Guidance on the use of the Road Restraint Risk Assessment Process (RRRAP) associated with TD 19/06

Introduction

This manual is intended to provide guidance and help to enable the Designer to navigate through the RRRAP in an efficient and effective way, so that appropriate decisions regarding provision of Vehicle Restraint Systems are made and documented. The guidance will also give the Designer a basic understanding of the mechanics of the RRRAP and how altering parameters such as location of hazard and VRS, length of VRS, etc affect the risk and benefit cost levels.

This manual is to be read in conjunction with TD 19/06 which contains some mandatory requirements and, in Chapter 2, general information and guidance on Risk and its Mitigation and particular information and guidance on the RRRAP in Paragraphs 2.17 et seq.

A précis of what the RRRAP covers and does not cover

The RRRAP covers
The RRRAP covers and enables an assessment to be made, based on risk, as to whether a vehicle restraint system (VRS) is warranted to prevent the occupants of an errant vehicle from hitting near side or offside hazards in the following situations.

1. **Motorways, All Purpose Roads and Other Classified Roads having a speed limit of 50 mph or greater and AADT of 5,000 or greater** in the following situations.
   - Motorways
     - Motorway (D2M, D3M, D4M) – near side (N/S) verge
     - Motorway Slips and Link Roads – near side and offside (N/S and O/S) verges
   - All Purpose Roads (D2AP, D3AP, Single) - near side (N/S) verge
   - Other Classified Roads (D2, D3, Single) - near side (N/S) verge
   - For single carriageways the RRRAP calculates need for and the length of VRS beyond the hazard as well as that in advance.

   Guidance is given in TD 19 Appendix 2 on how designers might deal with roads that are low flow (i.e. < 5,000 AADT) and or low speed (i.e. < 50 mph).

2. **Temporary VRS** requirements are covered in a different way to permanent hazards. The RRRAP contains a table in which designers are required to complete a series of standard questions relating to the temporary circumstances. This allows the design thought process to be formally documented and recorded in a consistent manner. The RRRAP calculation process is based on permanent situations and, although the RRRAP can be used as a guide to the temporary requirements in some circumstances, due to the wide variety of situations, scenarios and durations of deployment the RRRAP, it will only be a guide.

3. **Gantries and Railway parapets**. The RRRAP will give an indication only of the requirements for VRS provision at gantries and at Railway parapets, but reference must be made to Paragraph 3.36 and Chapter 5 of TD 19 respectively to confirm the containment level requirements.

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The RRRAP does not allow or may not be appropriate for a direct assessment for the following circumstances.
Designers should use the 'User Comments' worksheet of the RRRAP to describe the process they have gone through in determining the provision of VRS and their conclusions.

1. **Central reserves** – the requirements for these are mandated by TD 19 paras 3.59 et seq. Note that for wide central reserves (i.e. those over 10 m in width) of both motorways and other roads, there may be a need to assess the protection of hazards such as lighting columns, street signs, trees, etc that are present. This can be done by selecting the offside verge option. Note that this option assumes that crossover incidents are not possible due to the width and does not make any assessment of crossover incidents within the calculation.

2. **Roundabouts and junction areas.** Generally, the RRRAP is not suitable for use at a roundabout or a junction. At a roundabout it could potentially be used by running the RRRAP as a Motorway Slip or Link road and using the N/S for hazards on the outer ring of the roundabout and O/S for the inner ring. This is not ideal and may at best only be a rough guide to VRS requirements. A safety barrier may not be appropriate at a roundabout, and may cause more of a hazard than was there without it, due to the angle at which vehicles may impact the barrier. Other solutions such as passively safe furniture may be appropriate. Engineering judgement will need to be used in these circumstances. The RRRAP will indicate the VRS requirements on the approach to the junction and therefore will assist the designer in coming to an appropriate solution.

3. **Laybys.** Provision for hazards that lie to the rear of a layby area. It is recommended that data is input as though the layby is not there, i.e. with verge at standard width, hazards at the back of the layby at their actual offset from Psb. The RRRAP will indicate whether VRS is required to protect the hazards based on the level of risk to motorists on the carriageway, not on the level of risk to users of the layby per se.

   The RRRAP will calculate and show the set-back of the VRS based on its standard 1.2 m (or 0.6 m if there is a hardshoulder or hardstrip). Having calculated the risk in the Collation of Data worksheet, if the RRRAP shows that VRS is required to protect a hazard at the rear of the lay-by, the designer will then need to change the set-back of the VRS to its actual location relative to the back of the layby and press 'calculate risk' again, so that the programme calculates correctly.

   The designer will need to form an opinion as to whether the provision that the RRRAP shown as necessary to give an adequate level of risk for motorists on the carriageway is adequate for users of the layby as well and, if he considers it necessary, include additional VRS and or pedestrian restraint to the rear of the layby. Background to the decision process made in respect of the provision should be made in the User Comments worksheet.

The RRRAP does not cover provision of the following

- Pedestrian Restraint Systems
- Vehicle Arrester Beds
- Anti-Glare screens

The requirements for provision of these Restraint Systems are given in Chapters 9, 10 and 11 of TD 19.

The RRRAP does not calculate the difference in risk between Impact Severity Levels (ISL) B and C.

Revision history of the Guidance Document

Revision Number	Revision Date	Key changes
Trial	1 Sept 06	Initial issue for trialling by external designers
Issue 1 rev 0	2 April 07	General update
Issue 1 rev 1	4 May 07	Abbreviations and Definitions added Fig 1-1 updated to remove ref to HA database. Para 1.9 general comment re Error messages added. Para 5.2.5 and 5.2.6 relating to culverts and large bodies of water added. Para 5.3.3 and figs 5.3.3 (a), (b), and (c) relating to earthworks having multiple gradients added. Para 5.9.1 added guidance on min length of VRS to prevent direct impact with end of parapet, subsequent Paras renumbered. Additional guidance on Point of no Recovery added including new figs Figs 5.14 (c) and 15(c) , old figs renumbered accordingly. Para 5.17.2 added note re verges.
Issue 1 rev 2	30 Mar 11	Precis of what the RRRAP covers and does not cover added Error messages – further information added Further information and guidance on the following 5.7.1 Comms cabinets and equipment to allow for maintenance workers; 5.8 Crib walls and smooth faced walls 5.9.4 how parapet risk calculated; 5.9.5 specifying parapet working width, 5.9.6 pedestrian restraints; 5.9.7 ref to IAN 91, Structural Collision Loading and Collapse 5.11.1 Utility poles with stays; 5.11.2 Pylons and need to consider implication of pylon or cables falling 5.14.4 and 5.15.3 If H1 or H4a required on embankment 5.15.4 Slip roads in the vicinity of nosings;

Feedback

We would welcome feedback on the following items. The feedback should be sent to HARRRAP@mouchelparkman.com .

- The content and usefulness of the Guidance and where it could be improved, e.g. where additional examples may be of benefit.
- Problems encountered in understanding the RRRAP and or the Guidance.
- Instances where the RRRAP has returned unexpected answers, e.g. unusually long length of provision, or no provision where some VRS would have been expected.
- Situations where the RRRAP has been unable to provide a solution
- Areas where you consider that training would be of benefit.

List of contents

Abbreviations and Definitions

Reference should be made to the list of Terminology and Definitions contained in Paras 1.41 et seq of TD 19. A list of additional abbreviations and definitions used in the RRRAP is given below.

EMAC	Enhanced Managing Agent Contractor
MA	Managing Agent
MAC	Managing Agent Contractor
TMC	Term Maintenance Contractor
N/A	Not applicable – either because that the term does not apply in the situation or, in the case of such as Gantries, that the outcome of the RRRAP must be checked against the requirements in TD 19 as there are factors that the RRRAP cannot take account of in determining appropriate level of VRS.
PFI	Private Finance Initiative
PPP	Public Private Partnership

Point of No Recovery –

The Point of No Recovery is the point at which the driver has no chance of getting the vehicle back on the carriageway and, unless he hits an intervening hazard, is going to end up on (in) the adjacent road, railway, water hazard. This point may be the top of the road embankment slope or for example the top of the cutting to the railway or bank of a water hazard if the road is at grade. An assessment of the likelihood of reaching the adjacent hazard by virtue of the intervening topography (hence the need for site visit) is entered in the appropriate column in the RRRAP worksheet. Refer to figs 5.14(b) and (c), 5.15(b) and (c) and Paragraphs 5.3.3 and 5.14.1.

1. Overview of the RRRAP

1.1 Software used and Version number of the RRRAP

1.1.1 The RRRAP is currently based on an MS Excel spreadsheet (MS Excel 2000 and later versions) and uses 'drop downs' to facilitate data entry, and macros to assist in calculating and recording risk and cost benefit information for each of the options investigated. An important function of the RRRAP is that of providing an audit trail for the Designer and Overseeing Organisation. The RRRAP requires the Designer to input information that is ancillary to the process of hazard identification and risk mitigation that provides background details for the audit trail.

1.1.2 The Highways Agency may from time to time promulgate a revised version of the RRRAP, e.g. when there are improvements to its functionality, or changes in some of the parameters used within the RRRAP process. .

1.1.3 It is important that users of the RRRAP check that the version of the spreadsheet they are using is the most up to date version and that they download a new copy of the spreadsheet from the HA web-site each time that a new project or section within the project is started, rather than using or re-using an old version of the spreadsheet. The HA web site will indicate if for some reason a version of the spreadsheet should no longer be used in designs.

1.2 Opening the Spreadsheet, opening New Windows, Splitting Screens, Freezing Panes, Hiding Rows and Columns

1.2.1 The RRRAP requires macros to be enabled when the spreadsheet is opened. The programme cannot work unless they are enabled.

1.2.2 As the RRRAP uses macros that rely on the spreadsheet being in a certain configuration, it is recommended that users do not open a second window of the same spreadsheet to view different elements of the same or other worksheets simultaneously.

1.2.3 Splitting screens and freezing panes do not appear to affect the macros.

1.2.4 It is not possible to hide rows or columns, as the protection applied to the worksheets and cells prevents this.

1.3 Copying and pasting information from one part of worksheet / spreadsheet to another.

It is recommended that '*Paste Special / Paste Values*' is used rather than the standard '*Paste*' command. This will ensure that you do not get a notice stating that "*The value entered is invalid. A user has restricted the values that can be entered into this cell".*

1.4 Arrangement of Worksheets

1.4.1 The Excel spreadsheet is divided into a number of worksheets to record the information about the site and its hazards. The worksheets tabs are colour coded according to their function as follows.

Help / Information worksheets	These give details of the colour coding and formatting of the various worksheets, and help information and guidance.
Data / Information entry worksheets	These are split between Basic (Common) Details; Hazards based on MCHW categories; and 'Other' Hazards.
Calculation worksheets	These will normally be hidden
Temporary Hazards worksheet	Different to the rest of the RRRAP and is largely based around the Designer considering a number of questions about the temporary circumstances rather than a numerical calculation
Detailed Results worksheets	The data in the worksheet is automatically generated during the RRRAP.
Data / look up data worksheets	These contain such as default values, these will normally be hidden
Output worksheets	Also for recording decisions made and the background to the decisions. The output worksheets will also assist in preparation of Contract Data information.

1.4.2 Figure 1-1 below indicates how the worksheets within the RRRAP inter-relate and gives an overview of the process.

1.43 Note that the 'Point of Entry' worksheet gives basic information about the RRRAP version number and date of the RRRAP spreadsheet that is being used. It contains hyperlinks to the other worksheets within the spreadsheet to assist in navigation around the spreadsheet.

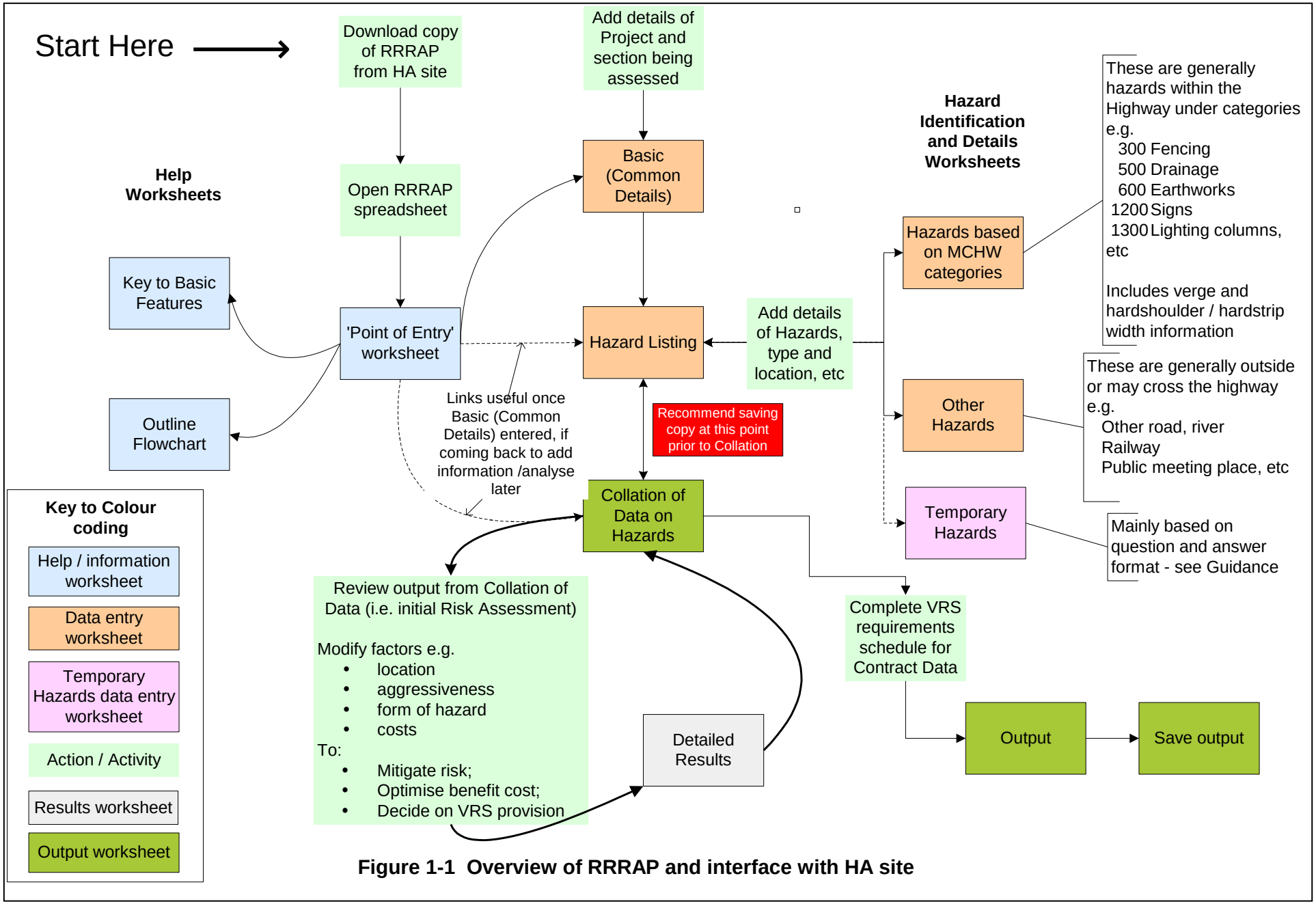


Figure 1-1 Overview of RRRAP and interface with HA site

1.5 How Permanent Hazards have been Categorized within the Various Worksheets

1.5.1 The listing of all the Hazards typically likely to be found within the Highway and the individual worksheets for entering details of these Hazards are arranged around the MCHW Series numbers. The spreadsheet has been set out in this way as it is considered that most design drawings will have been arranged around this numbering system, rather than being composite drawings that would show most or all of the hazard features. It is expected that it will speed up input of the data relating to each hazard.

1.5.2 Hazards that may affect 'Others' and which are typically outside the Highway boundary do not generally fall into the MCHW numbering regime. Details of these Hazards are entered on a separate series of worksheets entitled e.g. 'OH's – Roads'.

1.6 Temporary Hazards and Calculation of Risk and Benefit Cost for Temporary VRS

1.6.1 The RRRAP will calculate risk and benefit cost levels for permanent safety barrier provision. At present, due to the complexities of the risk and cost benefit analysis for temporary situations, temporary safety barrier provision has not been modelled within the RRRAP. Instead, the Designer is required to respond to a series of questions that prompt the designer to identify the various factors that he needs to consider, weigh up and take account of in deciding whether a temporary Road Restraint System is warranted.

1.7 Colour coding and other Basic Features within Worksheets

1.7.1 There is a common colouring system used in the various worksheets within the RRRAP. Details are shown on the following diagram Figure 1-2.

Basic Features of the RRRAP Spreadsheet and their significance

Basic Feature of Spreadsheet		Significance, and comment
Border around worksheet		Marks out the lateral and vertical limit of the Worksheet
Asterisk alongside text in some cells	*	Denotes that information must be provided in order that the RRRAP can run
Cell colouring	(Light green)	Requires data entry by the Designer
	(Light yellow)	Requires data entry by the Designer (gives drop down listing)
	(Black)	Cell blacked out to aid reading, not containing information or requiring data entry
	(Grey)	Auto fill based on a calculation and or copying information already entered elsewhere
	(White)	Cell usually contains a heading, a question, or a statement
	20.00 (Red)	Risk is in Unacceptable region
	25.00 (Amber)	Risk is in the Tolerable region
	35.00 (Green)	Risk is in the Broadly acceptable region
		Question cells where information is required, but in the current version, it is not contributing to the risk / benefit cost calculation, but will provide useful background information. Future (refined) versions may well use this type of information in the calculation process.
	N/A	Occurs in the Collation of Data on Hazards worksheet where the Designer **must** refer to the mandatory clauses in the written Standard TD 19 in order to confirm the containment level and or other requirements.
Cell protection		Note that many cells are write protected, these are generally cells containing formulae or other information that the Designer is not allowed to alter.
Help buttons	Drainage include?	These help menus can be retained on the screen and moved to a convenient place whilst data is input. They are closed by clicking on the x in the top right hand corner of the help menu.
"Action" buttons	To collate data on Hazards, press here	Note: 1. Action buttons that take the Designer to another part of the worksheet can be 'undone' by clicking on the return button. 2. Action buttons that perform a calculation or a macro cannot be undone. Care must therefore be taken to ensure that inputs are complete and checked prior to use of this type of button.

1.8 How the RRRAP works

General guidance on the RRRAP and how it works is given in Chapter 2 of TD 19/06. The guidance below is in addition to that and describes the basic mechanism of the RRRAP and some of the factors that influence the outcome.

1.8.1 Risk. Risk is assessed by looking at a combination of Likelihood and Consequences and is expressed in equivalent fatalities per 100 million vehicle km.

1 fatal = 10 serious = 100 slight accidents.

1.8.2 Likelihood:

(a) Probability of vehicle leaving road – this is based on road type, local factors such as alignment, traffic flow and type, accident history, junction location, etc.

(b) Probability of errant vehicle reaching object – this is affected by hazard location, topography, speed and type of vehicle, etc.

1.8.3 Consequences

(a) Effect on occupants of errant vehicle if it reaches the hazard – this is influenced by speed of errant vehicle, Aggressiveness of hazard, % LGV / MGVs

(b) Effect on Others e.g. using adjacent road or railway or occupying a building

Aggressiveness of the hazard based on research, Stats 19 and Engineering judgement and the aggressiveness value is automatically assigned by the RRRAP.

1.8.4 Total risk

Total Risk is the summation of

Risk to vehicle occupants in Cars +
Risk to LGVs (> 3.5 Tonnes) +
Risk to MGVs (> 1.5 Tonnes) +
Risk to Others

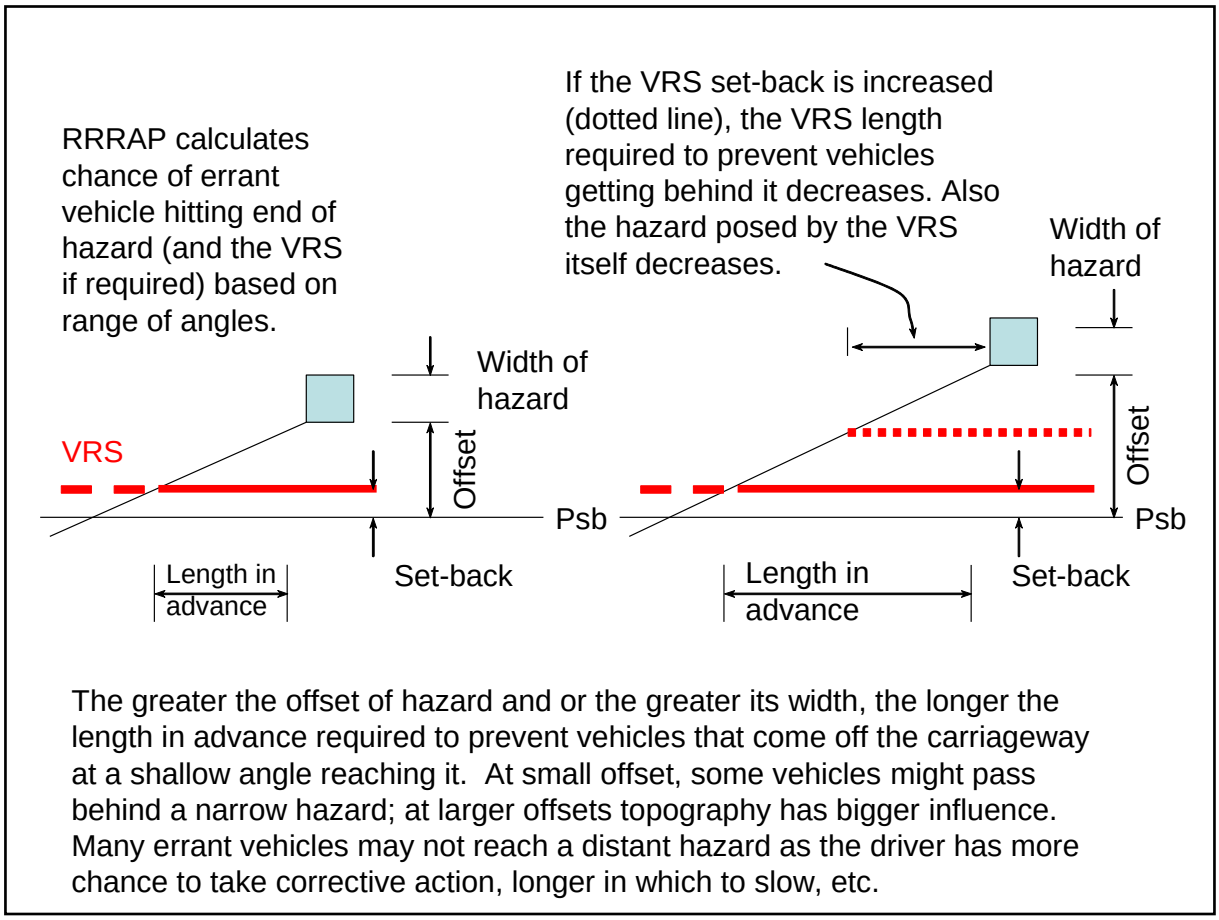
1.8.5 Thresholds used

The accident frequency is non-linear; the risk per vehicle changes with flow. At low flows the risk per vehicle is high, but the benefit / cost of providing a barrier will be low. At higher flows, the risk per vehicle is lower but, because overall there will be more accidents than on a low flow road, the benefit / cost is higher.

The thresholds used in RRRAP are also curved. They are set such that the risk posed by a hazard having an aggressiveness of, say, 1.5 will be unacceptable over a range of offsets, the risk becoming acceptable if sufficiently far from the running lane of the carriageway, or when protected by a safety barrier. Different hazards will have different aggressivenesses and will give rise to unacceptable levels of risk over different ranges of offsets.

1.8.6 Heavy vehicles may breach N2 containment safety barrier. H1 or H4A containment level may be needed where there is a combination of:

(a) High run-off rate and
(b) High proportion of heavy vehicles and
(c) Hazard is aggressive and
(d) ‘Others’ involved



The greater the offset of hazard and or the greater its width, the longer the length in advance required to prevent vehicles that come off the carriageway at a shallow angle reaching it. At small offset, some vehicles might pass behind a narrow hazard; at larger offsets topography has bigger influence. Many errant vehicles may not reach a distant hazard as the driver has more chance to take corrective action, longer in which to slow, etc.

Fig 1-3 Relationship between Offset of Hazard and VRS, and length of VRS

1.8.7 The RRRAP works out whether the level of risk is acceptable, tolerable, or unacceptable with a certain containment level(s) and length(s) of VRS in advance of the hazard and, for single carriageway roads, where vehicles can approach the hazard from either direction, the length beyond. The Designer can use this information to determine the required containment level and length of need (i.e. the total length of safety barrier required in advance, alongside and beyond the hazard to give an acceptable level of risk.

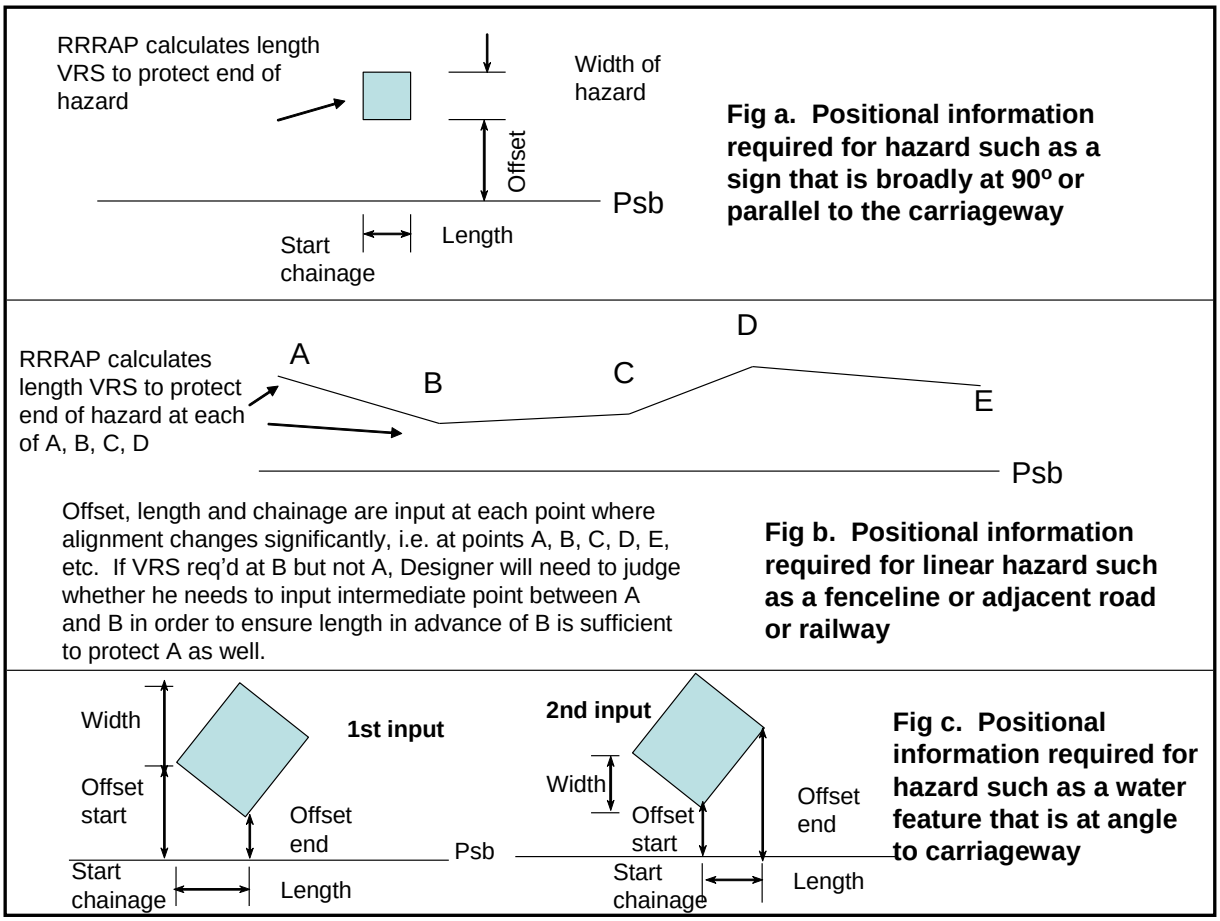


Fig 1-4 **Positional information required by RRRAP in order to calculate VRS requirements** – note that this gives typical details; further particulars are contained within each of the relevant sections.

