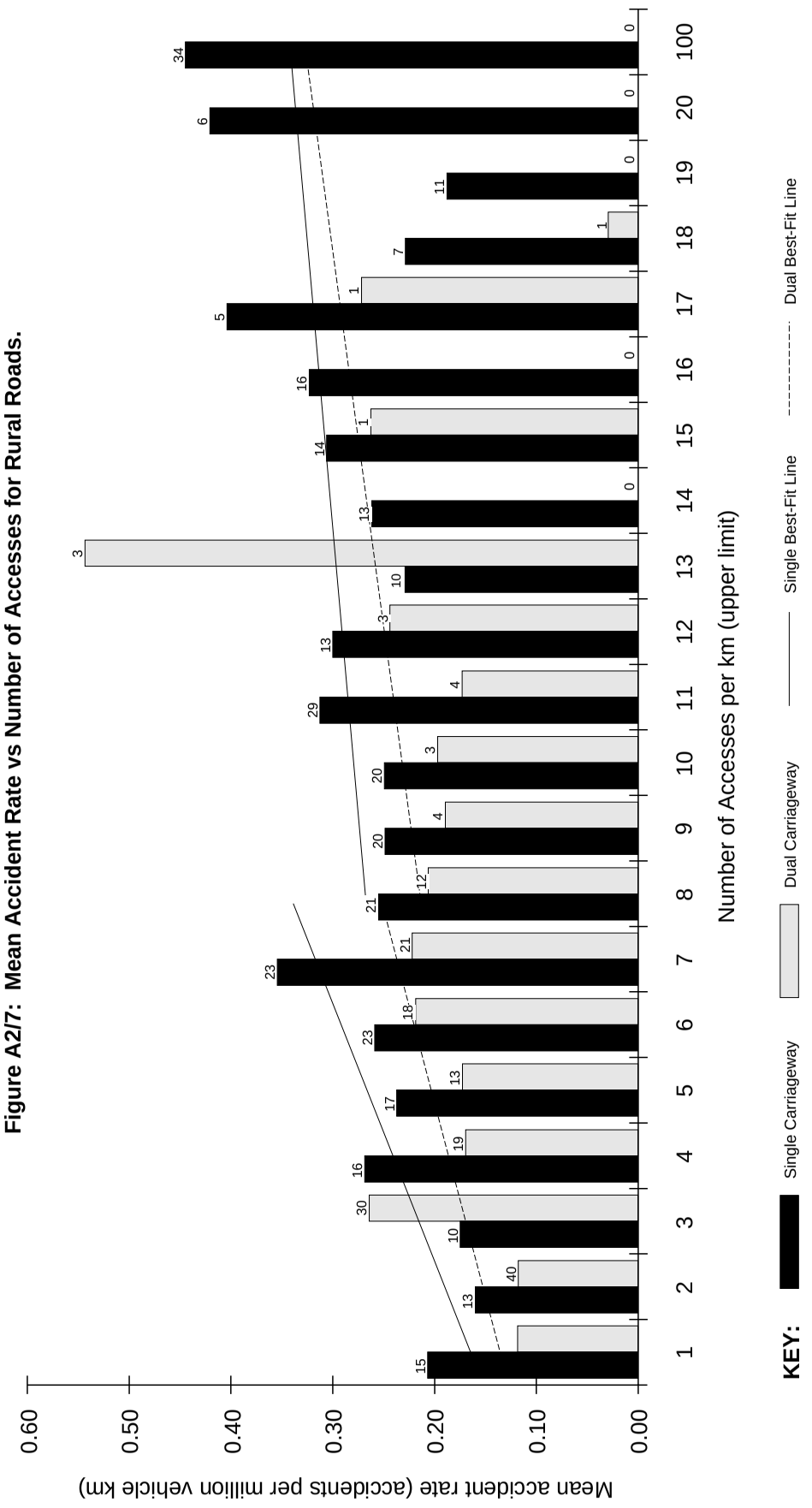


Figure A2/7: Mean Accident Rate vs Number of Accesses for Rural Roads.



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