At present the RRRAP cannot interpolate to ascertain whether VRS would be required at intermediate locations, the Designer should therefore review the information that he is inputting to ensure that the start point (and end point) of VRS requirement is being picked up properly by the RRRAP. The following figure illustrates the point.

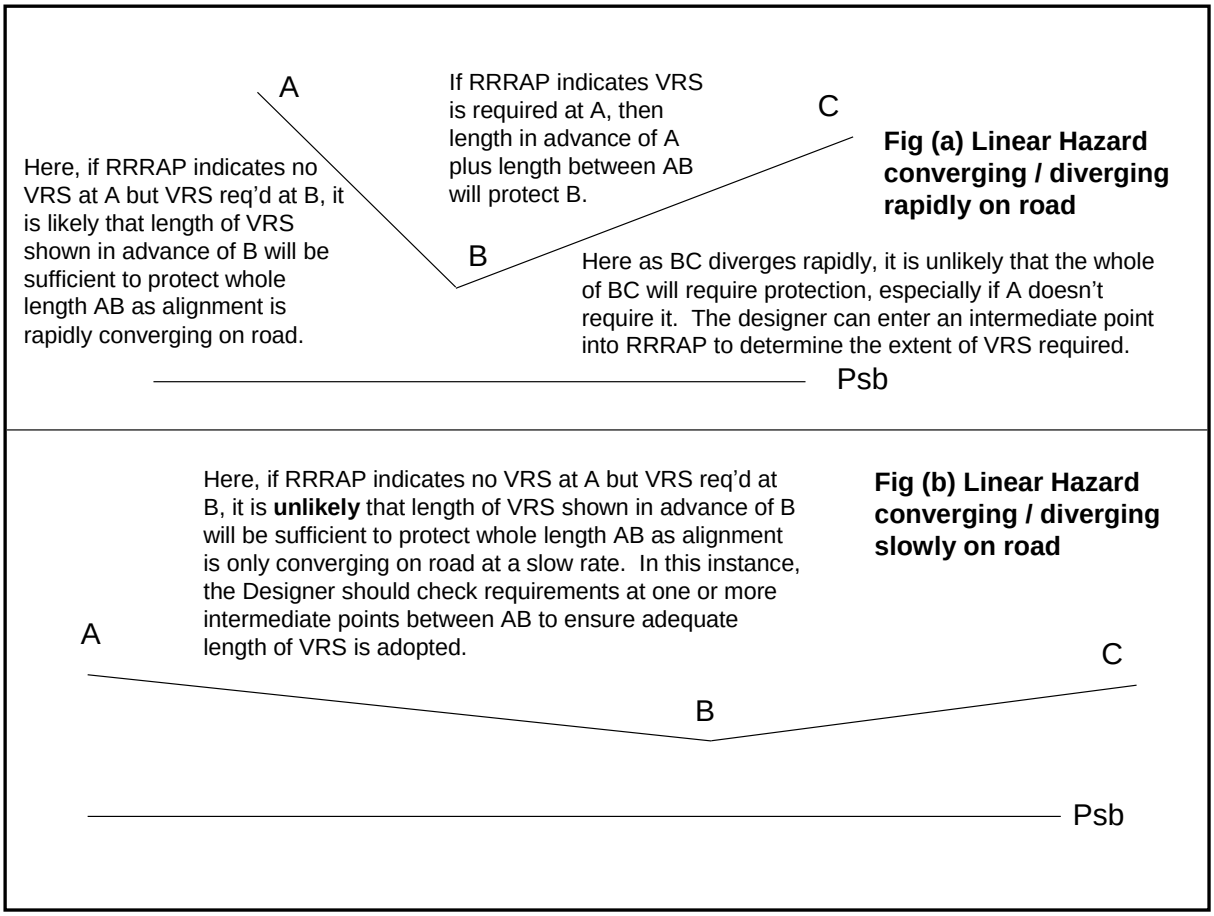


Fig 1-5 Influence of rate of convergence / divergence of hazard to Psb on VRS requirement calculation

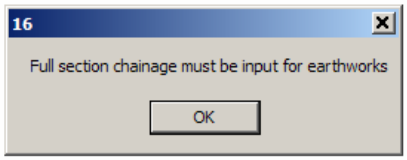
1.9 Error messages

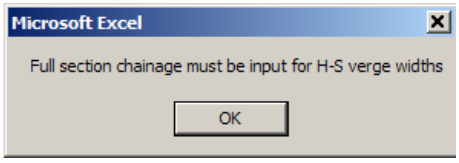
This section describes the various error messages that may be returned at the various stages of the RRRAP. Generally, if an error message is returned, the problem giving rise to the error message must be resolved prior to continuing to Collate Data or Calculate Risk as the results returned when there is still an error present may be incorrect and invalid.

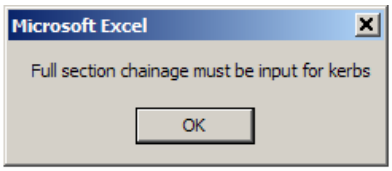
If an error message stops the programme, occasionally the word "Calculate" will appear in the status area at the bottom of the screen. If this occurs, the programme has stopped part way through a calculation and some cells may have a temporary value in them that is different to the original data entry. An example of this is the AADT value on the Basic Details worksheet. If the F9 button is pressed, the calculation should be completed or reset and the figure revert to the original value. It should also be corrected when the programme is restarted.

1.9.1. **When the 'Collation of Data' button is pressed** (on the Hazards Listing worksheet), the following error messages may be reported.

(a) If the start and end chainages for Hardshoulder and Verge widths, Earthworks, and or Kerbs do not match the start and end chainages for the Section (as entered on the Basic Common details worksheet).

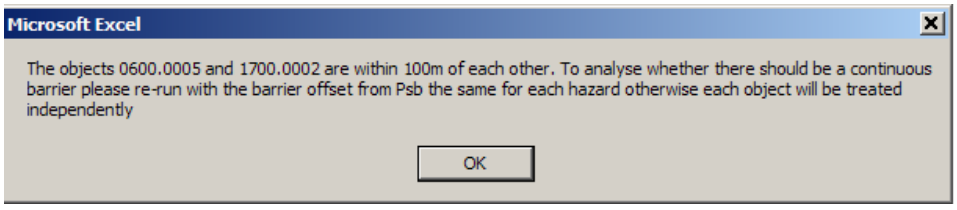




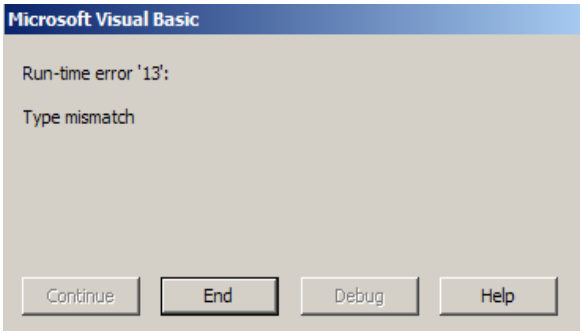


The requisite information must be entered on the appropriate worksheet(s) and the 'Collation of Data' button pressed again in order that the RRRAP will work.

(b) The safety barrier location may be altered to be at the same set-back for each hazard and the 'Collation of Data' pressed again. Alternatively the safety barrier could be placed at a different set-back for each hazard and the safety barrier requirements for each assessed independently of each other



(c) Run-time error '13'. Likely causes are:



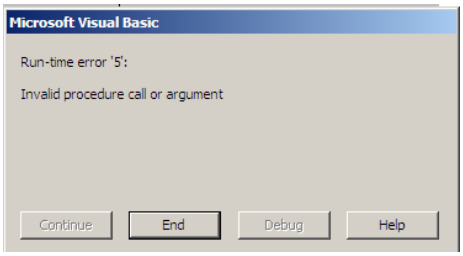
(i). Start or end chainage of section does not match start or end chainage given in Kerbing, Earthworks, or Verge and Hardshoulder pages.
(ii). Data is incomplete in kerbing, earthworks, or verge and hardshoulder worksheets.
(iii). An entry has been made that does not match the range of values offered in the drop down – may occur if data has been pasted into a cell.
(iv). Data has been entered in the green cells of column D in the H-S and Verge width worksheet, when none is required.

Failure to correct the cause of this error message may result in the RRRAP crashing when the Calculate Risk button is pressed.

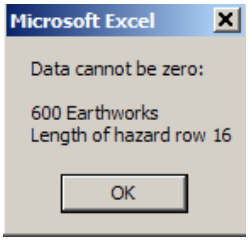
The error message may also be returned when the 'Calculate Risk' button has been pressed. The most likely reason is that the top 3 cells on the 'Barrier and Options Costs' worksheet have not been completed, or that a discount rate of zero has been entered. This worksheet is normally accessed using the 'Go to Barrier Options' macro button that is next to 'Scheme Duration' on the 'Basic (Common) Details' worksheet (note the asterisk alongside this cell indicating that it must be completed).

1.9.2 **When the Calculate Risk button is pressed** (on the Collation of Data worksheet), the following error messages may be reported.

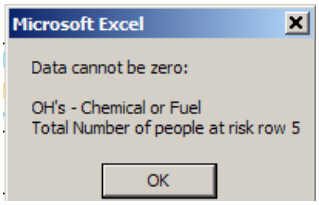
(a) Run-time error '5'. This may occur if the AADT value on 'Basic (Common) Details worksheet has been omitted.



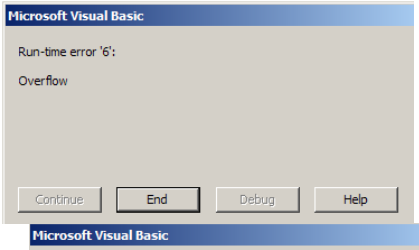
(b) Occurs if there is an Earthworks 'Width of Slope' entry that is zero. Typically this will be at an at-grade section. To rectify the situation, the 'Width of slope' should be entered as a nominal 0.1 m with the 'Overall Height slope' being 0.0 m.



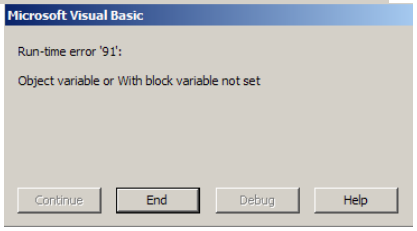
(c) This error message is typically returned when there is some data missing from one of the required fields, e.g. a hazard may have been listed but key information relating to it may have been omitted.



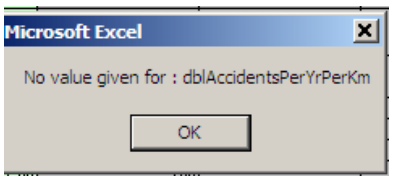
(d) Run-time error '6' was occasionally returned during the early trials of the RRRAP. It is thought that the problem has been resolved but if it is returned, then overall, there are too many entry lines of data for the macros to handle the data.



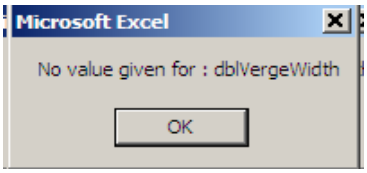
(e) Run-time error '91' is most likely to occur when programme is trying to correlate a parapet with the hazard that the parapet is protecting and either the cross referencing ID has not been entered or is entered incorrectly, or hazards have been entered after the end chainage of the section.

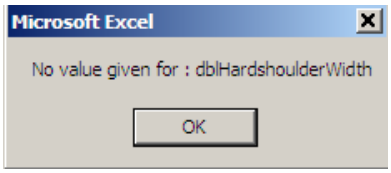


(f) This will be returned if the % LGV and or % MGV value has not been entered on the Basic (Common) Details worksheet. The programme is then unable to complete the calculation and may lock up.



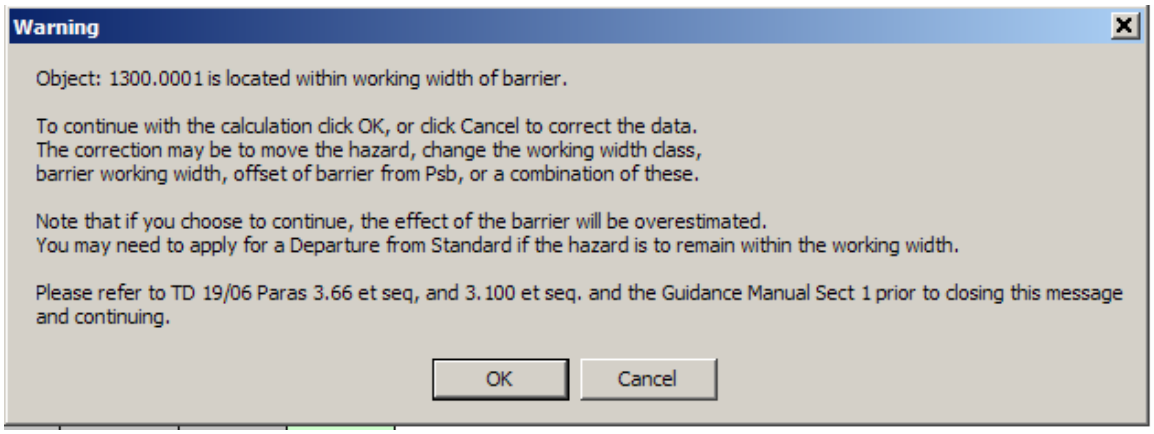
(g) One or other, or possibly both, of the following error messages will be returned if data has been incorrectly placed in column D of the 'Hardshoulder and Verge Width' worksheet and the Calculate Risk button pressed, having ignored the error message outlined in para 1.9.1(c)(iv) above. A zero verge width will also return the error message.





1.9.3 When the Calculate Risk button is pressed (on the Collation of Data worksheet), the following warning message (or similar) may be reported.

(a) If the hazard is located too close to the safety barrier.



If the OK button is pressed without the data being corrected or changed, the Collation of Data worksheet will highlight the data line that contains the information as shown below.

	Description of Feature								Description of Barrier				
ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet ure to placed contig with b
0300.0002	Close boarded fence - timber / concrete	60320.00	60340.00	8.00	Yes								
1300.0001	Row of lighting columns < 40m apart	60370.00	60460.00	0.75	No	Acceptable	5.0		N2	W2	0.15	0.60	
0300.0003	Wooden fence e.g. post and rail	60400.00	60420.00	8.00	Yes								
1200.0001	Sign on post(s)	60520.00	60520.08	1.45	No	Acceptable	7.0		N2	W2	0.80	0.60	

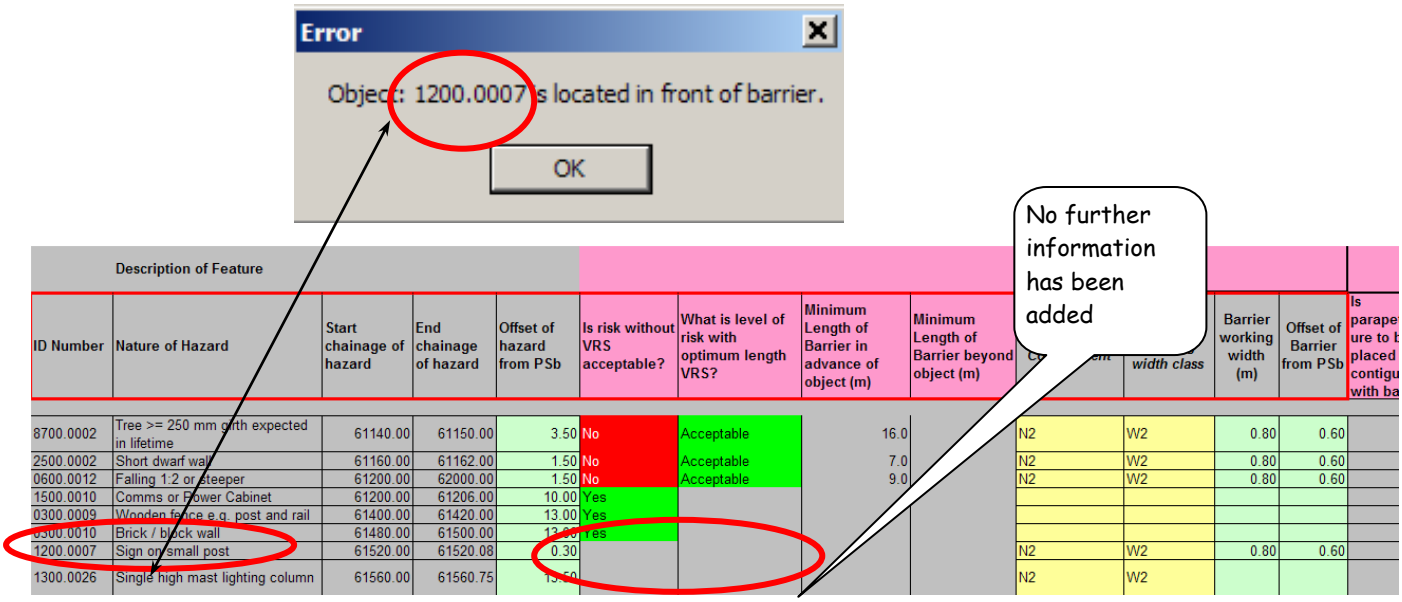
This highlighting will remain if the hazard remains within the working width of the barrier. It will disappear if the data is corrected.

This entry is highlighted and indicates the actual working width available given the offsets of barrier and hazard and barrier working width class.

If the warning has been caused by a mistype in the appropriate data entry worksheet, the data entry should be corrected and the 'Collate Hazards' button pressed again. This will ensure that the correct data is transferred into the 'Collation of Data' worksheet and that the information correlates between the worksheets correctly. The change can also be made by altering the entry in one of the light yellow or light green cells on the 'Collation of Data' worksheet, e.g. moving the hazard to say 1.5 m offset, though this alteration will not be reflected in the appropriate data entry sheet. If the data is altered on the Collation of Data' worksheet, the 'Calculate Risk' button should be pressed again to check the requirements for VRS or whether the change has been successful.

1.9.4 **When the Calculate Risk button is pressed** (on the Collation of Data worksheet), the following error message (or similar) may be reported.

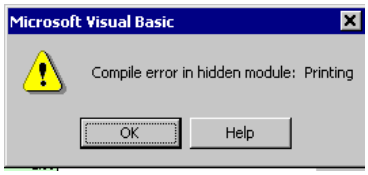
This error message will be posted if a hazard is in front of the barrier. The error will cause the process to halt the risk calculation at the hazard that has given rise to the fault as shown on the extract of the Collation of Data worksheet shown below.



The error might have been caused by a mistype of data, in which case it should be corrected on the appropriate data entry sheet and the 'Collate Data on Hazards' button re-pressed to complete the calculation process. It might though be the case that the hazard is an existing one for which the designer needs to check whether VRS protection is warranted. If this is the case, then the set-back of the barrier entry on the 'Collation of Data' worksheet (column M) should be manually altered to be the same as the offset of the hazard, and the 'Calculate Risk' button pressed to ascertain the risk level and VRS requirements. If no VRS is required for that particular hazard and there is no VRS requirement for any other hazard nearby, then the hazard may remain. If however, the hazard requires protection, then the programme will highlight the entry as detailed above and the actual barrier working width will be shown as 0.01 m, (rather than 0.00, as programme would consider a zero here a problem).

Note that there may be another hazard or hazards nearby for which a safety barrier is required even though a safety barrier is not required for the hazard in question. This situation would be likely to result in the hazard in question being behind the safety barrier required for the other hazards, which is likely to be unacceptable. In most cases it would be necessary to move the hazard to lie outside the safety barrier working width. The Designer's attention is drawn to TD 19/06 Paras 3.66 et seq. and Paras 3.100 et seq. which give further details and guidance.

1.9.5 **When the Copy data to VRS Summary button is pressed** (on the Collation of Data worksheet), the following error message may be reported.



This is a problem with Excel 2000 only. There is no easy fix. The most straight forward way of getting over the problem is to manually copy the results from the Collation of Data worksheet into a blank worksheet, (use copy / paste values) and filter the data to list only those items where the risk without VRS is unacceptable, then copy the requisite information into the VRS Summary worksheet. Take care to also copy for instance information relating to emergency telephones and other hazards that do not require VRS but which might influence the layout of the safety barrier systems.

1.10 Relaxations and Departures from Standard

1.10.1 Paragraphs 1.37 and 1.38, and Paragraphs 1.39 and 1.40 in Chapter1 (Introduction) of TD19 give details of the general information that is required from the RRRAP in support of a Relaxation and of a Departure from Standard.

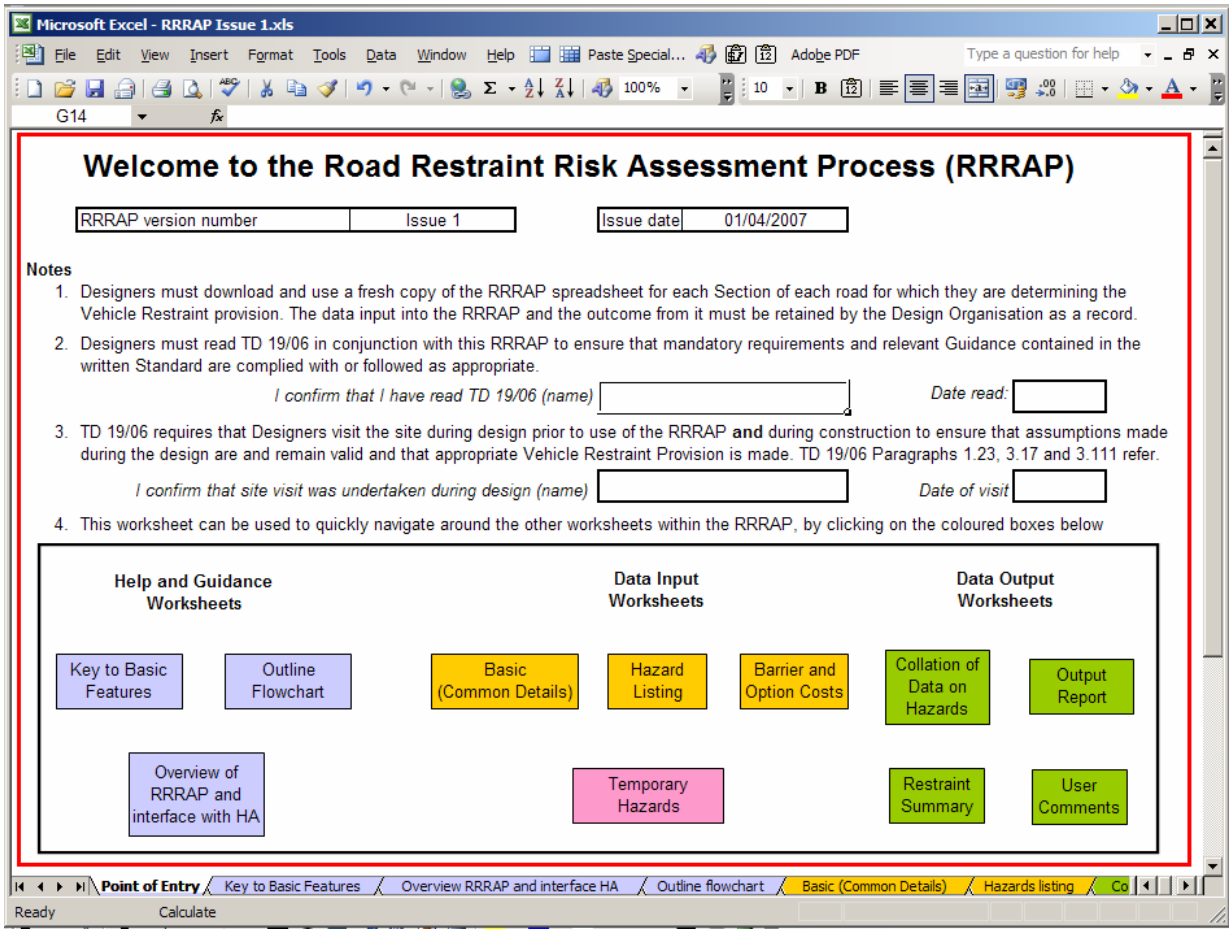
1.10.2 Paragraphs 3.36 to 3.39 in Chapter 3 (Criteria and Guidance for the Provision of Permanent Safety Barriers) gives guidance on Relaxations relating to locating a hazard within the working width or in front of a Vehicle Restraint System, and the circumstances under which a Departure from Standard may be considered to locate furniture meeting the requirements of BS EN 12767 in front of a single sided Vehicle Restraint System in the verge.

1.10.3 Where the decision relating to a Relaxation is devolved onto the Designer, the Designer should ensure that the completed RRRAP contains sufficient information to enable the Overseeing Organisation to review the decision made and options investigated should the need arise at some future date.

1.10.4 Designers should ensure that the completed RRRAP contains the required information in sufficient detail to allow the Overseeing Organisation to form an opinion as to the acceptability of a Departure or Relaxation, and that the preferred option is compared against options that would meet full Standards.

1.10.5 The completed RRRAP spreadsheet should form part of the application for a Departure from Standard.

2. Point of Entry worksheet



2.1 This worksheet records details of the version number of the RRRAP, and confirmation that the Designer has read TD 19 and visited the site. The Designer could be the Design Manager responsible for the team carrying out site surveys and the design and RRRAP process.

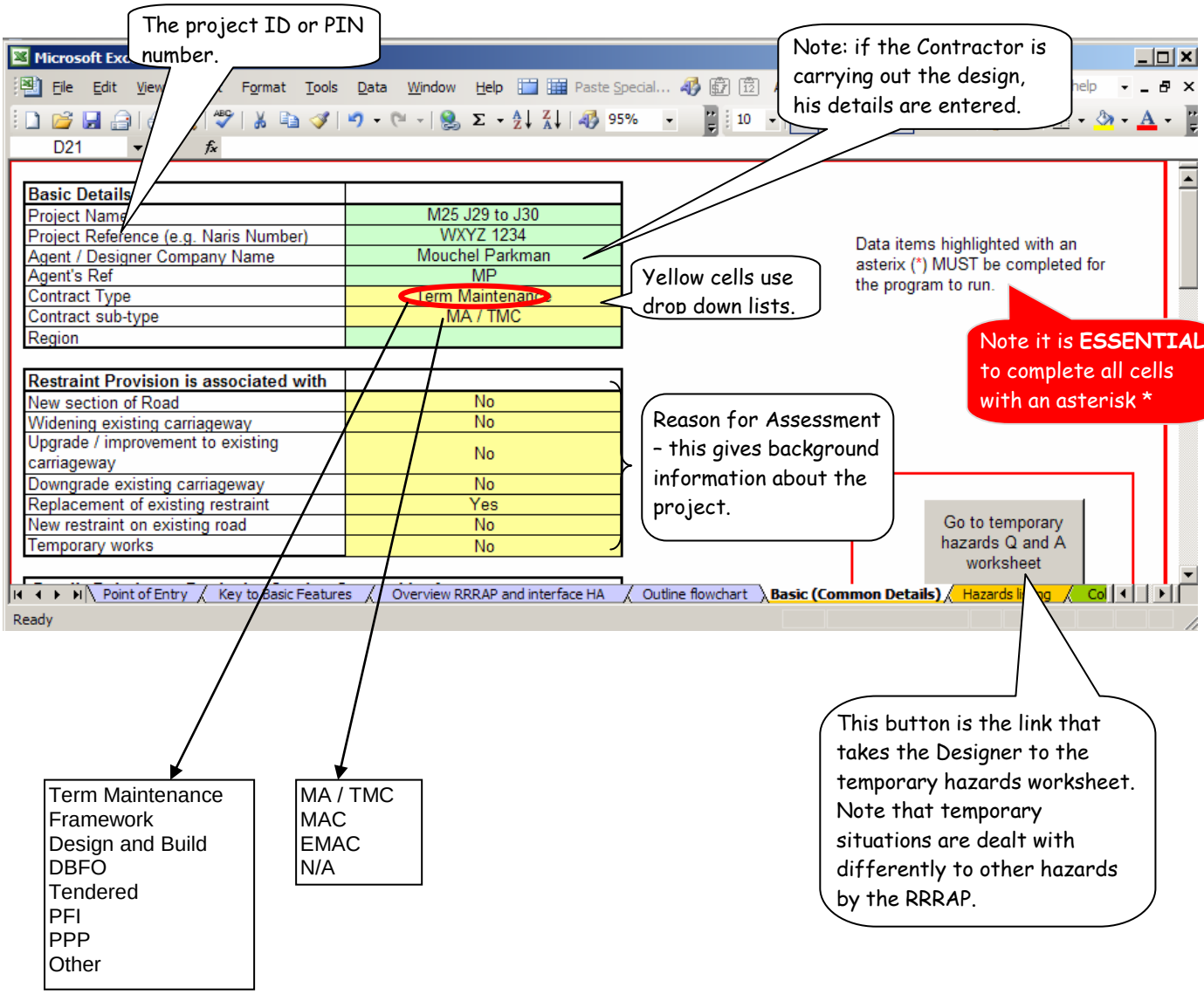
2.2 The worksheet also details when the Designer should download and use a fresh copy of the RRRAP spreadsheet.

2.3 The Designer can click on the coloured text blocks to get to the relevant part of the worksheet.

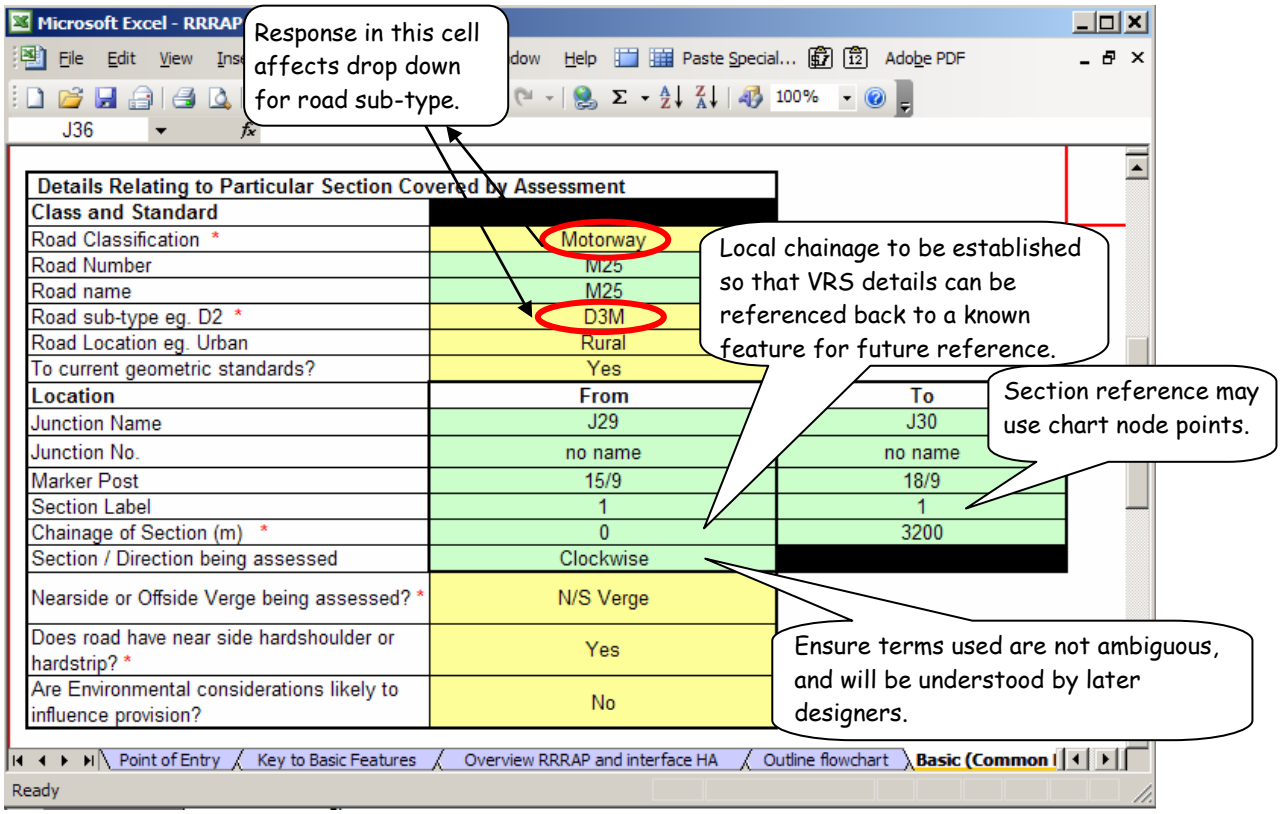
3. Data Entry - Basic (Common) Details.

3.1 This worksheet records key details of the project for which the assessment of Road Restraint System requirements is being undertaken.

3.2 Basic Details and Restraint Provision in Association with. The top part of the worksheet shown below is used to record overall details of the Project and why it is being done. It records details such as: Project name; Designer and company name; reason why the works are being done, e.g. upgrade or improvement to an existing carriageway or replacement of existing Restraint System; type of road; its location in terms of junction names or numbers, which side of the carriageway is being looked at, and start and end chainages of the section being assessed; traffic and, where available, accident data; date of submission and date of the Road Restraint Standard used in the assessment.



3.3 Details Relating to Particular Section Covered by Assessment. The middle part of the spreadsheet, shown below, is used to record details of the particular Section of the road that is under consideration. A road that has a length of Slip Road and a length of Mainline will need to be split into two Sections, as the traffic flows and cross section, alignment and hence run-off and accident characteristics of the Slip and Mainline will be different.



Details Relating to Particular Section Covered by Assessment		
Class and Standard		
Road Classification *	Motorway	
Road Number	M25	
Road name	M25	
Road sub-type eg. D2 *	D3M	
Road Location eg. Urban	Rural	
To current geometric standards?	Yes	
Location	**From**	**To**
Junction Name	J29	J30
Junction No.	no name	no name
Marker Post	15/9	18/9
Section Label	1	1
Chainage of Section (m) *	0	3200
Section / Direction being assessed	Clockwise	
Nearside or Offside Verge being assessed? *	N/S Verge	
Does road have near side hardshoulder or hardstrip? *	Yes	
Are Environmental considerations likely to influence provision?	No	

Note that if you are assessing a motorway with 5 or more lanes, use the D4M category.

3.4 Chainage

In the current version, the RRRAP cannot cope with Sections that are in decreasing chainage order. It is expected that future version will be able to work with either increasing or decreasing chainage.

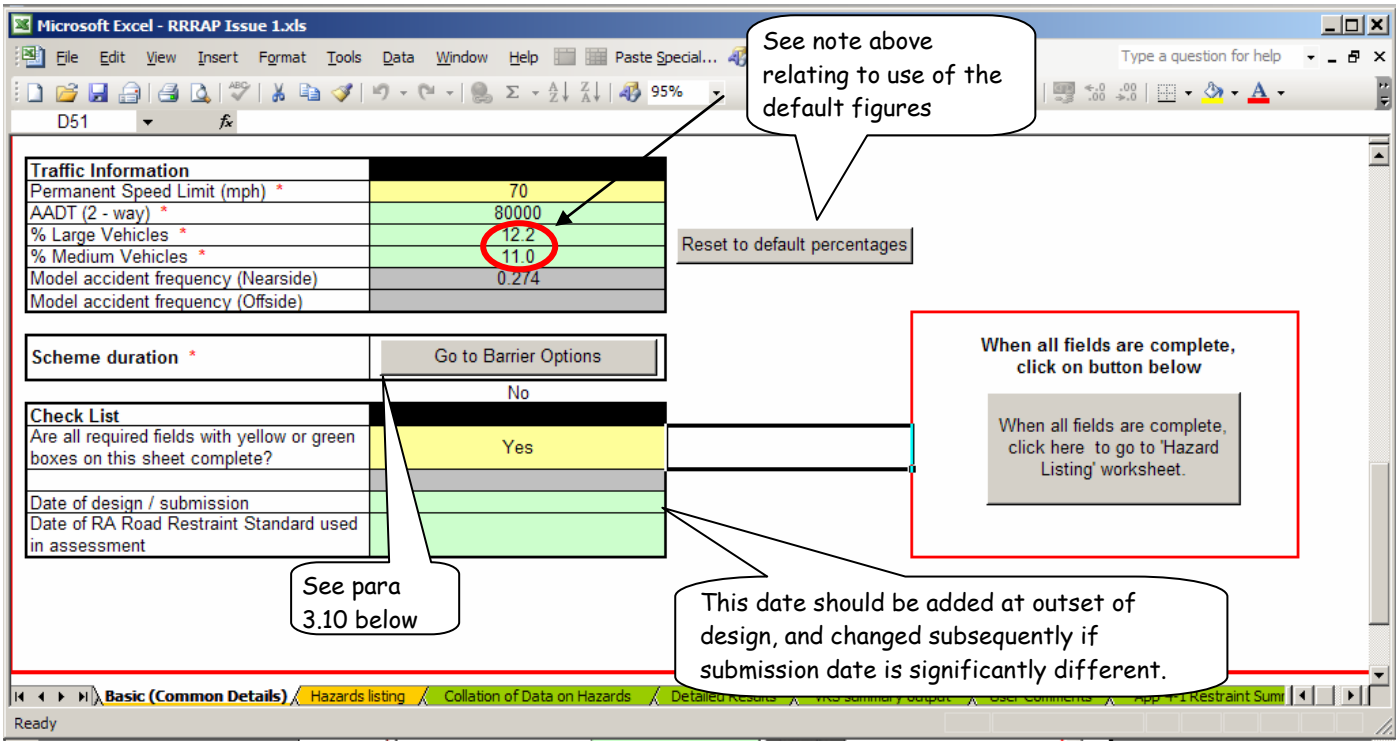
3.5 Environmental Considerations.

If Environmental considerations are likely to influence the decision on provision of VRS, e.g. snow build up on some forms of VRS may influence type to be specified, or e.g. RRRAP indicates protection required to localised one off hazard on low risk site within Area of Outstanding Natural Beauty and the Designer considers that VRS should not be provided, then background to the Environmental issue(s) and how that has influenced the decision should be given in the User Comments worksheet. The response entered is purely used for audit purpose and the calculation is not affected in anyway.

3.6 The lower part of the spreadsheet, shown below, requires traffic information details for the Section. These details are used by the RRRAP to calculate the run-off frequency and in the benefit / cost calculations and must be entered. The percentage of large vehicles (LGVs), i.e. those over 3.5 tonnes, and, to a lesser extent, of medium vehicles (MGVs), i.e. those over 1.5 tonnes and less than or equal to 3.5 tonnes, will affect the benefit / cost ratios and, especially where Others may be involved, the Containment Level of the VRS.

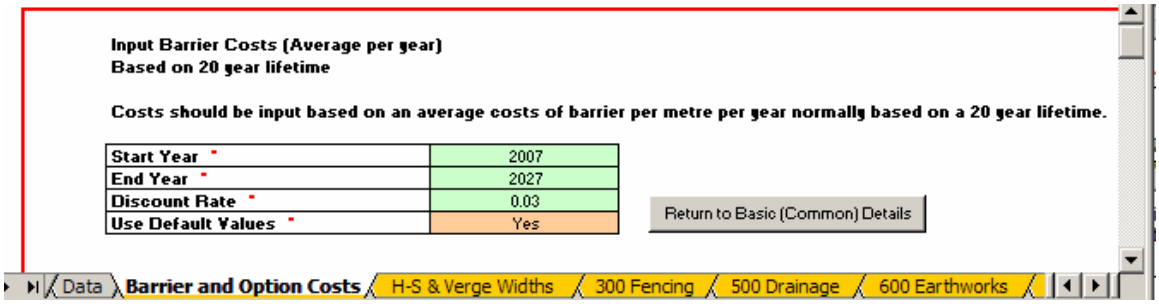
3.7 AADT, LGV and MGV. The AADT and percentage LGV and MGV values entered should be based on the predicted flow 5 years after the expected start of works date. If the LGV and MGV values are unknown for instance because it is a new road, then the default values can be entered by clicking on the 'Reset to default percentages' button.

3.8 The spreadsheet uses default values for accident frequency and details are reported in the grey cell. Accident frequency is equivalent fatalities per 100 million vehicle km.



3.9 It is important to note that, whilst the cells marked with an asterisk * are the minimum that must be completed in order that the RRRAP process can run and only completing these can be useful if for instance a quick trial is being carried out, it is essential that data is entered in all the other cells so that a complete auditable record is maintained for the final design.

3.10 Scheme duration. The extract of the Barrier and Option Costs worksheet shows the mandatory sections. The start year is for expected tender or start of works rather than design date. End year is normally 20 years after start date, but on e.g. DBFO schemes may be say 30 years. Further Guidance on this worksheet is given later in this Manual.



4. Data Entry - Hazards Listing

4.1 This worksheet, shown below on the next two pages, is used to identify whether or not any hazard listed in each category of hazard is present in the length of road verge (or central reserve) being assessed. The hazard categories are generally based around the numbering system used in the **MCHW, Volume 1.** Help buttons are available to assist the user in determining what items are covered in each hazard category.

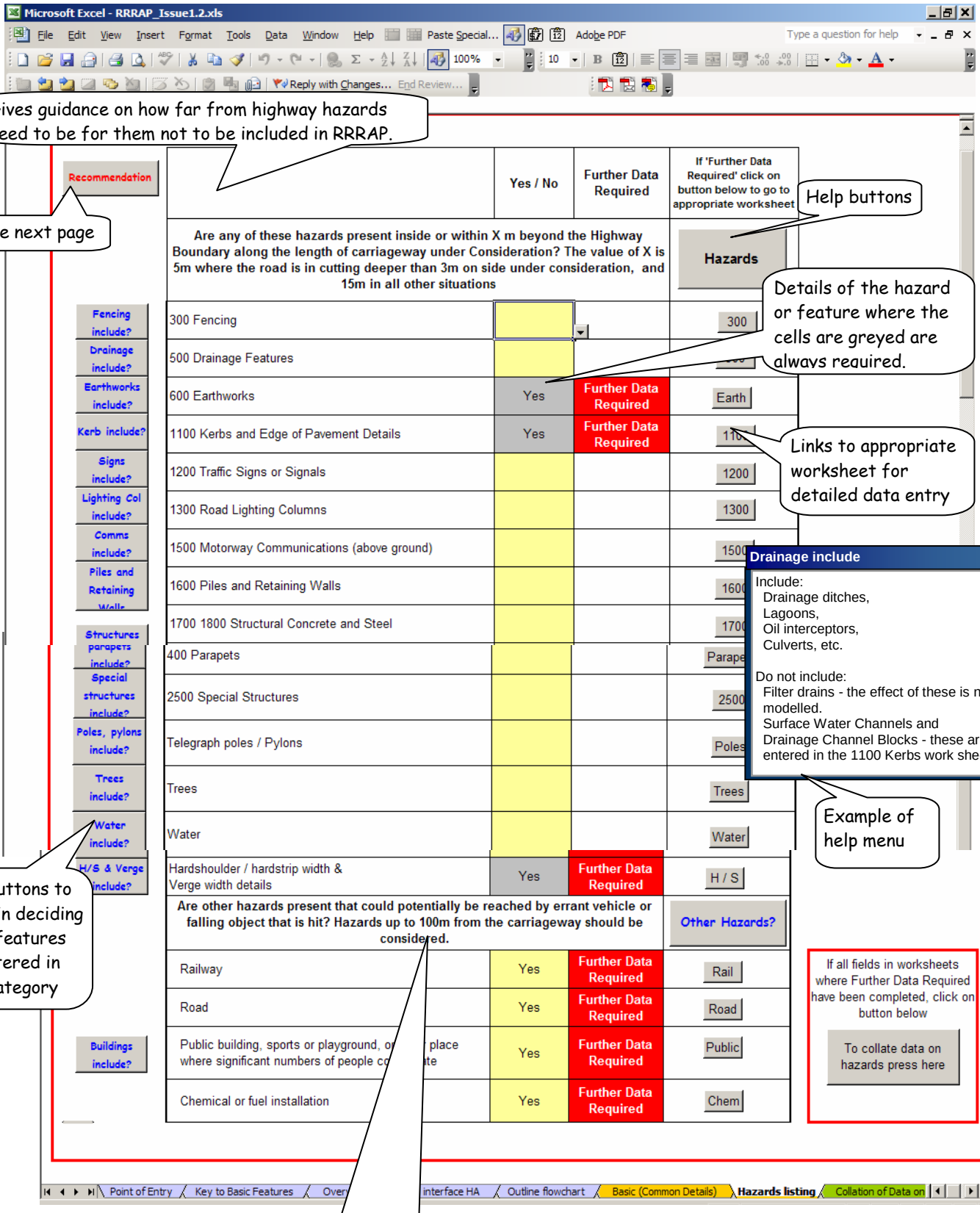
4.2 If there is one or more hazard of any particular category present a 'Yes' is entered in the 'Yes / No' column and the worksheet identifies that further details are required. These further detailed data entries are entered on the appropriate worksheet which is accessed by clicking on the adjacent button in the right hand column. There is a link on each detailed data entry worksheet that returns the user to the Hazards Listing worksheet, so that data on the next category of hazards can be entered.

4.3 Data is always required and must always be entered in the '600 Earthworks', '1100 Kerbs and Edge of Pavement Details', and 'Hardshoulder / hardstrip width & Verge Width details' worksheets. This is because of the way the RRRAP works. The RRRAP uses the earthworks information to calculate an 'effective offset' of the hazard; a cut slope, i.e. rising upwards from back of verge, making the hazard effectively further than its actual offset; a falling slope downwards from back of verge making the hazard effectively nearer. The 'Kerb and Edge of Pavement Details' currently do not alter the calculations, but will in future versions. The 'Hardshoulder / hardstrip width & Verge Width details' are particularly important as the RRRAP calculates the risk from the running lane under consideration. This will enable the designer to test for appropriate VRS provision where for instance the hardshoulder is narrower than standard, as is often the case where the road has been or is to be widened within the existing land–take, or its adequacy of provision when hardshoulder running for extended periods is contemplated.

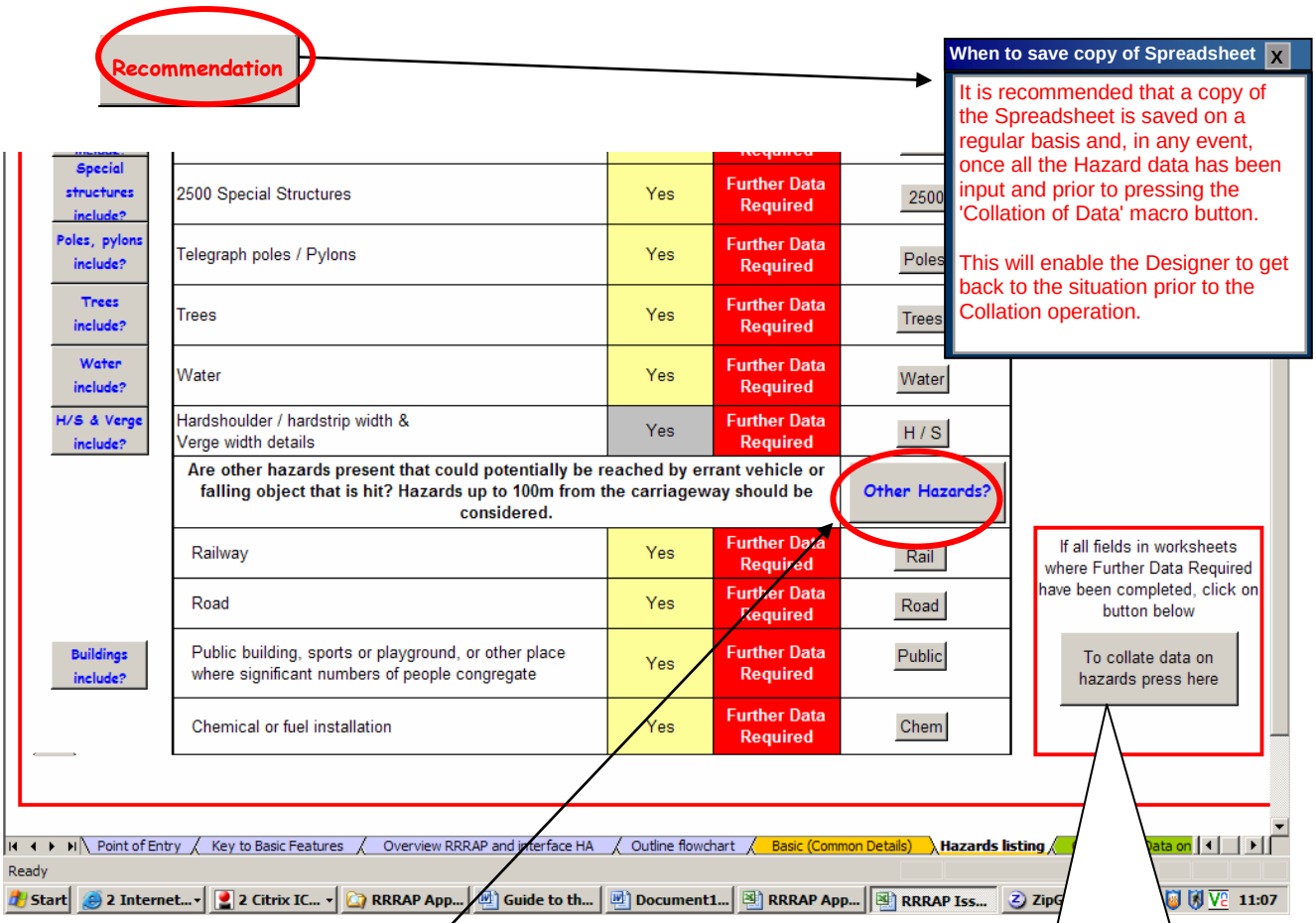
4.4 If the start and end chainages for the above key worksheets does not match the start and end chainages for the Section under consideration, then error messages will be generated, advising the user of the problem. A guide to the error messages is given at the end of Section 1 Overview of the RRRAP, above.

4.5 Upper and lower limits to the number of hazards.

There were a number of queries that arose during the trialling of the RRRAP relating to whether is was necessary to input data relating to **all** existing hazards along the entire length of a road where for instance a small number of discrete communications signs and associated cabinets were to be installed as part of a small scheme. The Designer's attention is drawn to the need to comply with the mandatory Implementation paragraphs (1.18 et seq) of TD 19. It should be noted that the RRRAP is capable of being used to determine the VRS requirements for as few as one or two hazards, with information local to only these hazards being entered (say covering 100 m to 200 m in advance and 50 m beyond depending on circumstances) or over the entire length of a scheme (as long as the flow and road types are consistent throughout the length). Note that the total number of each hazard that can be entered does alter according to the hazard type, and so there may be a practical limit to the length of section that can be analysed at any one time. Should feedback indicate that it would be advantageous to increase the number of hazards of a particular type that can be entered, this possibility will be investigated, but the overall number may be limited by the limitations of MS Excel.


Microsoft Excel - RRRAP_Issue1.2.xls
Gives guidance on how far from highway hazards need to be for them not to be included in RRRAP.
See next page
Recommendation
Yes / No
Further Data Required
If 'Further Data Required' click on button below to go to appropriate worksheet
Help buttons
Are any of these hazards present inside or within X m beyond the Highway Boundary along the length of carriageway under Consideration? The value of X is 5m where the road is in cutting deeper than 3m on side under consideration, and 15m in all other situations
Hazards
Details of the hazard or feature where the cells are greyed are always required.
Fencing include?
300 Fencing
Drainage include?
500 Drainage Features
Earthworks include?
600 Earthworks
Yes
Further Data Required
Earth
Kerb include?
1100 Kerbs and Edge of Pavement Details
Yes
Further Data Required
Signs include?
1200 Traffic Signs or Signals
1200
Lighting Col include?
1300 Road Lighting Columns
1300
Comms include?
1500 Motorway Communications (above ground)
Piles and Retaining Walls
1600 Piles and Retaining Walls
1700 1800 Structural Concrete and Steel
Links to appropriate worksheet for detailed data entry
Structures parapets include?
400 Parapets
Special structures include?
2500 Special Structures
Poles, pylons include?
Telegraph poles / Pylons
Trees include?
Trees
Water include?
Water
H/S & Verge include?
Hardshoulder / hardstrip width & Verge width details
Yes
Further Data Required
H / S
Drainage include
Include:
Drainage ditches,
Lagoons,
Oil interceptors,
Culverts, etc.
Do not include:
Filter drains - the effect of these is not modelled.
Surface Water Channels and Drainage Channel Blocks - these are entered in the 1100 Kerbs work sheet.
Example of help menu
Help buttons to assist in deciding which features are entered in each category
Are other hazards present that could potentially be reached by errant vehicle or falling object that is hit? Hazards up to 100m from the carriageway should be considered.
Other Hazards?
Railway
Road
Public building, sports or playground, o place where significant numbers of people co te
Chemical or fuel installation
Buildings include?
If all fields in worksheets where Further Data Required have been completed, click on button below
To collate data on hazards press here
Point of Entry
Key to Basic Features
interface HA
Outline flowchart
Basic (Common Details)
Hazards listing
Collation of Data on
Obviously if it is physically impossible for an errant vehicle to reach a hazard, e.g. due to intervening obstructions or topography, then there is no need to include it.

Guidance on the use of the Road Restraint Risk Assessment Process (RRRAP) associated with TD 19/06



Other Hazards X

These features may be inside the Highway boundary or outside it. They may be behind the Highway boundary fence.

An errant vehicle can travel a considerable distance, especially on a downward slope and may break through simple boundary fencing. If in doubt, include and assess the requirements for protection.

A site visit is required to confirm the reasonableness of the restraint provision proposed / determined by the Risk Assessment Process.

This button should not be pressed until all the data for all the Hazards on each of the worksheets has been entered.

It is recommended that the spreadsheet is saved prior to pressing this button. (See 'Recommendation' button above).

Should the 'collate data' button be pressed inadvertently before all the data has been input, the Designer should be able to come back to this worksheet and the other data entry worksheets and continue to input further details and data. The previously collated data will be over written when the button is pressed for the second and subsequent times. Occasionally, if key information is missing or incorrectly entered, error messages will come up, indicating the nature of the problem. In extreme cases it may not be possible to retrieve all the input information, hence the value of saving the spreadsheet, as recommended, which will allow checking and correction of the problem data.

5. Data Entry – Detailed Data on each Hazard

5.1 General notes

5.1.1 Unique ID reference number and aggressiveness

The RRRAP automatically assigns each hazard an ID Number and an aggressiveness factor that is based on a default value for the type of hazard.

5.1.2 Dimensions

Chainages are in metres. Lengths, widths and offsets of hazards are in metres. Heights are in either metres or millimetres, e.g. sign height and cut or fill height is in metres, kerb height is in millimetres.

5.1.3 Drop down listings and Helps

The right hand portion of many of the worksheets is the same and contains the following drop down listing and Help buttons. Where they differ, e.g. on the '600 Earthworks', '1100 Kerbs and Edge of Pavement Details', 'Railways', 'Roads', 'Buildings', and 'Chemical or fuel installation' worksheets, details and guidance has been given within the appropriate section of this Guidance Manual.

Road Alignment Locally [x]

Local alignment (F2)	
Good alignment	Full standard sight stopping distance (SSD), full width lanes, straight and constant grade
Average alignment	Full standard sight stopping distance (SSD), some curves and undulations but standard horizontal and vertical alignments and lane widths.
Poor alignment	Sub-standard SSD or vertical or horizontal alignment or lane widths.

Sleep related factors [x]

Sleep - related Site (F3)	
A	No obvious risk factor.
B	Site of featureless rural road with the minimal services and/or minimal distractions for drivers at the side of the roads.
C	Sweeping right hand bend or sweeping left hand bend, with no offside or central reserve safety barriers.
D	Site at the end of a long route.
E	Any combination of the above factors.

Site specific hazards increasing chance of RTA [x]

Site specific hazards increasing the likelihood of an RTA include the following features in the length of the section:

Farm access, road junction, private driveway, lay-by, bus stop, steep downhill slope, on approach, etc. Lack of adequate signage would also be included here.

W	No obvious hazards
X	Single site specific hazard
Y	Multiple minor hazards or single major hazard (e.g. junctions, steep slopes, sharp bends).
Z	Multiple major hazards

Speed (F4) [x]

Speed should normally be set to "approximately equal to speed limit" for motorways and dual carriageways.

Help will assist decision on appropriate entry in row below.

Currently the factor in this column is not used.

	I	J	K	L			
3	Local alignment?	Sleep related?	Speed (F4)?	Other features?			
4	Aggressiveness	Local alignment (F2)	Sleep - related Site (F3)	Speed (F4)	Other features (F6)	Multiplicative factor for runoff rate	Topography Factor
5	1.70	Good alignment	A	Mean speed < speed limit	W	0.9	1
6	1.70	Average alignment	B	Mean speed < speed limit	Y	1.0	1
7	1.70	Poor alignment	E	Mean speed exceeds speed limit	Z	1.1	1
8	1.70	Good alignment	A	Mean speed approximately equal to speed limit	W	0.9	1

Good alignment
Average Alignment
Poor Alignment

A
B
C
D
E

Mean speed < speed limit
Mean speed approximately equal to speed limit
Mean speed exceeds speed limit

W
X
Y
Z

Factors automatically alter depending on values given in preceding 4 columns. Changing parameters from most to least favourable changes runoff rate from 0.9 to 1.1 (approx 22% range).

5.2 300 Fencing and 500 Drainage

5.2.1 Note that each of these is broadly similar in content and layout. The extracts shown below are from the left hand and right hand sides of the worksheet.

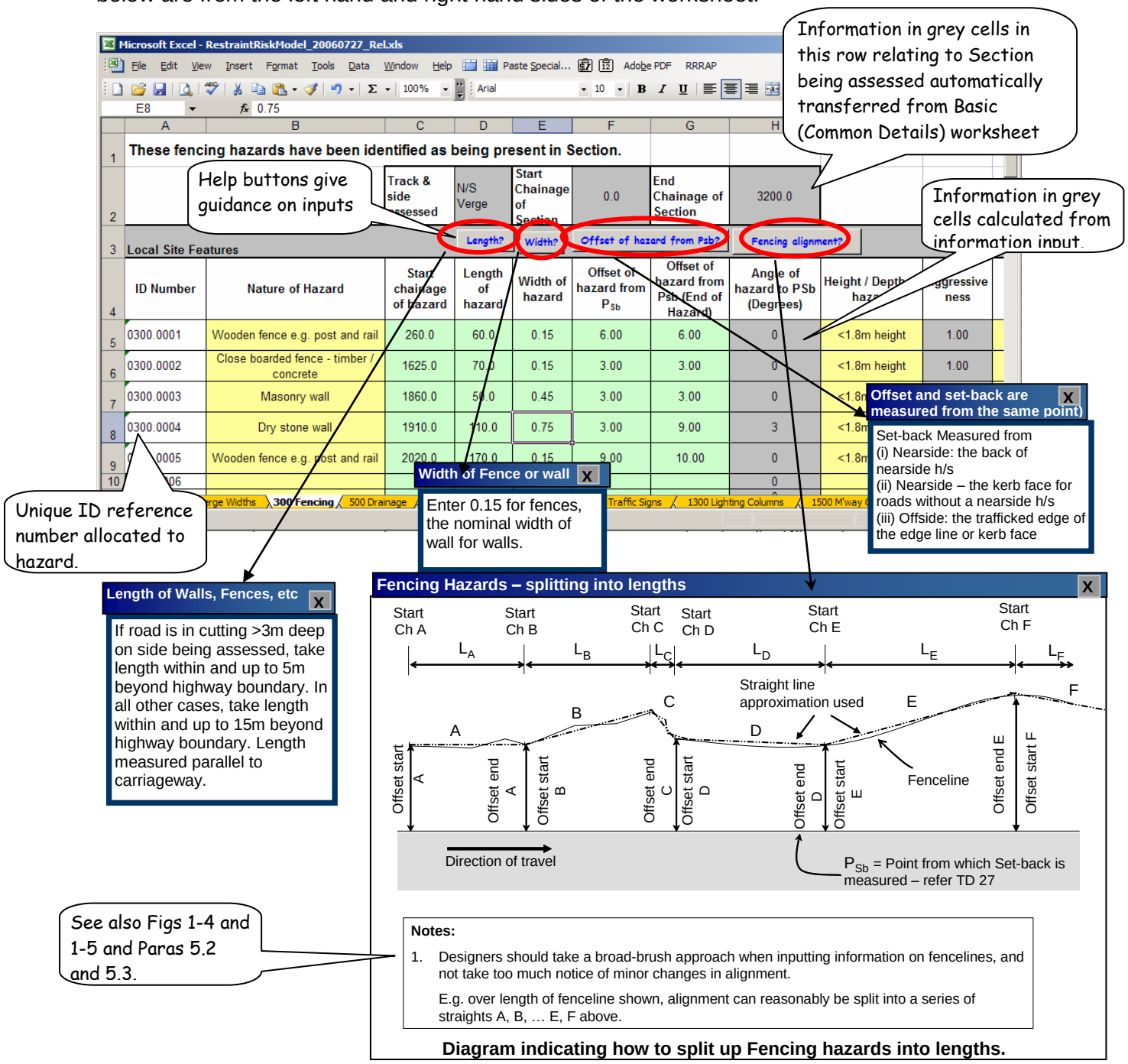


Diagram indicating how to split up Fencing hazards into lengths.

Drop down menu for Nature of Hazard

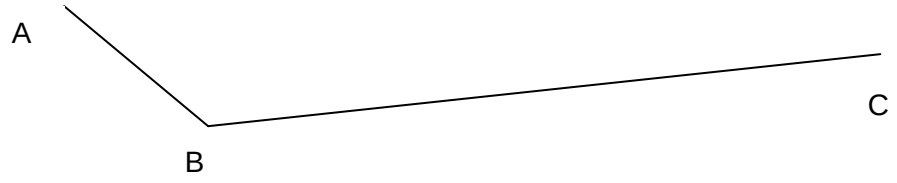
- Wooden fence e.g. post and rail
- Hurdle, strained wire fence
- Chain link / welded mesh / palisade
- Close boarded fence - timber / concrete
- Brick / block wall
- Concrete panel wall
- Masonry wall
- Dry stone wall

Usually regular size and shape, bound in place.

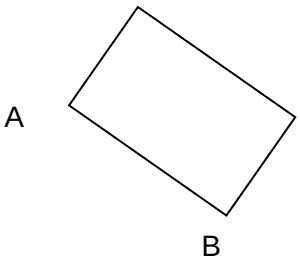
Unbound, often using irregular sized and shaped stones, easily dislodged and able to expose an edge if hit.

5.2.2 The RRRAP programme looks at the offset and hazard width at point A, and calculates VRS need for the hazard over length AB. For a linear hazard such as a fenceline, the programme will then look at the offset and hazard width of point B and calculate if VRS is needed to protect at point B for length BC, and so on. Thus for a linear hazard, the Designer will know at each input point along the fenceline whether VRS is required to prevent an errant vehicle hitting the hazard.

5.2.3 Checking VRS requirement when fenceline / hazard offset changes significantly. See also Figs 1-4 and 1-5 above. If the angle of the fence to the road approaches 90 degrees and say VRS is required at point B, but not at A, then the chances are that VRS placed in advance of B will be long enough to adequately protect the whole of length A to B. If the angle is shallow, then the designer may need to go back and check intermediate positions between A and B (say where the fence is 2 m further from Psb than point B, etc) in order to ensure adequate length of provision. The point at which the length of fenceline from B to C no longer needs to be protected can be ascertained. It is hoped that a future version of the RRRAP will automatically perform this calculation.



5.2.4 If there is a drainage item such as a drainage lagoon that is at an angle to the carriageway, e.g. as shown below, such that the difference in offset at A and B is significant, then the hazard should be entered twice, once to pick up chainage, offset and width at point A and second to pick up chainage, offset and width at point B. Where the offset at A and B are broadly similar, the data entered would be chainage A, nearer offset of A and B, and max width of hazard.



5.2.5 Data entry for culverts – these are typically for narrow bodies of water up to say 2 m overall width.

You should enter the culvert in the drainage section. If it crosses under the road, it is best to enter the details as follows.
Length = length in direction of the line of the carriageway, typically say 2m or so.
Width = width from headwall to 15 m beyond the highway boundary (i.e. as per guidance for length.
Offset of start of hazard and end of hazard would be the offset to the culvert side of the headwall from Psb.

If the RRRAP indicates that no VRS is required, then you would just need to install a pedestrian parapet / barrier to stop people falling over the vertical drop.

Putting the details in the parapets section would probably give a requirement for N2 containment even if the culvert headwall were very distant from the carriageway. This is because the parapets module assumes that the parapet is close to the carriageway, and typically at about or within the offset of back of standard verge.

5.2.6 Data entry for larger bodies of water, e.g. river, lake, lagoon, etc.

You should enter these into the OH's Water worksheet.

5.3 600 Earthworks

Note that Earthworks details must be provided **in increasing chainage order** from Start Chainage to End Chainage of Section. In this example, there must be at least one other entry detailing the gradient and slope height, etc at Ch 103,000

See next page for these helps and drop down information.

Microsoft Excel - RRRAP 1 Jan 07 Guide.xls

These Earthworks features have been identified as being present in Section.

Earthworks include?	Earthworks	Verge assessed	N/S Verge	Start Chainage of Section	60000.0	End Chainage of Section	103000.0

Viaduct - Parapet & Earthworks Input | Splayed Wingwall - Parapet & Earthworks Input | Parallel Wingwall - Parapet & Earthworks Input | Parallel Wingwall - Parapet & At-Grade Earthworks Input | Slope gradient?

Local Site Features

ID Number	Nature of Hazard	Start chainage of hazard	Width of slope	Offset of hazard from P_{Sb}	Overall Height slope	Overall width slope	Ave gradient of Slope % (+ve for cut, -ve for fill)
0600.0045	Falling 1:2 or steeper	102540.0	8.00	2.50	-4.00	8.00	-50.0%
0600.0046	Nominally at Grade	102600.0	0.10	2.50	0.00	0.10	0.0%
0600.0047	Rising 1:2 or shallower	102645.0					

300 Fencing | 500 Drainage | 600 Earthworks | 1100 Kerbs | 1200 Traffic Signs | 1300 Lighting Columns | 1500 M'way Comm

Ready

See para 5.3.1 for advice on inputs where earthworks are nominally at -grade and then change to a slope

Earthworks – Splitting into sections and nomenclature

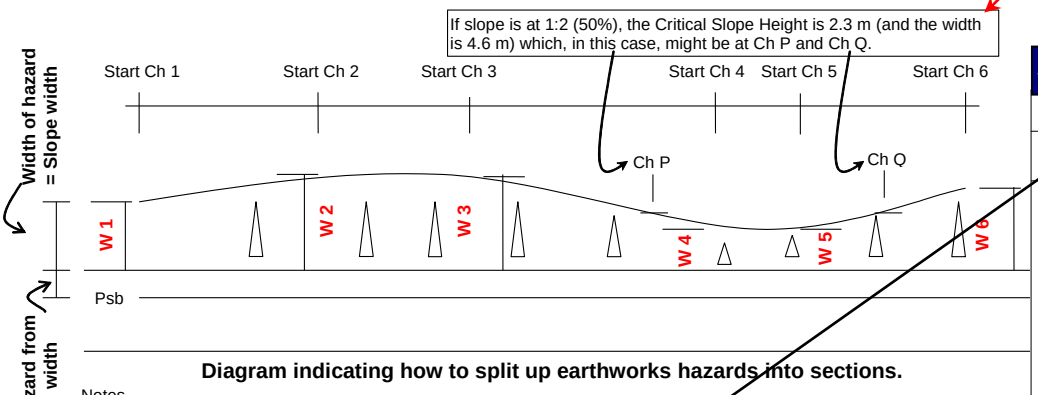
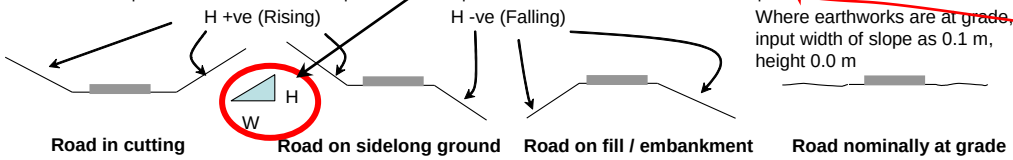


Diagram indicating how to split up earthworks hazards into sections.

Notes

1. Psb = point from which set-back is measured.
2. Designers should take a broad-brush approach when inputting information on slopes, and not take too much notice of minor changes in slope width. E.g. between Start Ch 2 and Start Ch 3 above, the width of slope is broadly the same, the length between Start Ch 3 and Start Ch 4 is changing broadly linearly and the length between Start Ch 4 and Start Ch 5 is again of broadly similar slope width.
3. Note that a new section is required where significant slope gradient changes occur, e.g. coming from an at-grade length into a length that is on a slope. The Designer must correctly identify the start point of the length on a slope.
4. Designers must also identify the chainage(s) at which the Critical Slope Height for the gradient of the slope is reached, see example above. Refer also to Help button for 'Slope Gradient Conversion and Critical Slope'.



Nomenclature

Slope Gradient & Critical Slope Height

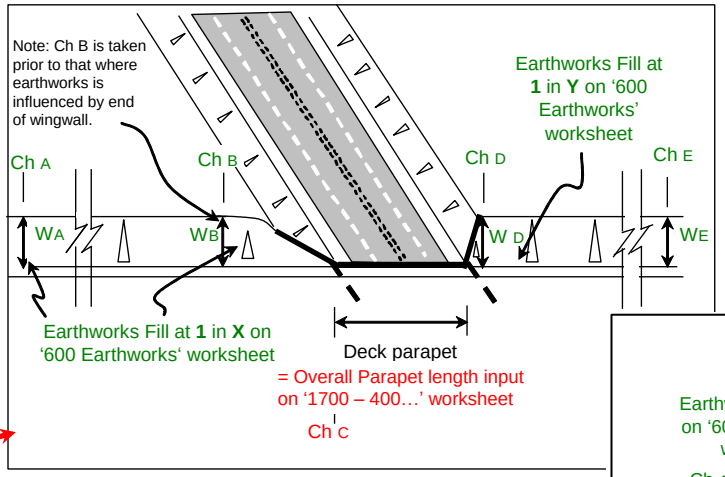
Slope conversion		Critical slope height
H : W	%	
Steeper than 1 : 1		1.0 m or higher
1 : 1	100	1.0 m
1 : 1.25	80	1.2 m
1 : 1.5	66.7	1.6 m
1 : 1.67	60	1.8 m
1 : 2	50	2.3 m
1 : 2.5	40	3.4 m
1 : 2.75	36	4.0 m
1 : 3	33	6.0 m
1 : 3.5	28.6	7.0 m
1 : 4	25	9.0 m
Shallower than 1 : 4		None

Nature of Hazard drop downs

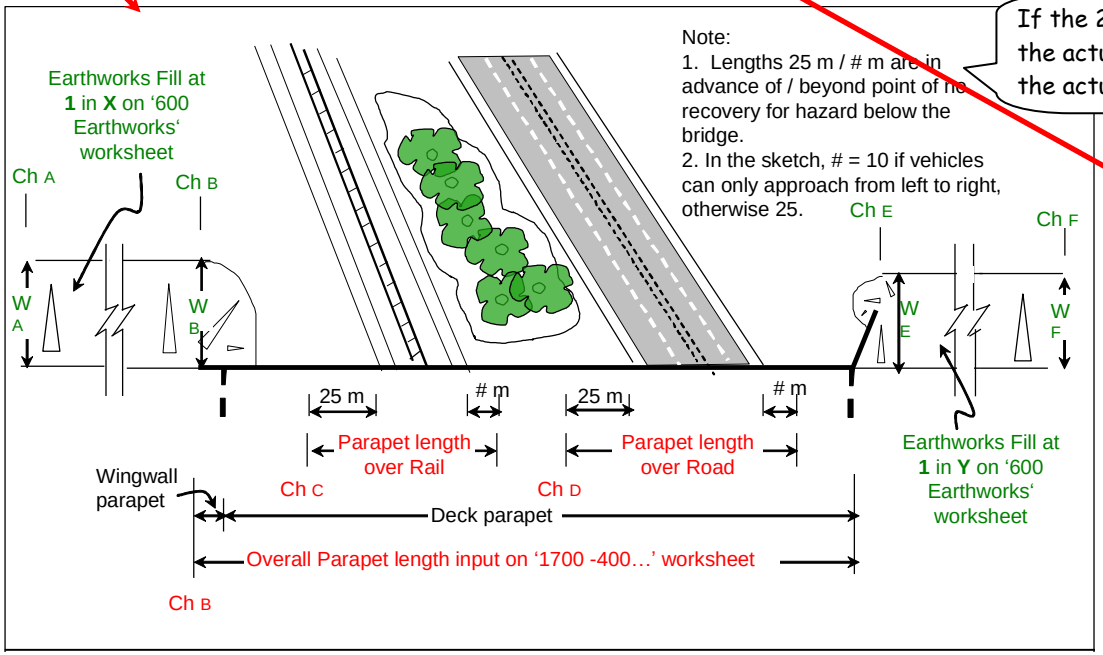
Falling 1:1 or steeper
Falling 1:1.5 or steeper
Falling 1:2 or steeper
Falling 1:2.5 or steeper
Falling 1:3 or steeper
Falling 1:5 or steeper
Falling shallower than 1:5
Nominally at Grade
Rising 1:1.5 or steeper
Rising steeper than 1:2
Rising 1:2 or shallower
Exposed rock face cutting

As an example, if the slope is falling and the gradient is, say, 1:2.3, then the category will be 'Falling 1:2.5 or steeper'. If the gradient is, say, 1:2.6, then the category will be 'Falling 1:3 or steeper'.

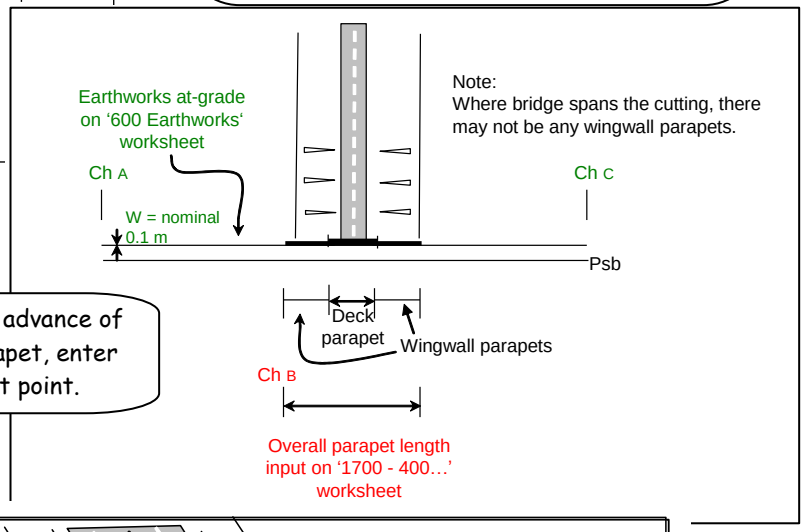
Parapet details are entered in the 1700 – 400 Structures – Parapets worksheet as indicated in these helps. See also the OH's Road and OH's Rail worksheets and Helps for how to input details relating to road and or railways.

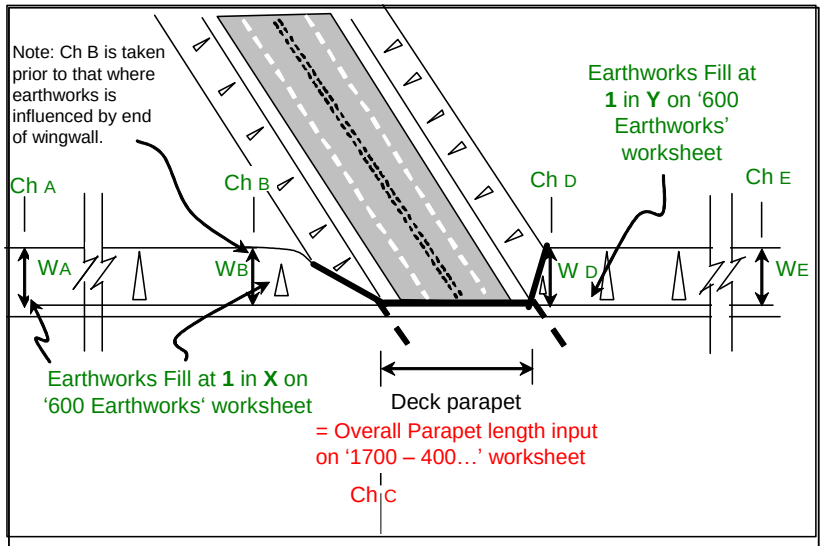


Viaduct - Parapet & Earthworks Input | Splayed Wingwall - Parapet & Earthworks Input | Parallel Wingwall - Parapet & Earthworks Input | Parallel Wingwall - Parapet & At-Grade Earthworks Input



If the 25 m extends in advance of the actual start of parapet, enter the actual parapet start point.





5.3.1 Dealing with lengths that are nominally at-grade. At locations where the road is nominally at-grade, the width of slope should be input as a nominal 0.1 m rather than zero to avoid an error message when 'Calculate Risk' is pressed. The RRRAP assumes that the ground beyond any slope or at-grade section is broadly level. In the above example (see screen snapshot), the earthworks goes into a 1 in 2 cutting soon after the 1 in 2 embankment ending, with a short length at-grade in between. It is important to ensure that the start of the earthworks slope after a length at-grade is assigned the correct Overall Slope Height, i.e. 0.05m in this case to correlate with the width of 0.1 m and gradient of 1 in 2. Note that no earthworks entries should be given the same chainage, so in this instance had the earthworks gone directly from cut to fill or vice versa, then a dummy nominal at-grade length of say 1 m should be entered.

5.3.2 Strengthened Slopes. Inputting information where the slope has been strengthened to steepen it may either be entered in the 600 Earthworks worksheet or in the 2500 Special Structures worksheet. The decision as to which largely depends on the length involved. If the length is substantial, then it is easier to enter the slope details in the Earthworks, if the length is localised, say round an obstacle, it is easier to enter it in the Special Structures worksheet, see also **Section 5.10** below.

5.3.3 Earthworks profile having multiple slope gradients. The following figures indicate the method of inputting earthworks information where there are multiple slopes. In Figs 5.3.3 (b) and (c), a situation is shown where a false cutting has been created. This is often done to create a noise and or visual barrier to a feature or features beyond the highway boundary

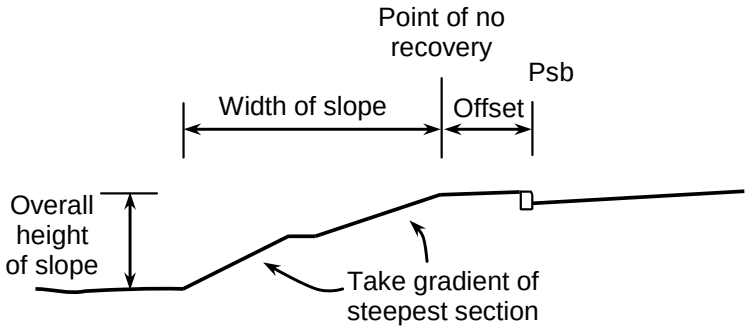


Fig 5.3.3 (a) Multiple slopes

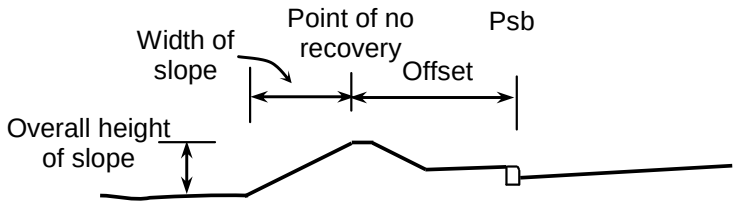


Fig 5.3.3 (b) Multiple slopes where height of false cutting is < 2.5 m

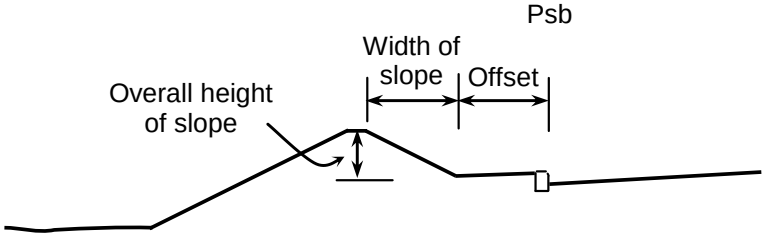
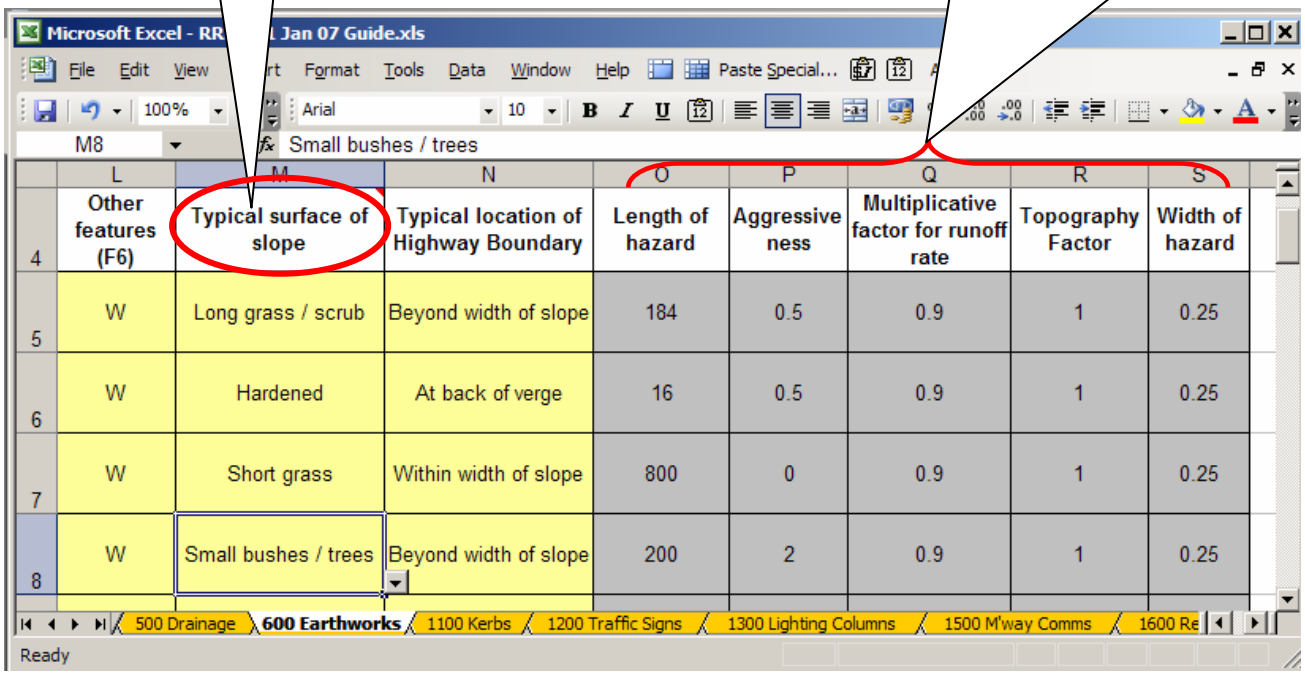


Fig 5.3.3 (c) Multiple slopes where height of false cutting is ≥ 2.5 m

5.3.4 The right hand portion of the Earthworks worksheet is as follows.

Site inspection to verify

These columns are auto-filled based on earlier entries. Currently, the Topography Factor does not do anything, but in future it is intended to influence the calculation.



	L	M	N	O	P	Q	R	S
4	Other features (F6)	Typical surface of slope	Typical location of Highway Boundary	Length of hazard	Aggressive ness	Multiplicative factor for runoff rate	Topography Factor	Width of hazard
5	W	Long grass / scrub	Beyond width of slope	184	0.5	0.9	1	0.25
6	W	Hardened	At back of verge	16	0.5	0.9	1	0.25
7	W	Short grass	Within width of slope	800	0	0.9	1	0.25
8	W	Small bushes / trees	Beyond width of slope	200	2	0.9	1	0.25

Drop down menu for Typical surface of Slope and Location of Highway Boundary

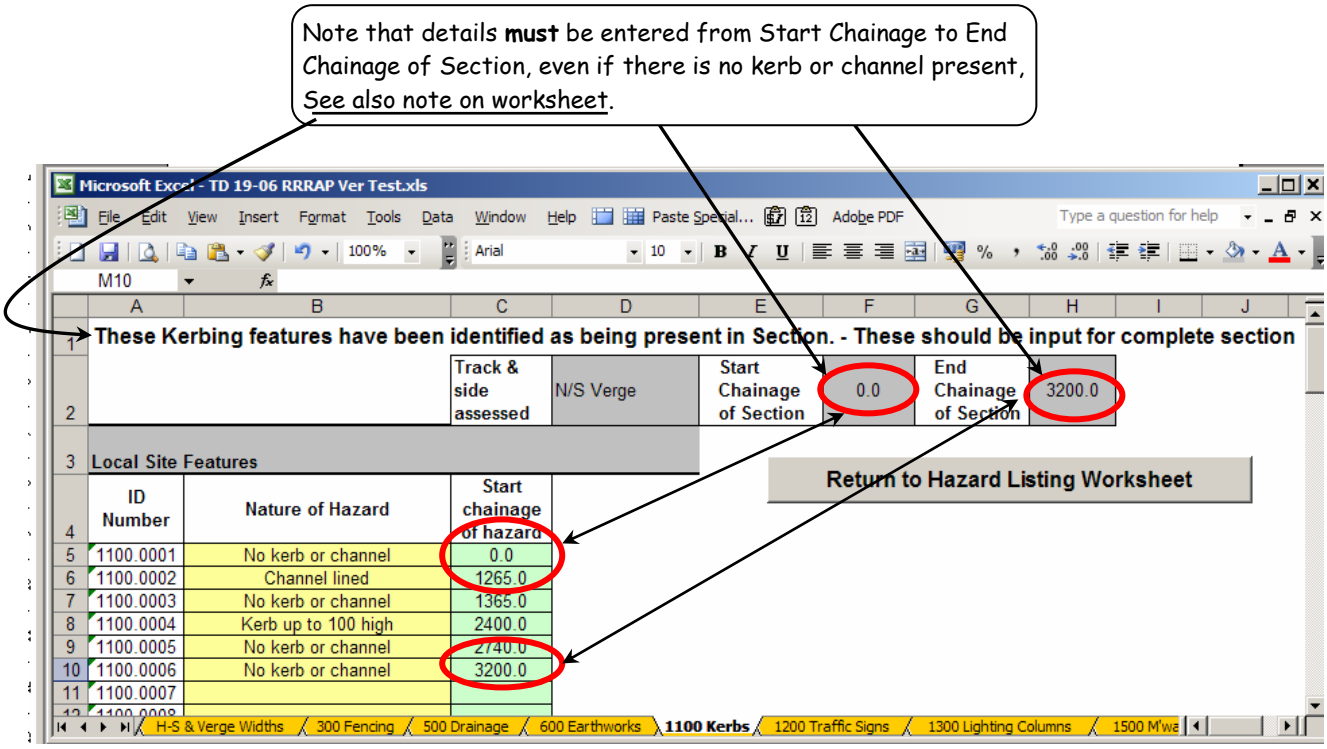
Hardened
Short grass
Long grass / scrub
Small bushes / trees

In future versions, these factors will have an influence, albeit limited, on the rate at which errant vehicles will decelerate. Be aware that scrub and small bushes / trees may be cleared at some future date, depending on circumstances.

At back of verge
Within width of slope
Beyond width of slope

If the road is nominally at-grade, then use "Beyond width of slope".

5.4 1100 Kerbs

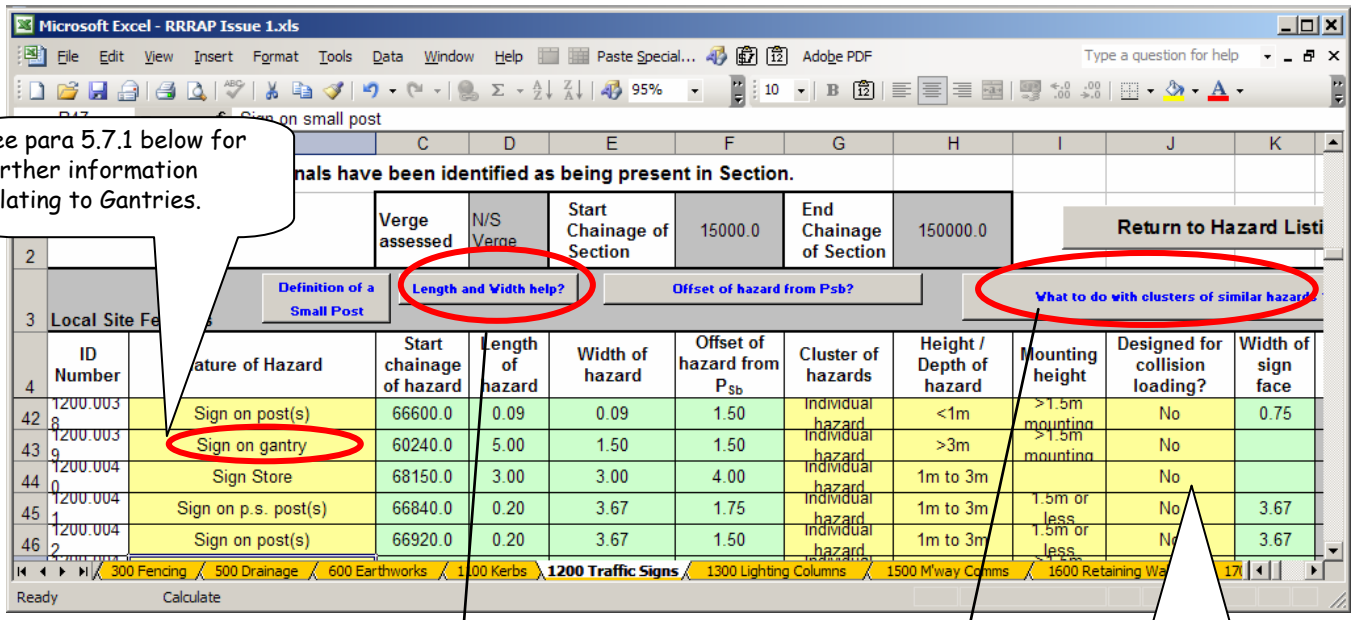


Drop down menu for Nature of Hazard

No kerb or channel
Channel lined
Channel unlined
Kerb up to 100 high
Kerb 100 to 250 high
Kerb > 250 high

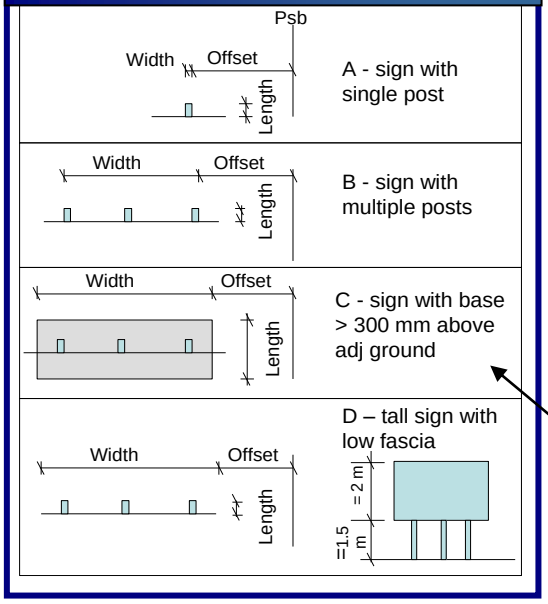
At present, these factors do not influence the risk calculation. In future versions, they may do.

5.5 1200 Traffic Signs and Signals



See para 5.7.1 below for further information relating to Gantries.

Help for width, length and offset for Signs X



This entry will influence the containment level of the safety barrier. The designer must check that appropriate containment level is chosen. See TD 19 Figure 3-9.

What to do with clusters of objects X

If you have a cluster of similar hazards within say 10 m or 15 m distance, treat as one hazard, the length of the cluster. Give the width as the width of the widest single hazard in the cluster, and the offset of the nearest of the hazards to Psb. Pick the hazard description that describes at least one of the hazards in the cluster and returns the highest aggressiveness of the possible descriptions for the hazards in the cluster.

Where base of sign may be hit rather than / as well as the sign itself

Drop down menu for Nature of Hazard

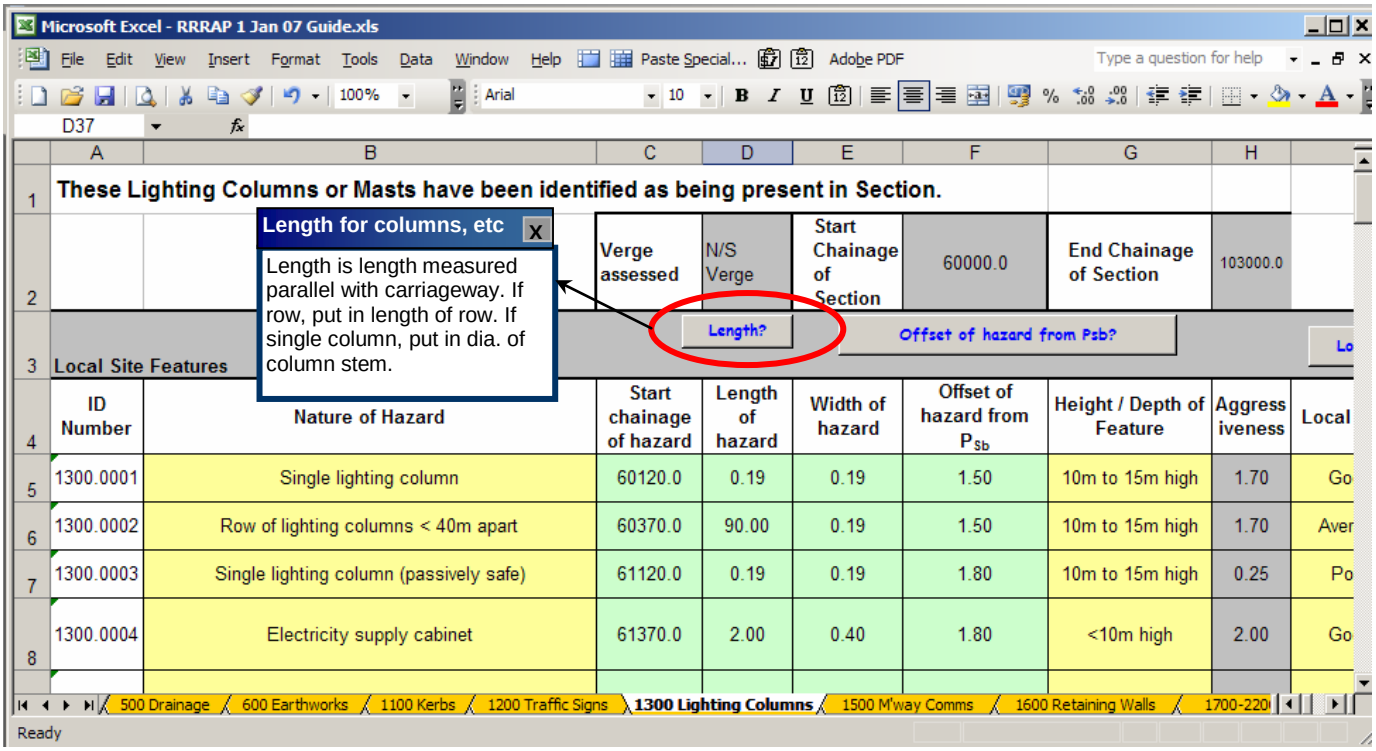
- Sign on post(s)
- Sign on small post
- Sign on p.s. post(s)
- Sign on gantry
- Sign on p.s. gantry
- Signal on post(s)
- Signal on p.s. post(s)
- Signal on gantry
- Signal on p.s. gantry
- Sign store

Passively safe (p.s.) signs and gantries may not require VRS protection on their own merit, but may be close to another hazard that may warrant protection or alter the cost benefit ratio in favour of protection of both hazards.

5.5.1 Use of Passively Safe Posts or Gantries. It may be beneficial in many situations to consider using passively safe posts or gantry rather than conventional posts or gantry, especially where the RRRAP indicates that VRS is only required to protect the one hazard and the hazard can be changed to be passively safe. It should be noted however that passively safe posts or gantries may not be suitable for all locations, e.g. where the sign could fall onto another carriageway or become a hazard to other vehicles. Additionally, the Designer should consider the importance of the sign(s), the message portrayed and its significance, and the implications of it being missing in the event of a knock down.

5.5.2 If 'Tolerable' risk level is returned on signs. When the hazards are Collated and the 'Calculate Risk' button pressed (see later in the Guidance), the risk level will sometimes be shown as 'Tolerable' rather than 'Acceptable' for a sign, even when H1 or H4a VRS is used. This may occur where for instance on a motorway, the hardshoulder has been locally reduced in width to say 1 m or less, leading to the hazard being closer than normal to the running lane. The total risk may reduce with the use of a safety barrier but, as the barrier is a hazard in its own right, the risk remains 'Tolerable'. As a safety barrier becomes stiffer with increased containment level, generally increasing the containment increase the total risk unless the LGV flow is very high. If the LGV flow is very high (>18%), then occasionally an 'Acceptable' result may be produced with an H1 or H4a safety barrier. It will normally be the case that the benefit cost ratio will reduce when H1 is provided and reduce again when H4a is provided. In all cases, if a 'Tolerable' result is returned or an 'Acceptable' result with H1 or H4a, then review the benefit cost ratio and use this to make the decision on the correct level of provision, even if this means accepting a lower containment level. A copy of the Detailed Results pertaining to the N2, H1 and or H4a provision should be provided (e.g. copied into the 'User Comments' worksheet) as part of the Departure from Standard process to back up the decision made.

5.6 1300 Lighting Columns



Microsoft Excel - RRRAP 1 Jan 07 Guide.xls

These Lighting Columns or Masts have been identified as being present in Section.

Length for columns, etc [X]

Length is length measured parallel with carriageway. If row, put in length of row. If single column, put in dia. of column stem.

Verge assessed	N/S Verge	Start Chainage of Section	60000.0	End Chainage of Section	103000.0

Length? Offset of hazard from Psb?

Local Site Features

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from P_{sb}	Height / Depth of Feature	Aggressiveness	Local
1300.0001	Single lighting column	60120.0	0.19	0.19	1.50	10m to 15m high	1.70	Go
1300.0002	Row of lighting columns < 40m apart	60370.0	90.00	0.19	1.50	10m to 15m high	1.70	Aver
1300.0003	Single lighting column (passively safe)	61120.0	0.19	0.19	1.80	10m to 15m high	0.25	Po
1300.0004	Electricity supply cabinet	61370.0	2.00	0.40	1.80	<10m high	2.00	Go

500 Drainage | 600 Earthworks | 1100 Kerbs | 1200 Traffic Signs | 1300 Lighting Columns | 1500 M'way Comms | 1600 Retaining Walls | 1700-220

Ready

Drop down menu for Nature of Hazard

Single catenary lighting column
Row of catenary lighting columns < 40m apart
Single catenary lighting column (passively safe)
Row of catenary lighting columns (passively safe) < 40m apart
Single lighting column
Row of lighting columns < 40m apart
Single lighting column (passively safe)
Row of lighting columns (passively safe)
Single high mast lighting column
Row of high mast lighting columns < 40 m apart
Electricity supply cabinet

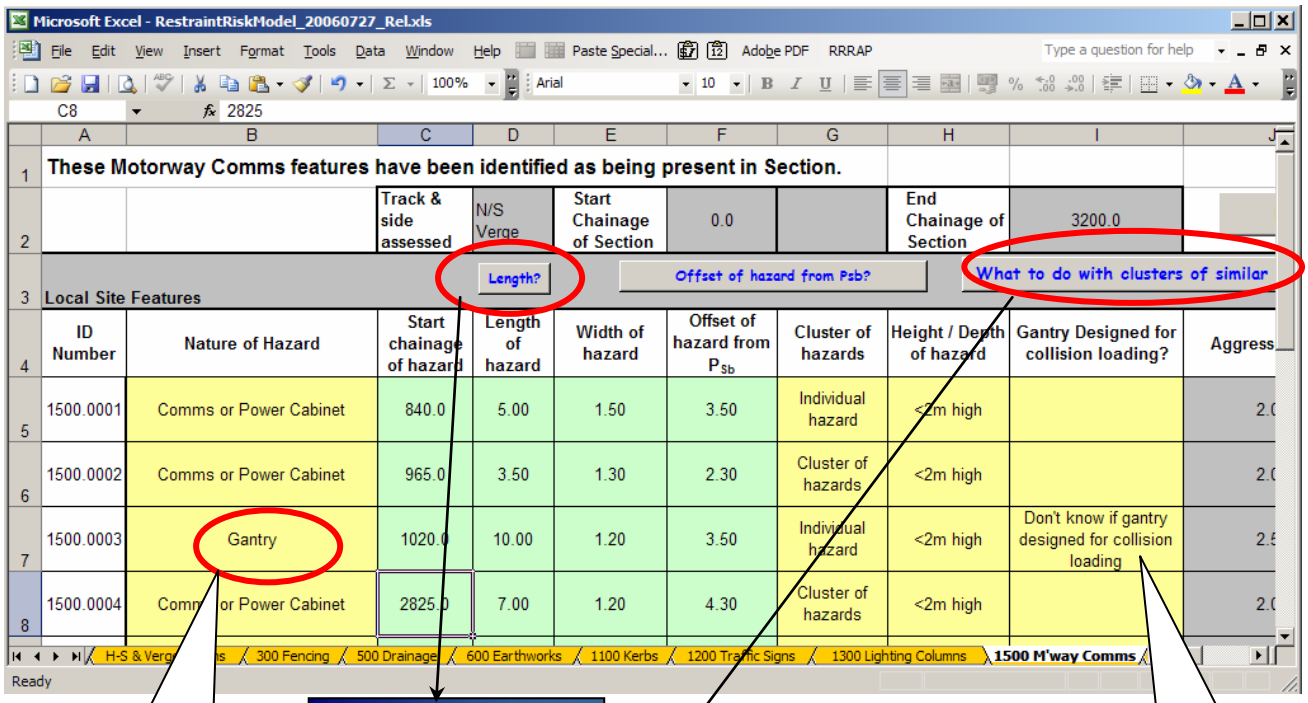
Passively safe columns may not require VRS protection on their own merit, but may be close to another hazard that may warrant protection or alter the cost benefit ratio in favour of protection of both hazards.

5.6.1 High Masts. A high mast is one that exceeds 18m in height.

5.6.2 Spacing of columns. Note that at present, the RRRAP assesses the risk of the first column in a row. It assumes that, if there is a need to protect it, then each column in the row will similarly need to be protected. The spacing of the columns is not currently taken into account. In practice, a line of closely spaced columns will in effect become akin to a continuous hazard and will therefore pose a greater risk than a widely spaced line which is more akin to a line of discrete hazards. It is intended that a future version of the RRRAP will automatically take account of the change in risk associated with the spacing. In the current version if there is a line of columns at broadly similar spacing or around 40 m, then enter as a row of columns, rather than enter each one separately.

5.6.3 Passively safe columns. There may be merit in considering the use of passively safe lighting columns, especially if the RRRAP indicates that a single column or row of columns requires VRS protection and that there is no other hazard within the length that warrants protection. It should be noted that not all locations are suitable for passively safe columns, e.g. where the column could fall onto another carriageway.

5.7 1500 Motorway Comms



Microsoft Excel - RestraintRiskModel_20060727_Rel.xls

These Motorway Comms features have been identified as being present in Section.

		Track & side assessed	N/S Verge	Start Chainage of Section	0.0		End Chainage of Section	3200.0	
			Length?		Offset of hazard from Psb?			What to do with clusters of similar	
Local Site Features									
ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from P_{sb}	Cluster of hazards	Height / Depth of hazard	Gantry Designed for collision loading?	Aggress
1500.0001	Comms or Power Cabinet	840.0	5.00	1.50	3.50	Individual hazard	<2m high		2.0
1500.0002	Comms or Power Cabinet	965.0	3.50	1.30	2.30	Cluster of hazards	<2m high		2.0
1500.0003	Gantry	1020.0	10.00	1.20	3.50	Individual hazard	<2m high	Don't know if gantry designed for collision loading	2.5
1500.0004	Comm or Power Cabinet	2825.0	7.00	1.20	4.30	Cluster of hazards	<2m high		2.0

H-S & Verg | 300 Fencing | 500 Drainage | 600 Earthworks | 1100 Kerbs | 1200 Traffic Signs | 1300 Lighting Columns | 1500 M'way Comms

Ready

See para 5.7.1 below for further information relating to Gantries.

Length of feature X

Length is length measured parallel with carriageway.

This entry will influence the containment level of the safety barrier. The designer must check that appropriate containment level is chosen. See TD 19 Figure 3-9 and para 5.7.2 below.

What to do with clusters of objects X

If you have a cluster of similar hazards within say 10 m or 15 m distance, treat as one hazard, the length of the cluster. Give the width as the width of the widest single hazard in the cluster, and the offset of the nearest of the hazards to Psb. Pick the hazard description that describes at least one of the hazards in the cluster and returns the highest aggressiveness of the possible descriptions for the hazards in the cluster.

Note that it is a cluster of features in 'Cluster of Objects?' column.

Aggressiveness of Comms Hazards X

The aggressiveness factor for communications equipment such as cabinets has been based on the hazard having no effect on Others. If the Designer considers that an item of equipment (or items in a cluster) would have a significant effect on for instance the safety of Others if it were to be out of action for a period, then the Aggressiveness factor should be increased accordingly.

Drop down menu for Nature of Hazard

Comms or CCTV Mast
Comms or Power Cabinet
Emergency Telephone
Gantry
Gantry (passively safe)
Posts
Posts (passively safe)
Steps
Transmission Station

The aggressiveness factor can be altered from its default value in the 'Collation of Data on Hazards' worksheet say to 2.5 to reflect the higher risk. If in doubt, it is better to protect than not protect. It the aggressiveness is altered, then the 'Calculate Risk' button will need to be pressed in order that the correct result is displayed.

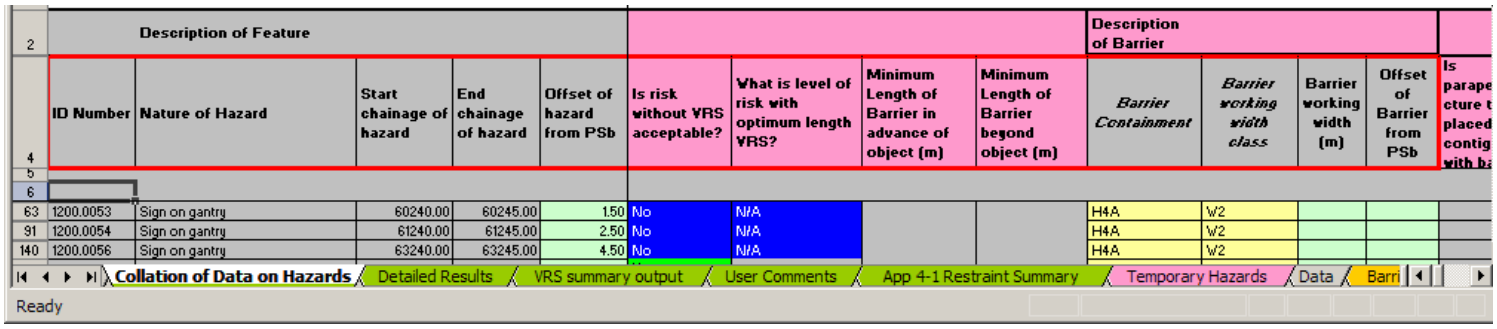
5.7.1 Results for Comms Cabinets and Equipment

The results for Communications (Comms) cabinets and equipment will indicate if risk from an errant vehicle hitting the hazard and whether a safety barrier is required to reduce this risk. A safety barrier may be provided where none is indicated or the containment increased if it is felt that there is an increased risk to any road workers maintaining the Comms cabinet or equipment or due to its effects on the Network if the Comms cabinet or equipment were damaged. These increased risks are not calculated within the programme and, if the provision is altered as a result, a note should be made in the 'User Comments' worksheet and cross referenced in the 'Comments' column of the 'VRS Summary Output' worksheet.

Designers also need to consider the working space required for maintenance workers working on the cabinets and equipment and the like. Ideally the cabinets and equipment should be located such that the working space around them as well as the cabinets and equipment lies fully beyond the working width of the safety barrier.

5.7.2 Results for Gantries

The output relating to Gantries and Gantry mounted signs in the 'Collation of Data on Hazards' worksheet will be as per the example shown below. Where the offset from Psb exceeds 4.5 m an N2 containment level will be returned, otherwise H4a. The Designer must check the requirements of TD 19 figure 3-9 , and adjust the Barrier Containment level in the 'Collation of Data on Hazards' worksheet accordingly to ensure that the mandatory requirements of the TD are met.



	Description of Feature									Description of Barrier				
4	ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet structure t placed contig with ba
63	1200.0053	Sign on gantry	60240.00	60245.00	1.50	No	N/A			H4A	W2			
91	1200.0054	Sign on gantry	61240.00	61245.00	2.50	No	N/A			H4A	W2			
140	1200.0056	Sign on gantry	63240.00	63245.00	4.50	No	N/A			H4A	W2			

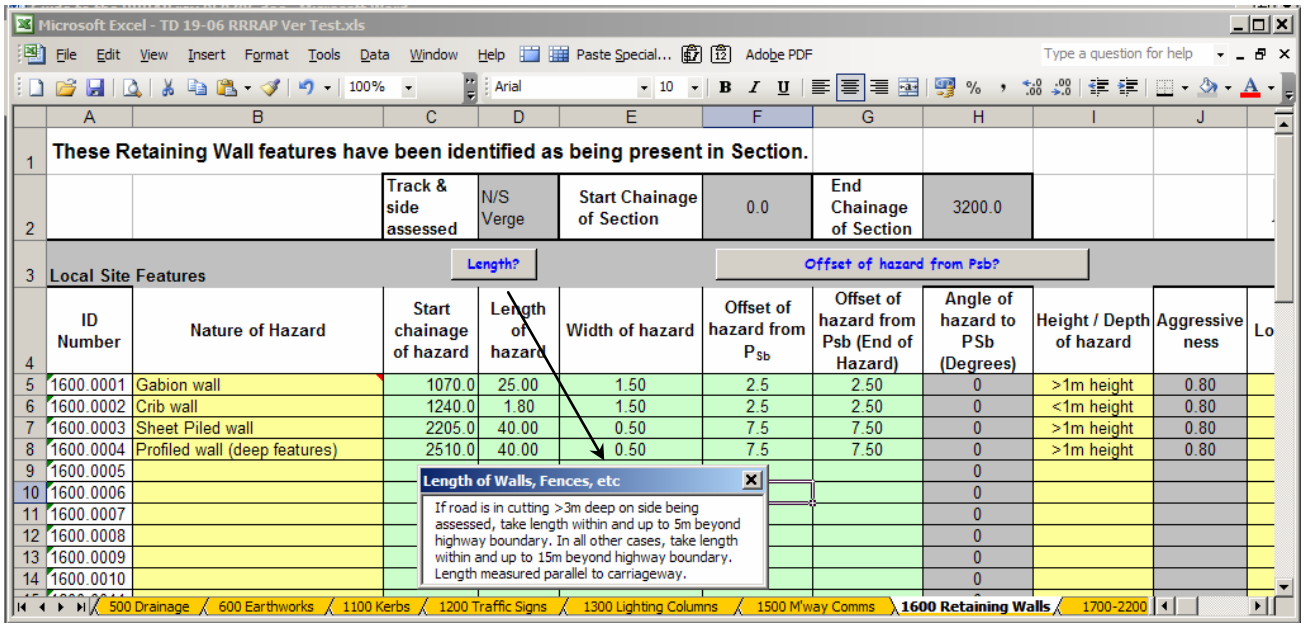
Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Temporary Hazards | Data | Barri

Ready

5.8 1600 Retaining Walls

The following are included under 1600 Retaining Walls: Sheet / Piled retaining walls; Brick / Stone retaining walls; Gabion walls; Crib walls; etc.

And under 2500 Special Structures the following: Corrugated buried structures; Reinforced soil structures; Reinforced clay / brick retaining walls; Dwarf retaining walls around e.g. services chambers, etc; Environmental barriers such as bunds and noise fences; etc.



Note the remaining part of this worksheet to the right of that shown is similar to that for Lighting Columns above.

Drop down menu for Nature of Hazard

Refer to TD 19 paragraph 3.12 for guidance on what constitutes a 'smooth' face.

Smooth faced wall
Profiled wall (shallow features)
Profiled wall (deep features)
Sheet Piled wall
Concrete Piled wall
Rough faced wall
Gabion wall
Crib wall

Vehicles hitting a wall are more likely to be snagged by features that are wide and deep than they are when the features are shallow. There are therefore differences in aggressiveness assigned to the various types of wall. The Designer should choose the description that best matches the type of wall.

Fig 5.8 -1 Crib Wall

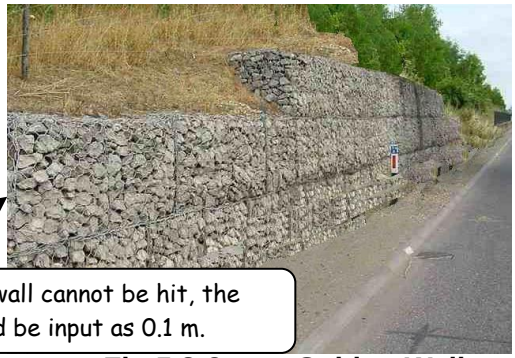


Fig 5.8-2 Gabion Wall

If the leading end of the wall cannot be hit, the width of the hazard should be input as 0.1 m.

In the case of a crib wall that is retaining a cutting slope, the RRRAP does not take into account the special requirements of BD 68 in respect of preventing vehicle collision with the face of the wall that might lead to the crib wall failure; it is only assessing the risk to vehicle occupants posed by impact with the crib wall.

Similarly, with gabion walls the RRRAP does not assess the likelihood or implications of the wall collapsing or maintenance requirements should it be impacted.

The designer should indicate his reasoning in respect of any decision made on VRS provision at such locations in the User Comments and VRS Summary worksheets.

A smooth faced wall over 1 m in height should not require safety barrier protection to prevent errant vehicles impacting the face of the wall and may be suitable as a vehicle restraint, but a safety barrier may be required to prevent errant vehicles from impacting the leading edge of the wall.

5.9 1700 - 400 Structures and Parapets

This includes parapets and pedestrian restraints, bridge abutments and piers and other structures. Note that the RRRAP will output containment levels for parapets including those over or adjacent to railways, but will not differentiate between new and existing situations nor location, e.g. if within Northern Ireland. The Designer must check RRRAP output against the requirements of TD 19 Chapter 4 to ensure correct provision.

Note that for existing parapets, the assessment should follow the IAN 97/07 procedure with the details and outcome of the assessment entered into the 'User Comments' worksheet of the RRRAP.

Can VRS be contiguous with Parapet or Structure?

Refer to TD 19/06
- Figures 3-8 and 3.10
- Paragraphs 3.30 to 3.33, 3.102 and 3.103, and 4.20.

Length of Structures, etc

Length of Structure is length measured parallel with carriageway. If abutment or pier is made up of row of columns or pillars, take overall length. If base of abutment or pier is > 0.25 m above adjacent ground level, take length of structure as length of base.

Parapet Width

Take nominal width of parapet to be 0.25 m regardless of parapet type.

If headroom is Substandard

substandard over any part of the paved carriageway (e.g. hardshoulder or hardstrip), over the verge or over the central reserve, then refer to Figures 3-8 and 3-10 in TD 19.

These Structural features have been identified

		Verge assessed	N/S Verge	Start Chainage of	15000.0	End Chainage of	150000.0			
	Local Site Features		Can VRS be contiguous?		Length?	Width?		? What is it protecting		What if headroom ? substandard
4	ID Number	Nature of Hazard	Is parapet/structure to be placed contiguously with barrier?	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from P_{ss}	Structure Carries / Parapet protecting	Protected ID	Substandard headroom over c'way, verge or ctres?
5	1700.0001	Parapet over vertical drop >2m	Yes	100072.0	43.0	0.25	1.75	Road Protected	8200.0001	Headroom adequate over all C'way
11	1700.0007	Parapet over vertical drop >2m	Yes	101750.0	85.0	0.25	1.75	Railway Protected	8100.0007	
12	1700.0008	Parapet over vertical drop >2m	Yes	101840.0	70.0	0.25	1.75	Road Protected	8200.0011	
13	1700.0009	Bridge Abutment - rough faced	No	66810.0	20.0	4.00	1.50	Bridleway or Farm Track carried		Bridleway or Farm Track carried
21	1700.0017	Bridge Abutment - smooth faced	no	15960.0	20.0	3.50	2.00	Waterway carried		Headroom adequate over all C'way
23	1700.0019	Parapet over vertical drop less than 2m	No	106320.0	40.0	0.25	3.00	Footway, Bridleway or Farm Track Protected		

600 Earthworks | 1100 Kerbs | 1200 Traffic Signs | 1300 Lighting Columns | 1500 M'way Comms | 1600 Retaining Walls | 1700-400 Structures - Parapets

Ready

Main Hazard(s) that Parapet is protecting?

Name from the drop-down list the major hazard or hazards of those that are present.

If the structure is a long one, there may be a number of different hazards from the drop down list that the parapet is protecting. If this is the case, then split the total length of the parapet into discrete sections, each section protecting the hazard listed, see Guidance Manual for more advice and

See below for more guidance

For a Parapet, offset is to the outside face of the Parapet or to the outside of the edge beam supporting the parapet, whichever is greater.

If the parapet is protecting a Road or a Railway, information about these hazards is entered in the appropriate 'Other Hazards' worksheet, and the correct ID is cross referenced in this worksheet. Note that other hazards, such as 'Substantially open land' and 'Culverts or Ditches', are not cross referenced in this way.

Drop down menu for Nature of Hazard

Parapet
Bridge Abutment - smooth faced
Bridge Abutment - rough faced
Bridge Pier
Other structure - smooth faced
Other structure - rough faced

Refer to TD 19 paragraph 3.12 for guidance on what constitutes a 'smooth' face.

Drop down menu for what the Parapet is protecting or Structure carries

Waterway e.g. Canal or River Protected
Culvert or Ditch Protected
Built up area or building Protected
Footway, Bridleway or Farm Track Protected
Railway Protected
Road Protected
Substantially open land Protected
Vertical drop over 2 m Protected

Bridleway or Farm Track carried
Footpath carried
Railway carried
Road carried
Services pipe carried
Waterway carried
Carrying other feature

5.9.1 Minimum length of VRS to prevent direct impact with approach end of parapet.
Note that there may be some situations where the RRRAP will indicate the containment level required for the parapet, but will show that the level of risk for the feature the parapet is protecting is acceptable without a VRS. A typical example would be where the parapet is protecting a vertical drop to a bridleway or small culvert. In such an instance the Designer should refer to Paragraph 3.30 of TD 19 and ensure appropriate provision of VRS to prevent direct impact with the end of the parapet.

5.9.2 Guidance on inputting data into worksheets for Parapets and Earthworks

The following figures identify how information relating to Parapets and to Earthworks are input into the respective worksheets.

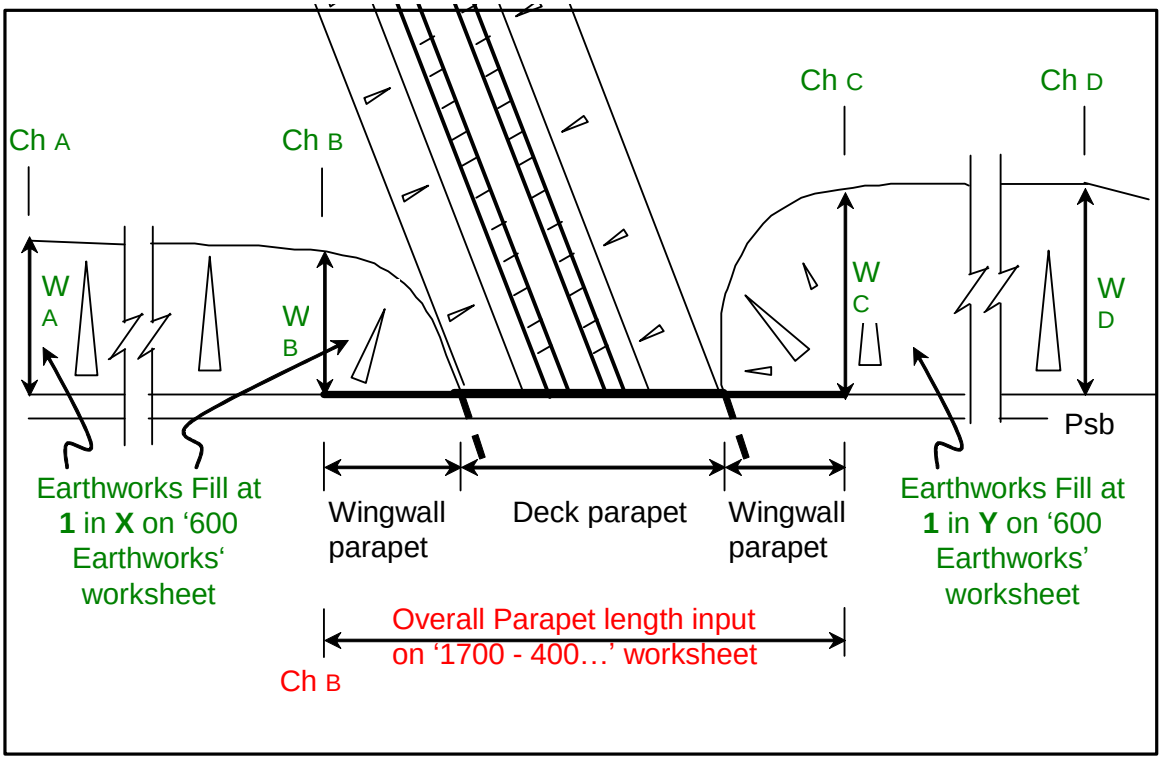


Figure 5.9 (a) Parapet and Earthworks Inputs at Underbridge with Parallel Wingwalls

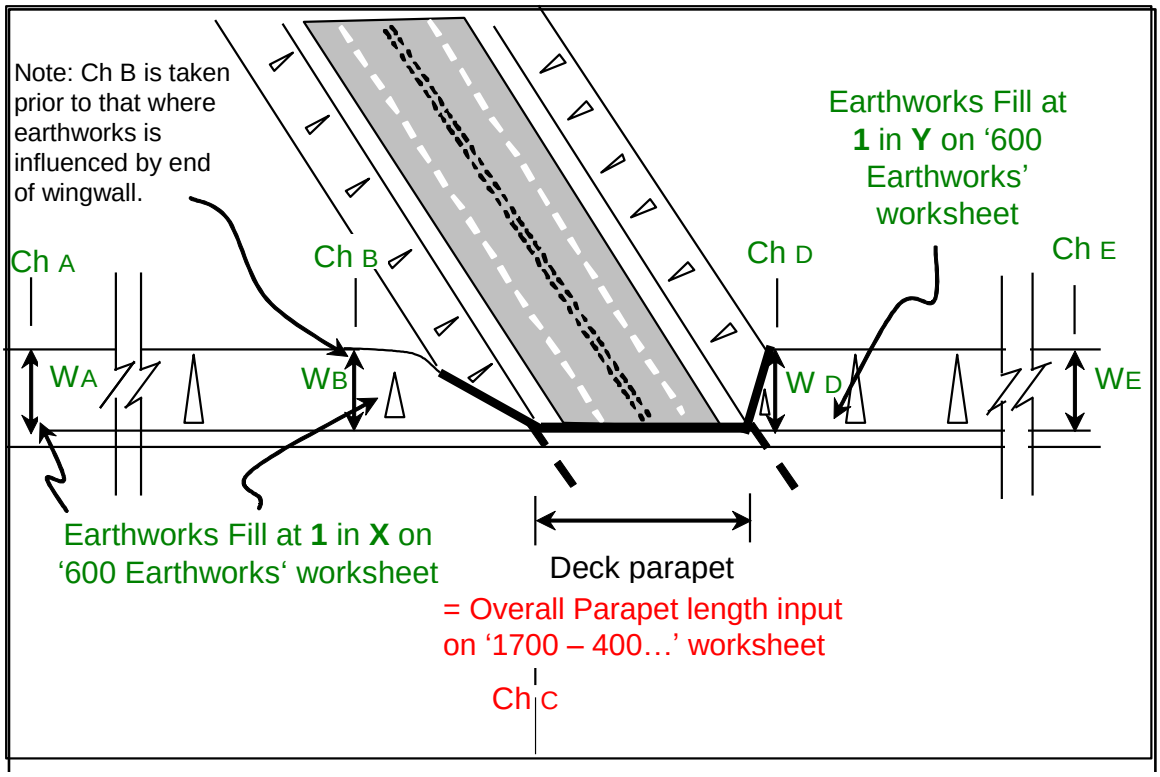


Figure 5.9 (b) Parapet and Earthworks Inputs at Underbridge with Splayed Wingwalls

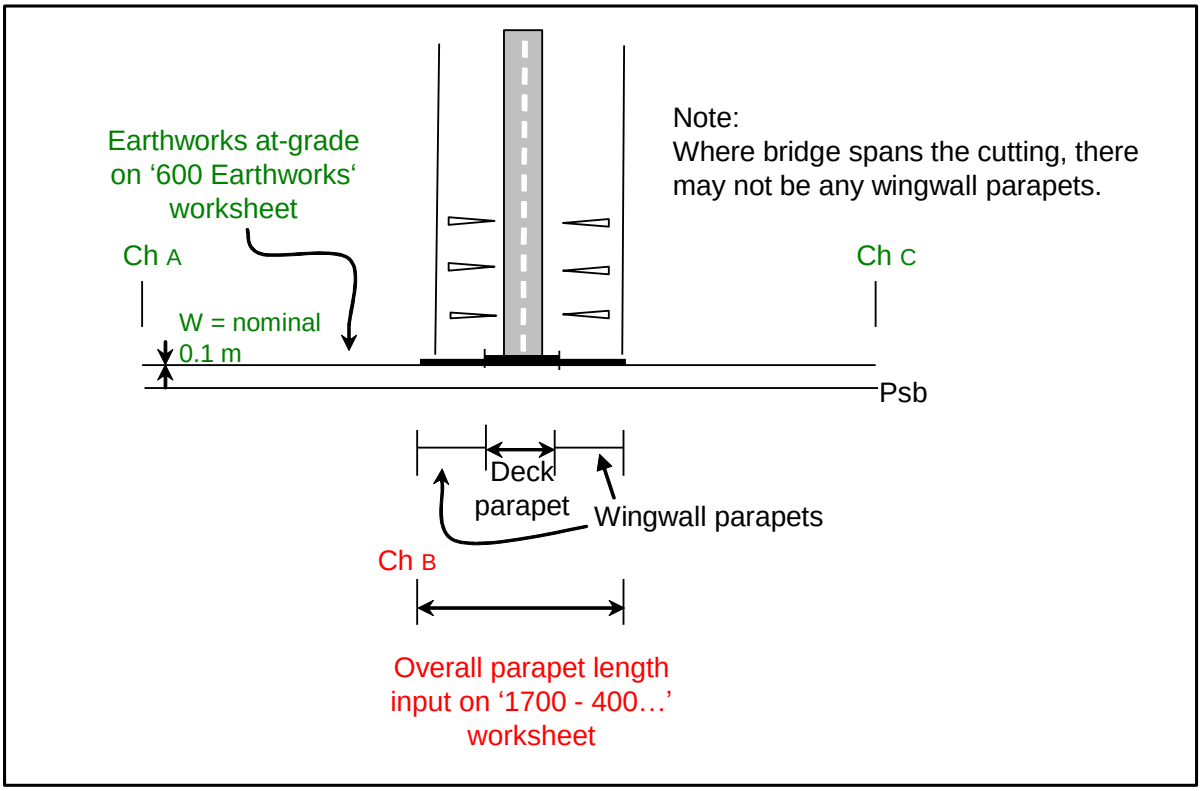


Figure 5.9 (c) - Parapet and Earthworks Inputs at Underbridge when road at-grade

5.9.3 Parapet details on a Viaduct or other long structure

If the structure is a long one, e.g. a viaduct, it is possible that it will span over one or more of the categories listed in the drop down menu. If this is the case, then the parapet should be split into sections to differentiate each, as indicated in Figure 5.9 (d), see also the following photograph by way of an example. The RRRAP will indicate the containment level required for each section of parapet. Remember to allow for transitions between parapets having different containment levels.

Note that only hazards that are high risk, namely roads, railways or built up areas are likely to require higher containment parapet (or higher containment safety barrier if placed in front of an existing low containment parapet). Due to the very varied factors that apply with built up areas, the RRRAP cannot calculate the containment level required and the Designer therefore must decide the appropriate level taking account of all the relevant circumstances.

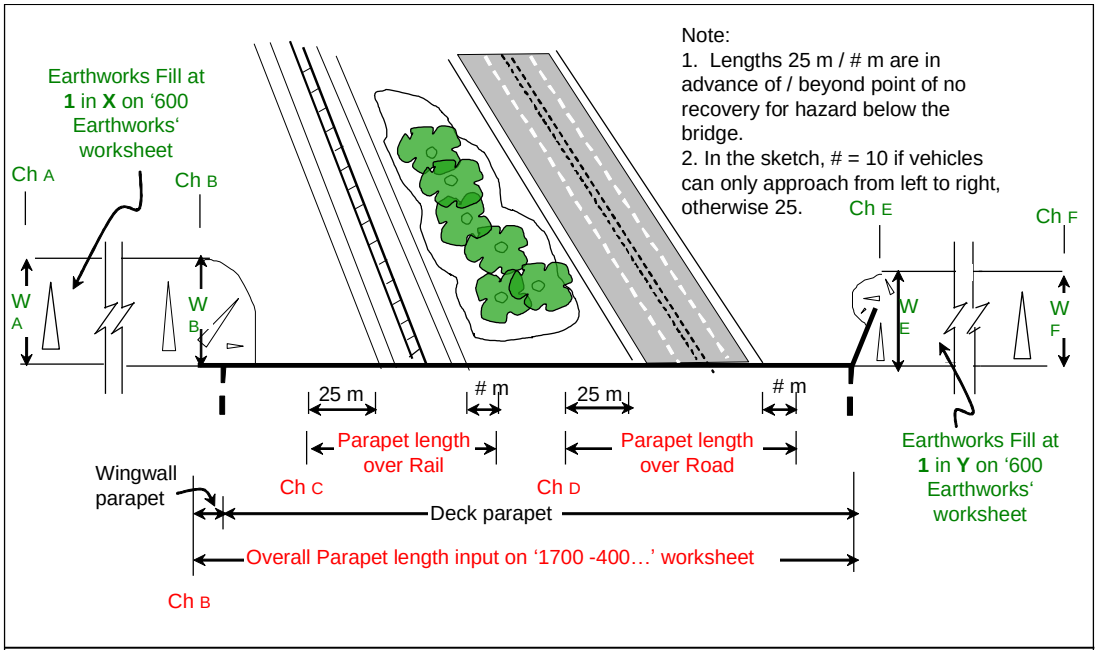
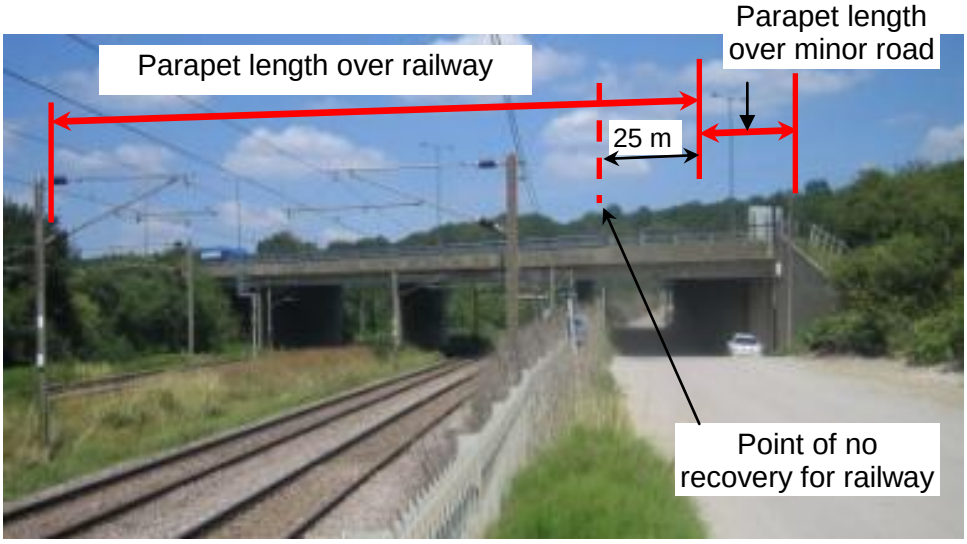


Figure 5.9 (d) - Parapet and Earthworks inputs on a Viaduct or other long structure



If the lengths in between P_{Rail} / P_{Road} / Parapet ends are relatively short, it may be impracticable to have different containment levels from that required at P_{Rail} and or P_{Road}. In

which case, the parapet having the higher of the two containment level requirements should be continued.

Similarly, in other instances, the length in advance of one section of parapet may overlap the length beyond the adjacent section.

There may be instances where, due to the local layout, either the length in advance and or the length beyond the point of no recovery would extend beyond the overall limit of the parapet. In this event, the actual end point of the respective parapet would be input in the RRRAP.

5.9.4 Note about how the RRRAP calculates Parapet risk

In the calculation process, the RRRAP programme assumes that a parapet is relatively close to the carriageway. This is normally the case for instance on a motorway bridge. However there are instances, e.g. with a culvert, where the vertical drop may be a significant distance from the carriageway. Entering a culvert as a 'Parapet with vertical drop < 2 m (or > 2 m)' will result in N2 containment regardless of how far from the carriageway the parapet and vertical drop are. Hence it is better to input culverts in the drainage worksheet (refer to Guidance para 5.2.5). There may be a need to install a pedestrian restraint system to prevent falls over the vertical edge.

5.9.5 Parapet Working Width

Designers should check and specify the greatest working width that meets the requirements of Paragraphs 4.14 and 4.15 of TD 19 which may be greater than the default of W2 that the RRRAP returns.

5.9.6 Pedestrian Restraints

Pedestrian Restraints may take the form of pedestrian parapets, pedestrian guardrails, or pedestrian protection in the form of post and rail fence. Pedestrian Restraints may in themselves not warrant vehicle restraint provision, however their presence is recorded as it may affect the nature and location of the vehicle restraint that is required to protect other hazards. Reference should also be made to TD 19 Para 9.5 regarding pedestrian guardrails.

5.9.7 Structural Collision Loading and Collapse.

Designers should check the requirements of IAN 91/07 'Advice on the identification of 'Particularly at Risk' Supports' when determining the appropriate containment level for the VRS at structures. The background to decisions made in respect of VRS provision should be included in the User Comments Worksheet.

5.9.8 Example layout and corresponding inputs for Earthworks, Parapet and Road and Rail

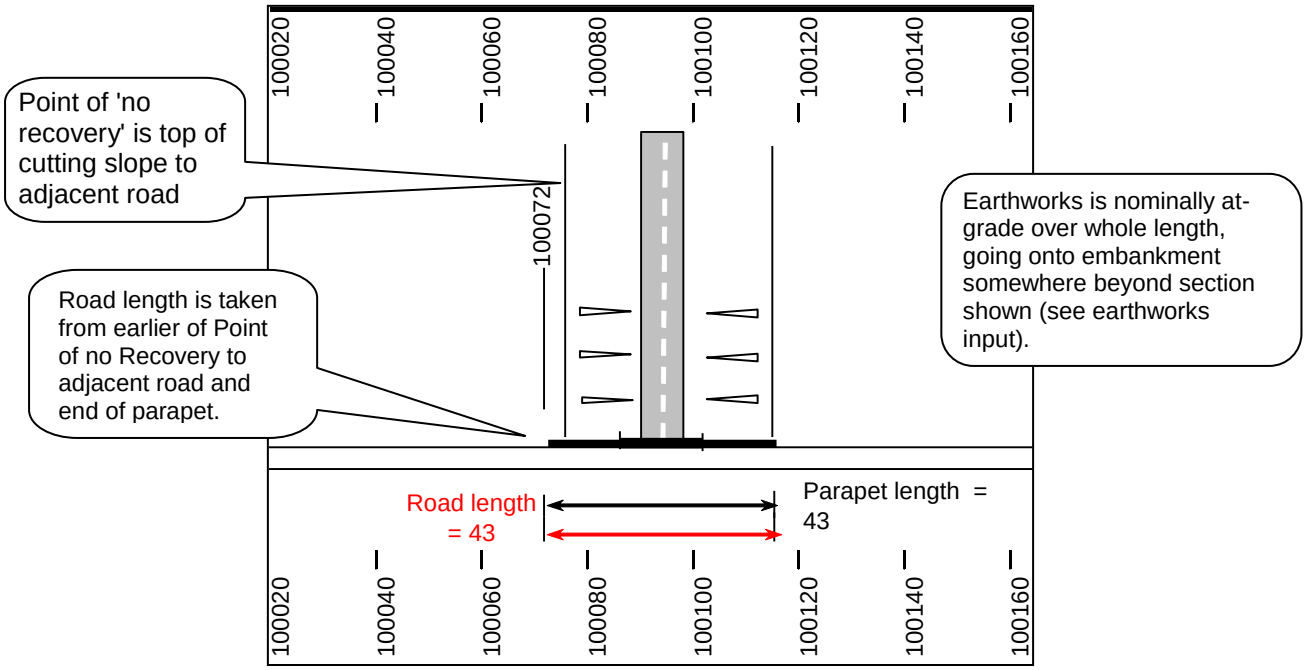


Figure 5.9 (e) Adjacent Road crossing at-grade and or at around 90°

EARTHWORKS

ID Number	Nature of Hazard	Start chainage of hazard	Width of slope	Offset of hazard from PSb	Overall Height slope	Overall width slope	Ave gradient of Slope % (+ve for cut, -ve for fill)
0600.0027	Nominally at Grade	100000.0	0.01	1.50	0.00	0.01	0.0%
0600.0028	Falling 1:2 or steeper	100296.0	0.01	1.50	-0.01	0.01	-50.0%

This entry row is for next section of earthworks (not shown in fig).

PARAPETS

ID Number	Nature of Hazard	Is parapet / structure to be placed contiguously with barrier?	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Structure Carries / Parapet protecting	Protected ID
1700.0001	Parapet over vertical drop >2m	Yes	100072.0	43.0	0.25	1.75	Road Protected	8200.0001

8200 – OH's ROADS INPUT

Check that these correlate correctly

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Offset of hazard from Psb (End of Hazard)	Angle of hazard to PSb (Degrees)
8200.0001	Adjacent Road Single	100072.0	43.0	50.00	1.75	1.75	90

Note that a copy of the output from this and the following examples relating to Figs 5.9 (e) to 5.9 (h) are shown at the end of this section.

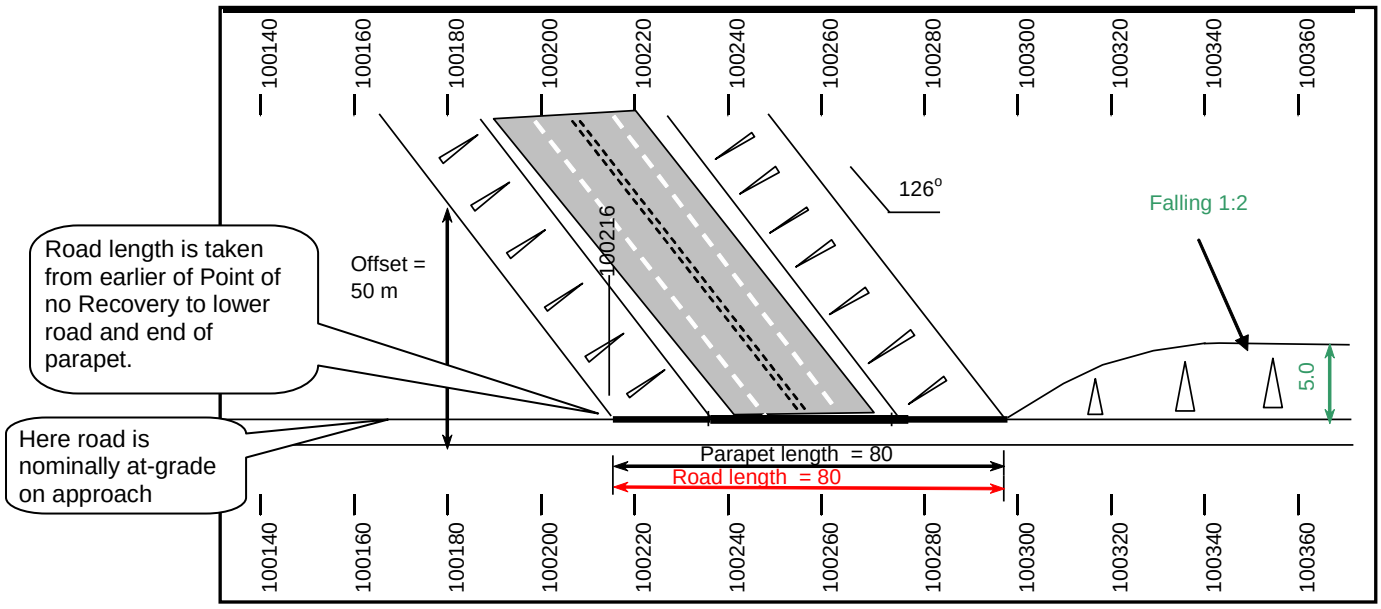


Figure 5.9 (f) Adjacent Road crossing under the road

Note that RRRAP is not overly sensitive to changes in angle, width and or offset in these situations, so no need to be too precise.

600 EARTHWORKS INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Width of slope	Offset of hazard from PSb	Overall Height slope	Overall width slope	Ave gradient of Slope % (+ve for cut, -ve for fill)
0600.0027	Nominally at Grade	100000.0	0.01	1.50	0.00	0.01	0.0%
0600.0028	Falling 1:2 or steeper	100296.0	0.01	1.50	-0.01	0.01	-50.0%
0600.0029	Falling 1:2 or steeper	100340.0	5.00	1.50	-2.50	5.00	-50.0%

Here the start of section that is falling is picked up

1700-400 PARAPETS INPUT

ID Number	Nature of Hazard	Is parapet / structure to be placed contiguously with barrier?	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Structure Carries / Parapet protecting	Protected ID
1700.0002	Parapet over vertical drop >2m	Yes	100216.0	80.0	0.25	1.75	Road Protected	8200.0003

Check that these correlate correctly

8200 OH's - ROADS INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Offset of hazard from Psb (End of Hazard)	Angle of hazard to P (Degrees)
8200.0002	Adjacent Road D2AP	100180.0	36.0	50.00	50.00	1.75	126
8200.0003	Adjacent Road D2AP	100216.0	80.0	50.00	1.75	1.75	126

Refer to Adjacent Road help button on worksheet for details of how measurements are determined.

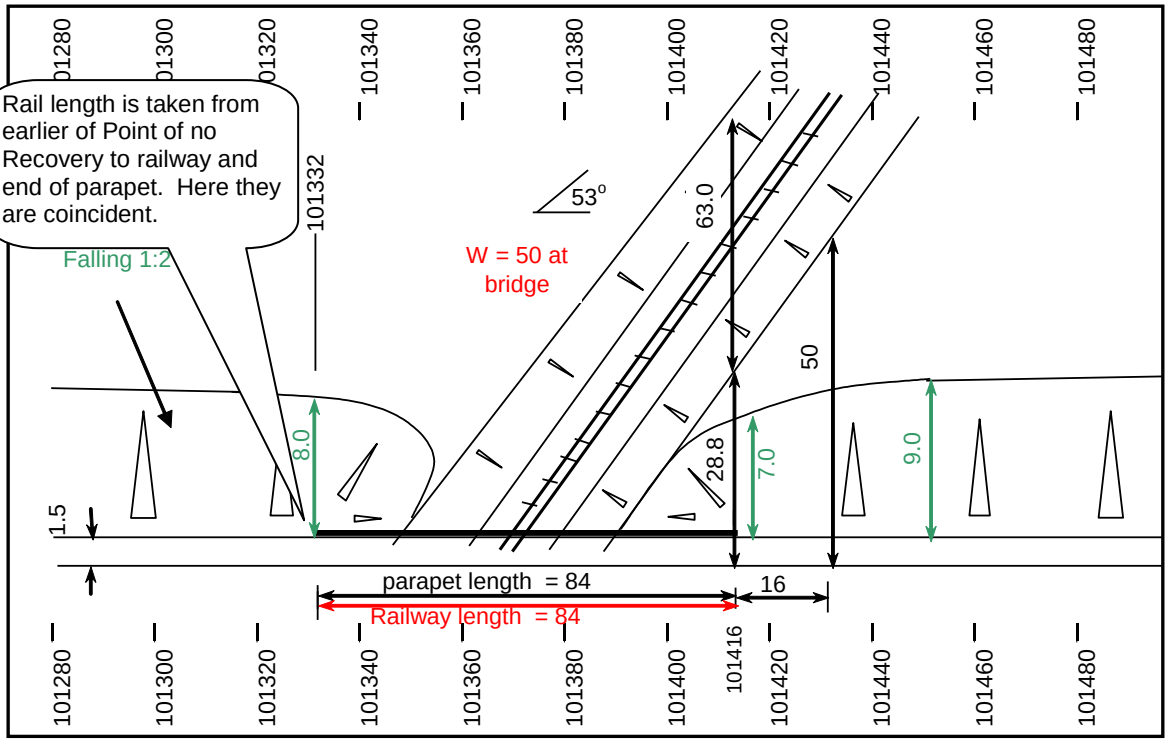


Figure 5.9 (g) Adjacent Railway crossing under Road

600 EARTHWORKS INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Width of slope	Offset of hazard from PSb	Overall Height slope	Overall width slope	Ave gradient of Slope % (+ve for cut, -ve for fill)
0600.0038	Falling 1:2 or steeper	101244.0	11.00	1.50	-5.50	11.00	-50.0%
0600.0039	Falling 1:2 or steeper	101332.0	8.00	1.50	-4.00	8.00	-50.0%
0600.0040	Falling 1:2 or steeper	101416.0	7.00	1.50	-3.50	7.00	-50.0%
0600.0041	Falling 1:2 or steeper	101452.0	9.00	1.50	-4.50	9.00	-50.0%
0600.0042	Falling 1:2 or steeper	101719.0	9.00	1.50	-9.00	9.00	-100.0%

1700 – 400 PARAPETS INPUT

ID Number	Nature of Hazard	Is parapet/structure to be placed contiguously with barrier?	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Structure Carries / Parapet protecting	Protected ID
1700.0005	Parapet over vertical drop >2m	Yes	101332.0	84.0	0.25	1.75	Railway Protected	8100.0003

8100 OH's - RAILWAY INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Offset of hazard from Psb (End of Hazard)	Angle of hazard to PSb (Degrees)
8100.0003	Railway	101332.0	84.0	50.00	1.75	1.75	53
8100.0004	Railway	101416.0	16.0	63.00	28.80	50.00	53

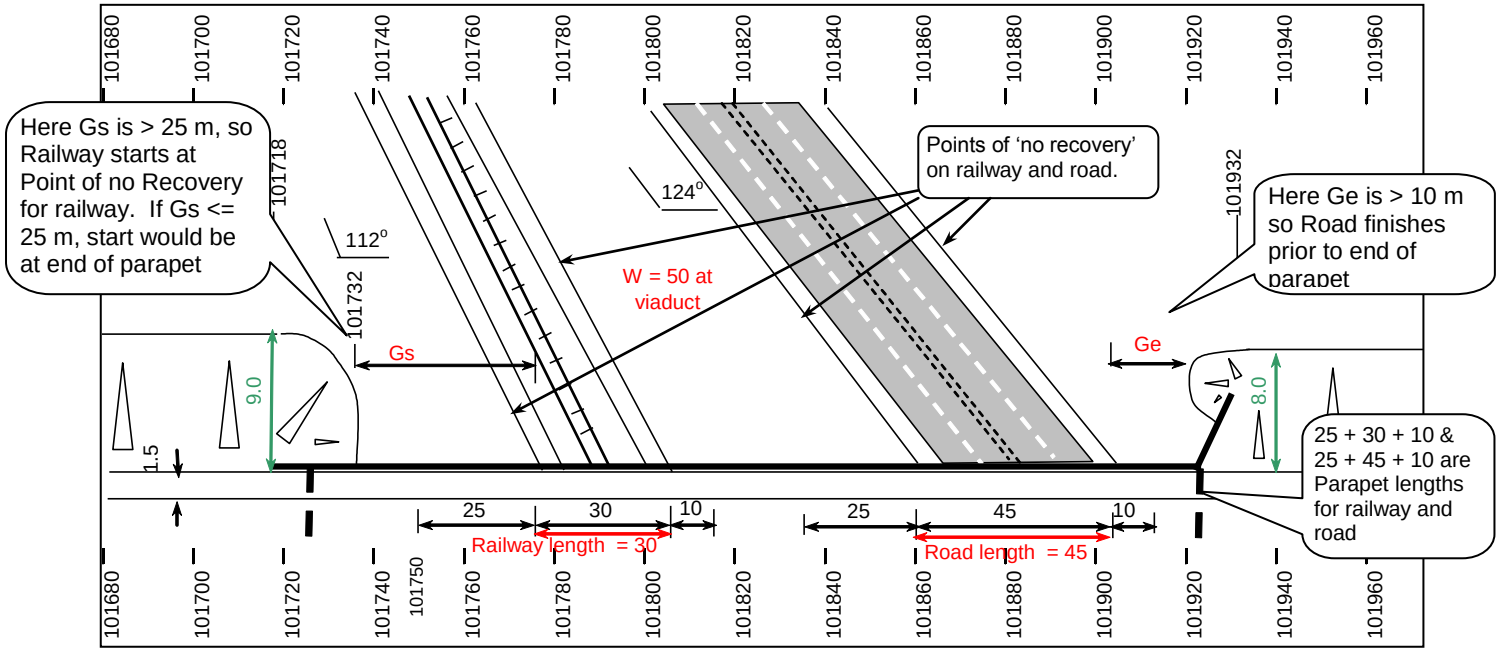


Figure 5.9 (h) Adjacent Railway and Road crossing under Viaduct

600 EARTHWORKS INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Width of slope	Offset of hazard from PSb	Overall Height slope	Overall width slope	Ave gradient of Slope % (+ve for cut, -ve for fill)
0600.0041	Falling 1:2 or steeper	101452.0	9.00	1.50	-4.50	9.00	-50.0%
0600.0042	Falling 1:2 or steeper	101718.0	9.00	1.50	-9.00	9.00	
0600.0043	Falling 1:2 or steeper	101940.0	8.00	1.50	-4.00	8.00	
0600.0044	Falling 1:1.5 or steeper	102096.0	8.00	1.50	-4.00	8.00	

Offset is to the outside face of the Parapet or to the outside of the edge beam supporting the parapet, whichever is greater.

1700 – 400 PARAPETS INPUT

ID Number	Nature of Hazard	Is parapet / structure to be placed contiguously with barrier?	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Structure Carries / Parapet protecting	Protected ID
1700.0006	Parapet over vertical drop >2m	Yes	101718.0	214.0	0.25	1.75	Substantially open land Protected	
1700.0007	Parapet over vertical drop >2m	Yes	101750.0	65.0	0.25	1.75	Railway Protected	8100.0007
1700.0008	Parapet over vertical drop >2m	Yes	101840.0	80.0	0.25	1.75	Road Protected	8200.0011

8100 OH's RAILWAY INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Offset of hazard from Psb (End of Hazard)	Angle of hazard to PSb (Degrees)
8100.0007	Railway	101775.0	30.0	50.00	1.75	1.75	112

Check that these correlate correctly

8200 ROAD INPUT

ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from PSb	Offset of hazard from Psb (End of Hazard)	Angle of hazard to PSb (Degrees)
8200.0011	Adjacent Road D2AP	101860.0	45.0	50.00	1.75	1.75	124

The length beyond only populates if there is 2 way flow on the road under consideration. Refer to Table 3-1 in TD 19/06 for min requirements.

Description of Feature									Description of Barrier					
ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet / structure to be placed contiguously with barrier?	Parapet Containment
0600.0027	Nominally at Grade	100000.00	100296.00	1.50	Yes									
1700.0001	Parapet over road	100072.00	100115.00	1.75								1.75	Yes	N2
8200.0001	Adjacent Road Single	100072.00	100115.00	1.75	No	Acceptable	54.0		N2	W2	0.80	0.60		
8200.0002	Adjacent Road D2AP	100180.00	100216.00	50.00	Yes									
1700.0002	Parapet over road	100216.00	100296.00	1.75								1.75	Yes	H1
8200.0003	Adjacent Road D2AP	100216.00	100296.00	1.75	No	Acceptable	67.0		N2	W2	0.80	0.60		
0600.0028	Falling 1:2 or steeper	100296.00	100340.00	1.50	Yes									
0600.0029	Falling 1:2 or steeper	100340.00	100416.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
0600.0038	Falling 1:2 or steeper	101244.00	101332.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
0600.0039	Falling 1:2 or steeper	101332.00	101416.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
1700.0005	Parapet over railway	101332.00	101416.00	1.75								1.75	Yes	N2
8100.0003	Railway	101332.00	101416.00	1.75	No	Acceptable	39.0		N2	W2	0.80	0.60		
0600.0040	Falling 1:2 or steeper	101416.00	101452.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
8100.0004	Railway	101416.00	101432.00	28.80	Yes									
0600.0041	Falling 1:2 or steeper	101452.00	101718.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
0600.0042	Falling 1:2 or steeper	101718.00	101940.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		
1700.0006	Parapet over vertical drop >2m	101718.00	101932.00	1.75								1.75	Yes	N2
1700.0007	Parapet over railway	101750.00	101815.00	1.75								1.75	Yes	N2
8100.0007	Railway	101775.00	101805.00	1.75	No	Acceptable	55.0		N2	W2	0.80	0.60		
1700.0008	Parapet over road	101840.00	101920.00	1.75								1.75	Yes	H1
8200.0011	Adjacent Road D2AP	101860.00	101905.00	1.75	No	Acceptable	72.0		N2	W2	0.80	0.60		
0600.0043	Falling 1:2 or steeper	101940.00	102368.00	1.50	No	Acceptable	10.0		N2	W2	0.80	0.60		

Requirements for single c'way situation in Fig 5.9 (e)

Requirements for dual c'way situation in Fig 5.9 (f)

Approach and departure embankment requires VRS

Requirements for single track railway situation in Fig 5.9 (g). But see TD 19/06 req'ments

Approach embankment requires VRS

Requirements for single track railway and dual c'way road situation in Fig 5.9 (h). But see TD 19/06 req'ments relating to railways

Departure embankment requires VRS

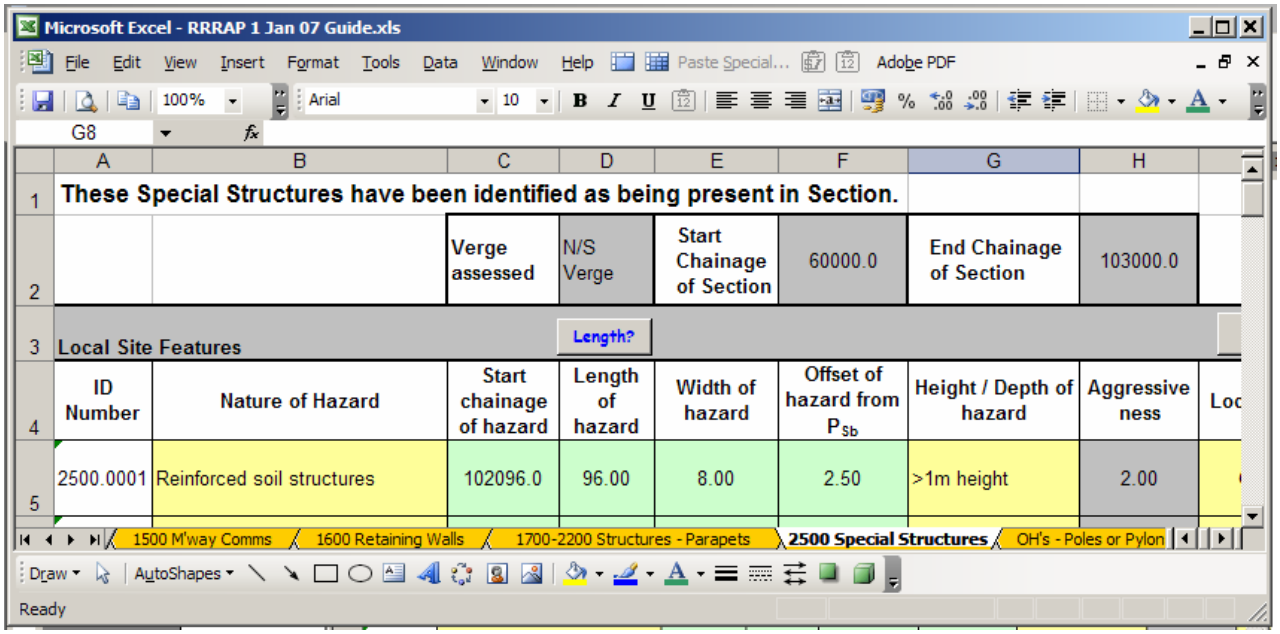
The requirements for road and railway approaches and parapet containment obviously depended on the factors that were input relating to likelihood of reaching road or railway, flow speeds and flow rates on the road and railway, as well as the AADT and % LGV and MGV and road type etc on the road being considered. These inputs are not shown here.

Fig 5.9 (i) Extract from Collation of Data relating to the situations shown in Figs 5.9 (e) to 5.9 (h)

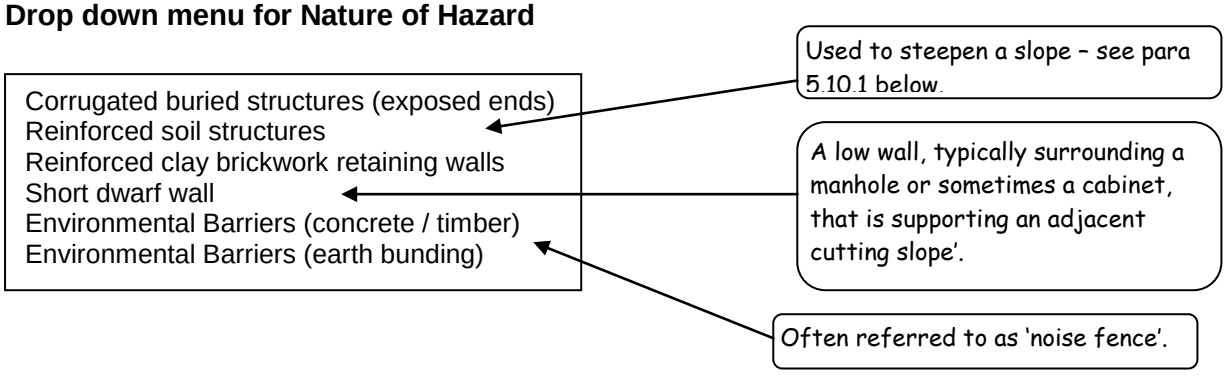
ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Parapet Containment	Barrier working width (m)	Offset of Barrier from PSb	Comments
1700.0001	Parapet over road	100072.00	100115.00	1.75					N2		1.75	
8200.0001	Adjacent Road Single	100072.00	100115.00	1.75	54.0		N2	W2		0.80	0.60	
1700.0002	Parapet over road	100216.00	100296.00	1.75					H1		1.75	
8200.0003	Adjacent Road D2AP	100216.00	100296.00	1.75	67.0		N2	W2		0.80	0.60	
0600.0029	Falling 1:2 or steeper	100340.00	100416.00	1.50	10.0		N2	W2		0.80	0.60	
0600.0038	Falling 1:2 or steeper	101244.00	101332.00	1.50	10.0		N2	W2		0.80	0.60	
0600.0039	Falling 1:2 or steeper	101332.00	101416.00	1.50	10.0		N2	W2		0.80	0.60	
1700.0005	Parapet over railway	101332.00	101416.00	1.75					N2		1.75	
8100.0003	Railway	101332.00	101416.00	1.75	39.0		N2	W2		0.80	0.60	
0600.0040	Falling 1:2 or steeper	101416.00	101452.00	1.50	10.0		N2	W2		0.80	0.60	
0600.0041	Falling 1:2 or steeper	101452.00	101718.00	1.50	10.0		N2	W2		0.80	0.60	
0600.0042	Falling 1:2 or steeper	101718.00	101940.00	1.50	10.0		N2	W2		0.80	0.60	
1700.0006	Parapet over vertical drop >2m	101718.00	101932.00	1.75					N2		1.75	
1700.0007	Parapet over railway	101750.00	101815.00	1.75					N2		1.75	
8100.0007	Railway	101775.00	101805.00	1.75	55.0		N2	W2		0.80	0.60	
1700.0008	Parapet over road	101840.00	101920.00	1.75					H1		1.75	
8200.0011	Adjacent Road D2AP	101860.00	101905.00	1.75	72.0		N2	W2		0.80	0.60	
0600.0043	Falling 1:2 or steeper	101940.00	102368.00	1.50	10.0		N2	W2		0.80	0.60	

Fig 5.9 (j) Extract from VRS Summary relating to the situations shown in Figs 5.9 (e) to 5.9 (h)

5.10 2500 Special Structures



Drop down menu for Nature of Hazard



5.10.1 Reinforced soil slopes.

Where there is a section of earthworks where the slope has been steepened by use of reinforced soil techniques, there are two ways of inputting the information into the RRRAP depending upon the circumstances.

(i) If the reinforcing is over a relatively long length of carriageway, then it is best to input the slope information in the '600 Earthworks' worksheet. Select the slope gradient banding from the drop down based on the gradient of the steepened part of the slope. The overall width and height of the slope are entered in the normal way. There is no entry in the 2500 Special Structures worksheet.

(ii) If the reinforcing is only over a relatively short length, say 50 m, e.g. where the cutting or embankment locally steepened due to land-take difficulties, it may be easiest to assume the earthworks continues past the strengthened section at its normal gradient (i.e. that the strengthening is not there) and enter the earthworks information into the '600 Earthworks' worksheet, and then to add the details for the strengthened length into the 2500 Special Structures section.

The following drawing illustrates the situation.

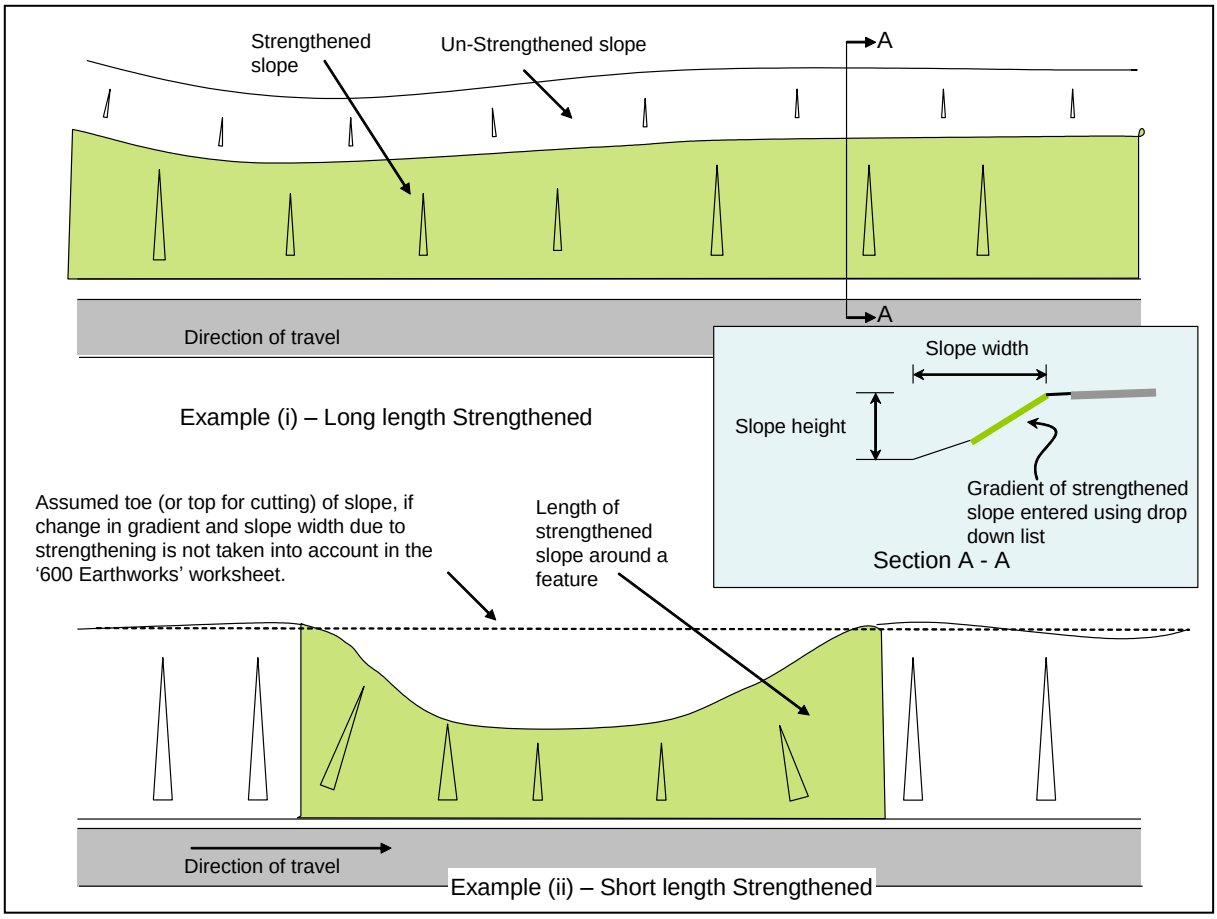
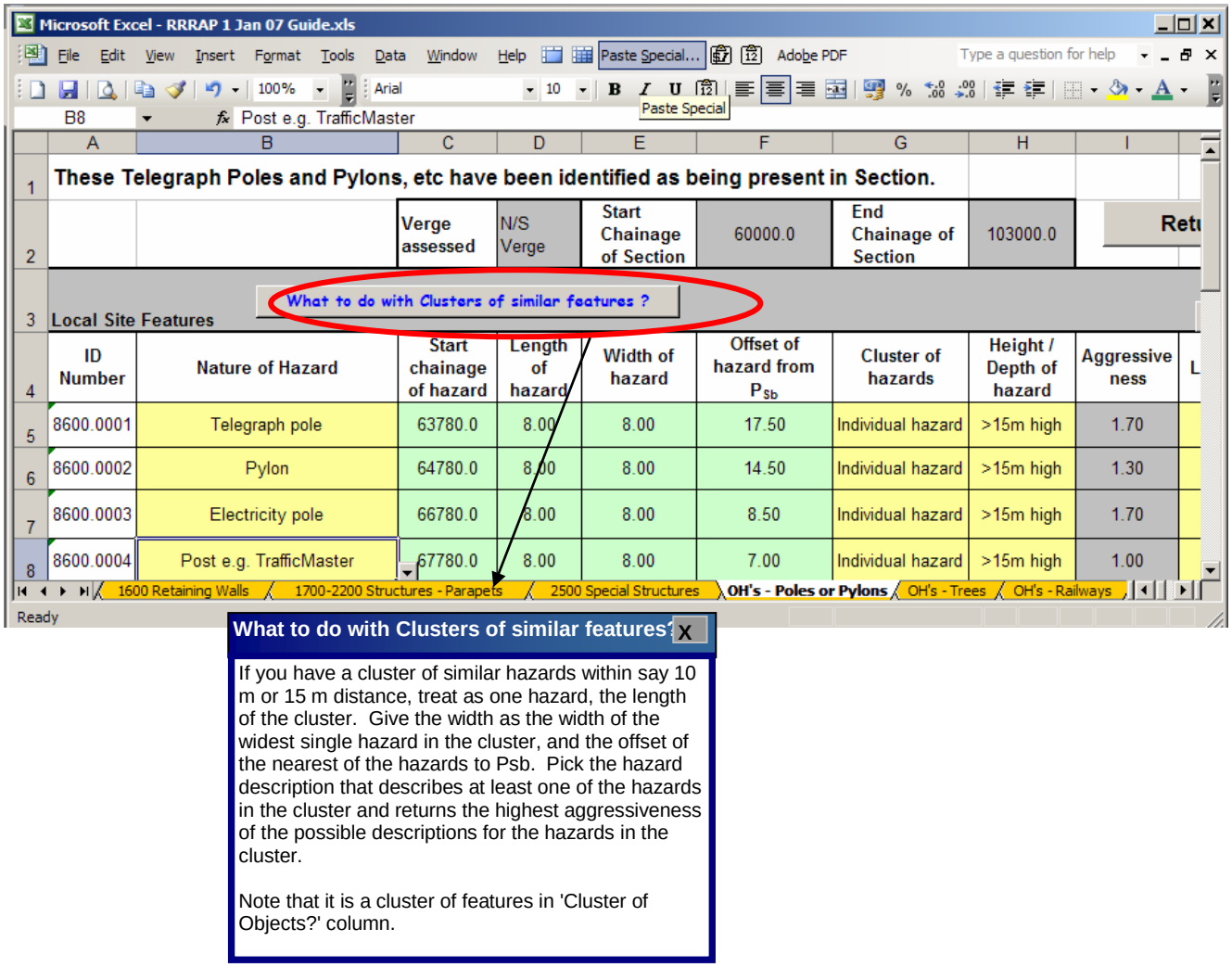


Figure 5.10 (a) Strengthened Slopes

5.11 Poles or Pylons



What to do with Clusters of similar features?

If you have a cluster of similar hazards within say 10 m or 15 m distance, treat as one hazard, the length of the cluster. Give the width as the width of the widest single hazard in the cluster, and the offset of the nearest of the hazards to Psb. Pick the hazard description that describes at least one of the hazards in the cluster and returns the highest aggressiveness of the possible descriptions for the hazards in the cluster.

Note that it is a cluster of features in 'Cluster of Objects?' column.

Note the remaining part of this worksheet to the right of that shown is similar to that for Lighting Columns above.

Drop down menu for Nature of Hazard

Telegraph pole
Pylon
Electricity pole
Post e.g. Traffic Master

5.11.1 Utility Poles with cable stays

A typical cable stay will not break when struck by a vehicle moving at moderate speeds. Unless the ground anchor fixing is weak and fails, or there is a frangible connection between the stay and anchor or stay and pole, the pole itself will normally fail before the stay. If the ground anchor and connections hold, which is likely, the pole will be either pulled directly toward the vehicle or the tensioned cable stay will slice through the vehicle, or there will be a combination of the two actions. This creates a serious potential for injury to the vehicle's occupants.

With this in mind, the cable stay should be entered as a pole in the RRRAP, with the offset being to the anchor position and the width / length being to where 1.5 m height clearance is

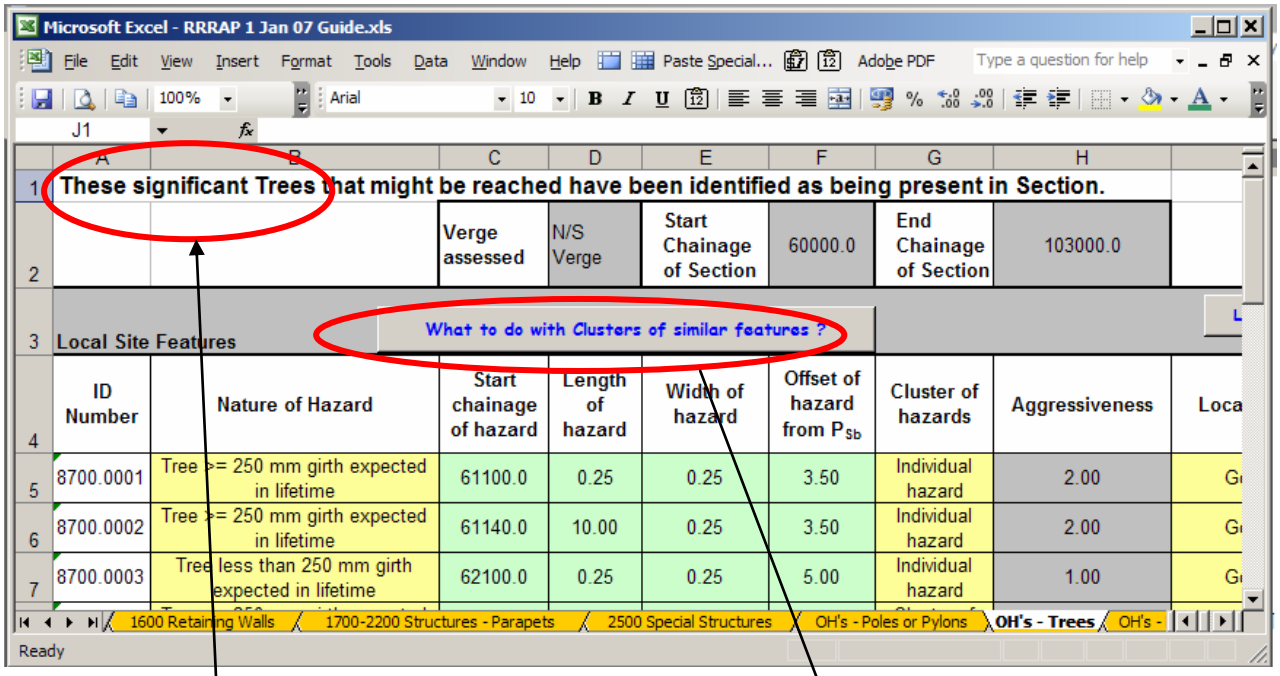
reached. The pole itself should be entered as a separate hazard. A note should be added in the User Comments worksheet to explain that in this instance it is the stay rather than the pole that is the nearer hazard. The stay may require a longer length of VRS in advance than would a pole at the same offset, this will be due to the greater width of hazard.

If the pole itself at its current offset does not warrant protection, but the stay does, and there is no other requirement for safety barrier, it would be worthwhile investigating the possibility of installing a frangible connection to the stay or seeing if the stay itself could be moved so as not to pose a hazard. If a frangible stay connection is put in place, then the stay will not be classed as a hazard (the pole will remain a hazard) and a note should go in the User Comments worksheet to explain that the stay has a frangible connection.

5.11.2 Pylons

The RRRAP will indicate whether the pylons require protection but, as there is no easy way of automatically estimating or calculating the risk to Others e.g. if pylon and or cables were to fall, it will not be able to calculate whether normal containment level N2 is sufficient. The Designer should therefore consider all the circumstances and decide whether a higher containment level H1 safety barrier is warranted. Details of the factors considered and the decision process should be entered in the User Comments worksheet and the VRS Summary accordingly.

5.12 Trees



The important thing is to identify the significant trees / tree features that are currently or may in the future pose a hazard. Areas of planting can be picked up as a cluster.

What to do with Clusters of similar objects X

If you have a cluster of similar hazards within say 10 m or 15 m distance, treat as one hazard, the length of the cluster. Give the width as the width of the widest single hazard in the cluster, and the offset of the nearest of the hazards to Psb. Pick the hazard description that describes at least one of the hazards in the cluster and returns the highest aggressiveness of the possible descriptions for the hazards in the cluster.

Note that it is a cluster of features in 'Cluster of Objects?' column.

Drop down menu for Nature of Hazard

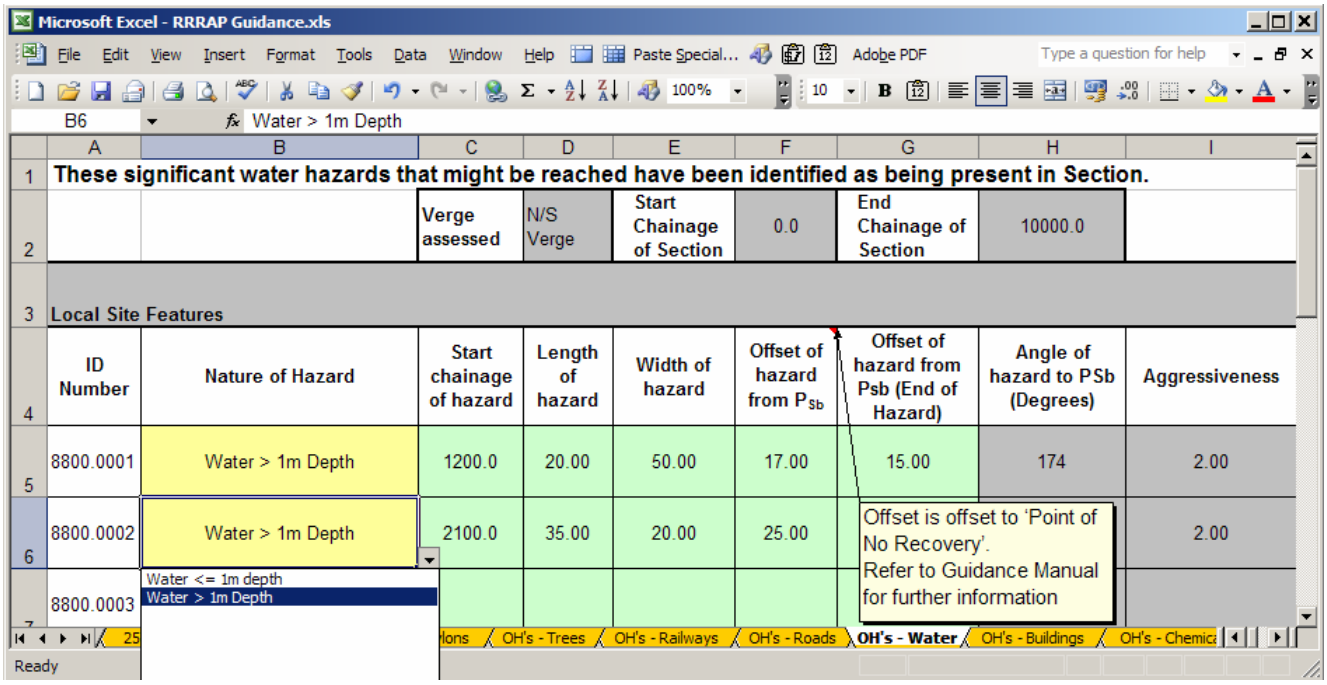
Tree >= 250 mm girth expected in lifetime
Tree less than 250 mm girth expected in lifetime

If the tree or trees may grow to more than 250 mm in life, then it must be entered as Tree >= 250mm girth. If in doubt, assume it will.

Drop downs are given for trees that are both greater and less than 250 mm in girth. This is to allow clusters or groups of trees that are individually less than 250 mm girth expected in life of tree to be input, because as a group, they may present a sufficient hazard to warrant protection.

Hedges are not normally considered a hazard and there is no need to input details. However, the Designer should take note that there may be individual trees within the hedgerow that could pose a significant hazard to an errant vehicle, often these trees are relatively isolated within the length. Such trees should be entered into the RRRAP as individual trees of the appropriate size and offset, (as a cluster if close together).

5.13 Water



5.13.1 Include standing, running and tidal water hazards. Water hazards have been split into depth ranges as indicated above. Water that is not expected to exceed 250 mm in depth at any time need not be considered, unless it is close to the running lane and is considered likely to lead to skidding or aquaplaning of an errant vehicle.

5.13.2 Point of No Recovery for Water situations.

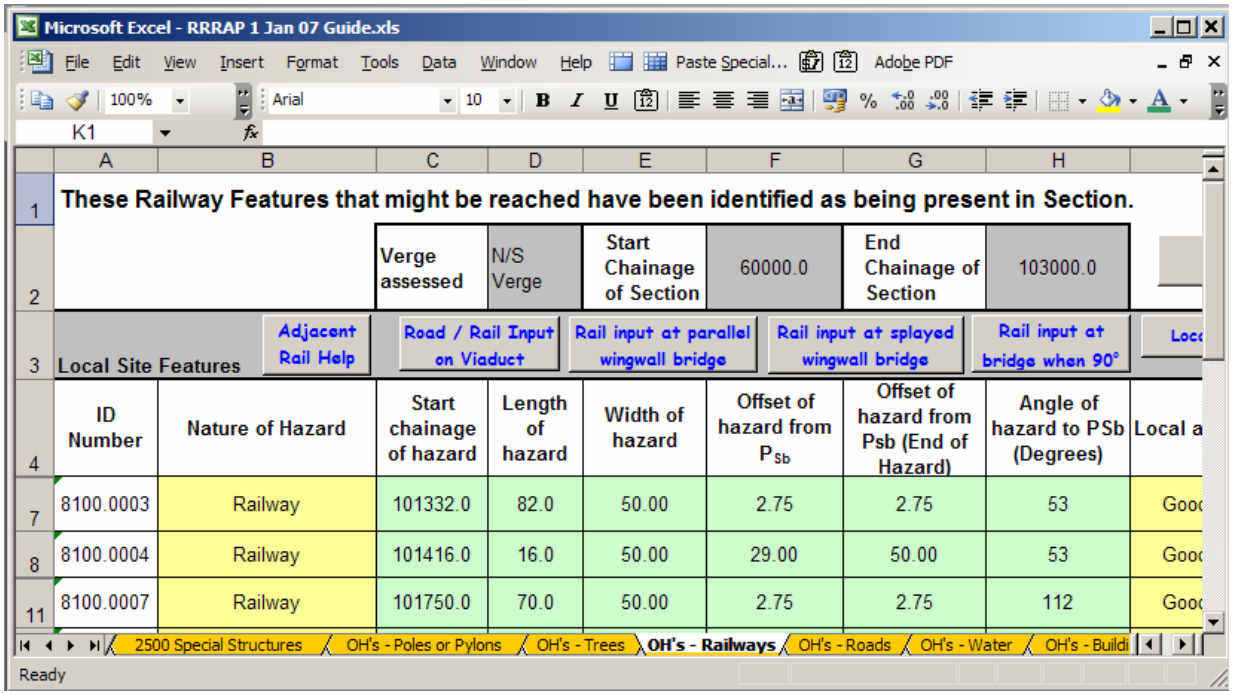
(a) Where the road is on embankment or sidelong ground falling towards the body of water, follow the guidance for OH's Roads in Figs 5.15(b) and (c).

(b) Where there is a false cutting of height < 2.5 m prior to an embankment or sidelong ground that falls towards the body of water, the Point of No Recovery is the top of the embankment slope side of the false cutting, (see fig 5.3.3 (b)).

(c) Where the road is nominally at grade, and the water hazard is 15 m or less from Psb, take the offset to the water hazard as being the offset to the back of the nominal verge.

(d) Where the road is nominally at grade, and the water hazard more than 15 m from Psb, or where there is a false cutting or other cutting face of height ≥ 2.5 m between the water hazard and Psb, take the offset to the water hazard as being the offset to the point of No Recovery of the water hazard itself (e.g. to the top of the bank or slope leading into the water hazard).

5.14 Other Hazards – Railways



Microsoft Excel - RRRAP 1 Jan 07 Guide.xls

These Railway Features that might be reached have been identified as being present in Section.

Verge assessed	N/S Verge	Start Chainage of Section	60000.0	End Chainage of Section	103000.0

Local Site Features — Adjacent Rail Help | Road / Rail Input on Viaduct | Rail input at parallel wingwall bridge | Rail input at splayed wingwall bridge | Rail input at bridge when 90°

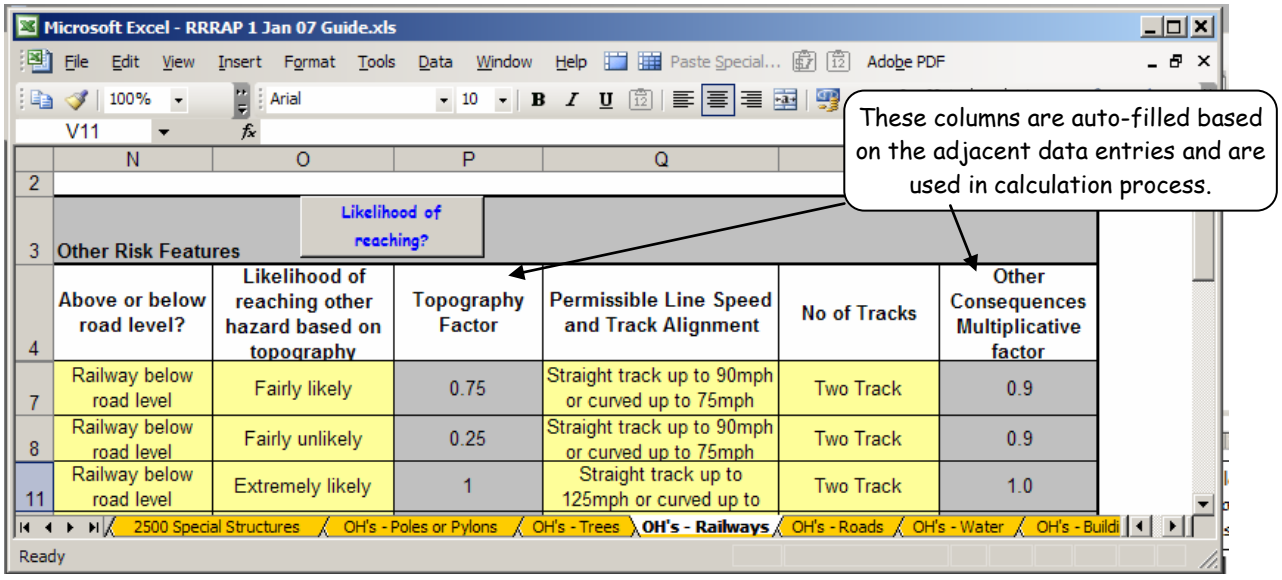
ID Number	Nature of Hazard	Start chainage of hazard	Length of hazard	Width of hazard	Offset of hazard from P_{sb}	Offset of hazard from Psb (End of Hazard)	Angle of hazard to PSb (Degrees)	Local a
8100.0003	Railway	101332.0	82.0	50.00	2.75	2.75	53	Gooc
8100.0004	Railway	101416.0	16.0	50.00	29.00	50.00	53	Gooc
8100.0007	Railway	101750.0	70.0	50.00	2.75	2.75	112	Gooc

2500 Special Structures | OH's - Poles or Pylons | OH's - Trees | **OH's - Railways** | OH's - Roads | OH's - Water | OH's - Buildi

Ready

5.14.1 The various help menus indicated above and below are shown on the next pages.

5.14.2 The various factors input on this worksheet are used to calculate the length of need and containment level of the VRS (safety barrier and or parapet) to protect the railway based on the parameters that are entered into the RRRAP. Where a structure takes the road over or adjacent to a railway, the Designer must follow the mandatory requirements of TD 19, Paragraphs 4.5 to 4.7 and 4.10, and use the output from the RRRAP as a guide only.



Microsoft Excel - RRRAP 1 Jan 07 Guide.xls

Likelihood of reaching?

Other Risk Features

Above or below road level?	Likelihood of reaching other hazard based on topography	Topography Factor	Permissible Line Speed and Track Alignment	No of Tracks	Other Consequences Multiplicative factor
Railway below road level	Fairly likely	0.75	Straight track up to 90mph or curved up to 75mph	Two Track	0.9
Railway below road level	Fairly unlikely	0.25	Straight track up to 90mph or curved up to 75mph	Two Track	0.9
Railway below road level	Extremely likely	1	Straight track up to 125mph or curved up to	Two Track	1.0

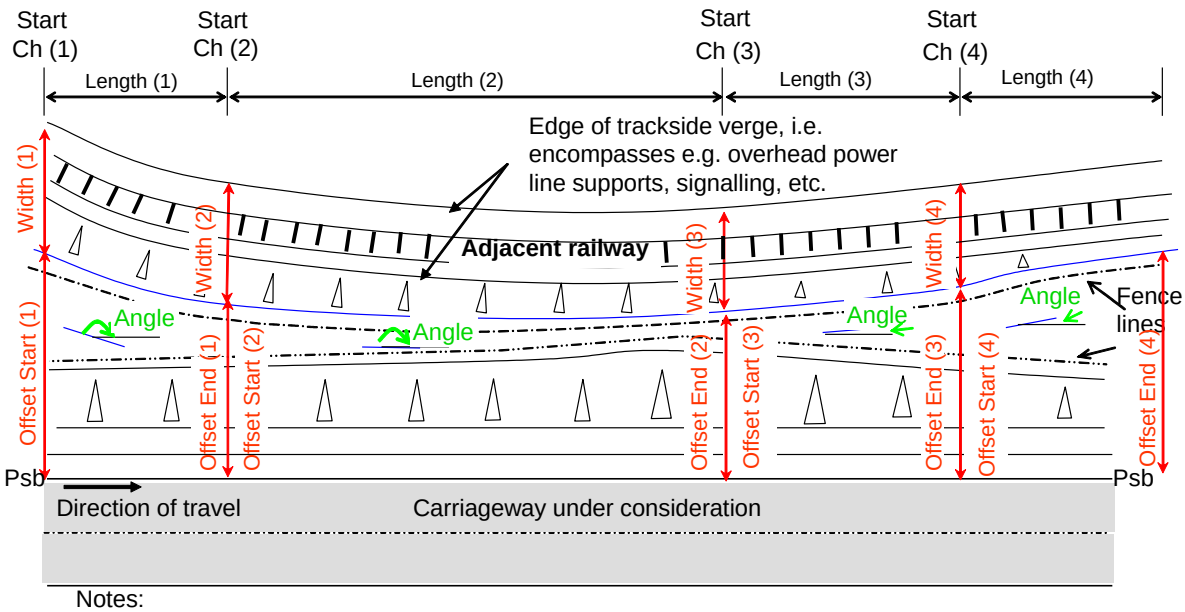
2500 Special Structures | OH's - Poles or Pylons | OH's - Trees | **OH's - Railways** | OH's - Roads | OH's - Water | OH's - Buildi

Ready

Drop down lists for Permissible Line Speed and Track Alignment, and No of Tracks

Straight track up to 45mph
Straight track up to 75mph or curved up to 45mph
Straight track up to 90mph or curved up to 75mph
Straight track up to 100mph or curved up to 90mph
Straight track up to 125mph or curved up to 100mph
Straight track up to 140mph or curved up to 125mph
Straight track above 140mph or curved above to 125mph

Single track
Two Track
Multiple Track



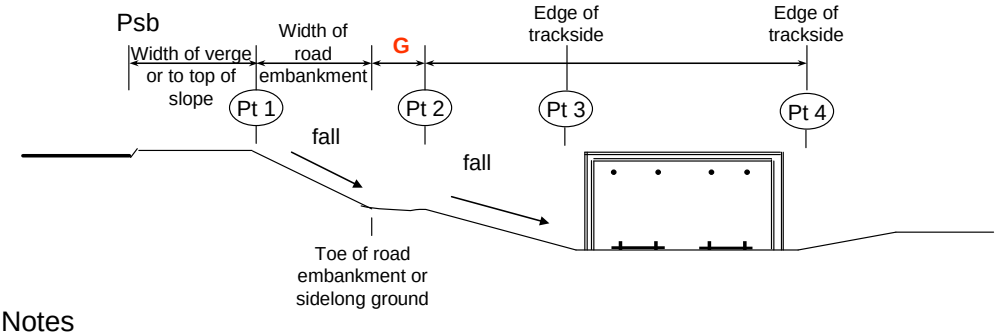
Notes:

1. Lengths (1), (2), (3), etc are decided on a broad brush approach based on adopting a section where alignment of the point of 'no recovery' (i.e. to top of cutting slope to the adjacent railway, or edge of trackside if no side slope) is broadly similar – here Lengths (3) and (4) could be joined.
2. Offsets are measured from Psb to point of 'no recovery'. Offsets in excess of 100 m need not be considered.
3. Psb = Point from which Set-back is measured – refer TD 27.

Offset, width, length and angle dimensions for an Adjacent Railway to the Road for which VRS provision is being assessed.

Adjacent Rail Help

Figure 5.14 (a) Railway adjacent to the Road



Notes

1. If G ≤ 10 m then 'Point of No Recovery' is taken from Pt 1, and width of railway = distance Pt 1 to Pt 4.
2. If G > 10 m then 'Point of No Recovery' is taken from Pt 2, and width of railway = distance Pt 2 to Pt 4.
3. If ground between toe of road embankment and Pt 3 is broadly level and distance toe to Pt 3 > 10 m, then 'Point of No Recovery' is taken from Pt 3, and width of railway = distance Pt 3 to pt 4. If distance toe to Pt 3 ≤ 10 m, then 'Point of No Recovery' is taken from Pt 1, and width of railway = distance Pt 1 to Pt 4.
4. If road is not on embankment or sidelong ground, 'Point of No Recovery' is either Pt 2 if railway is in cutting, otherwise it is Pt 3.

Point of no recovery help

Figure 5.14 (b) Point of No Recovery for Parallel Road / Rail situation (1)

See also the examples given below.

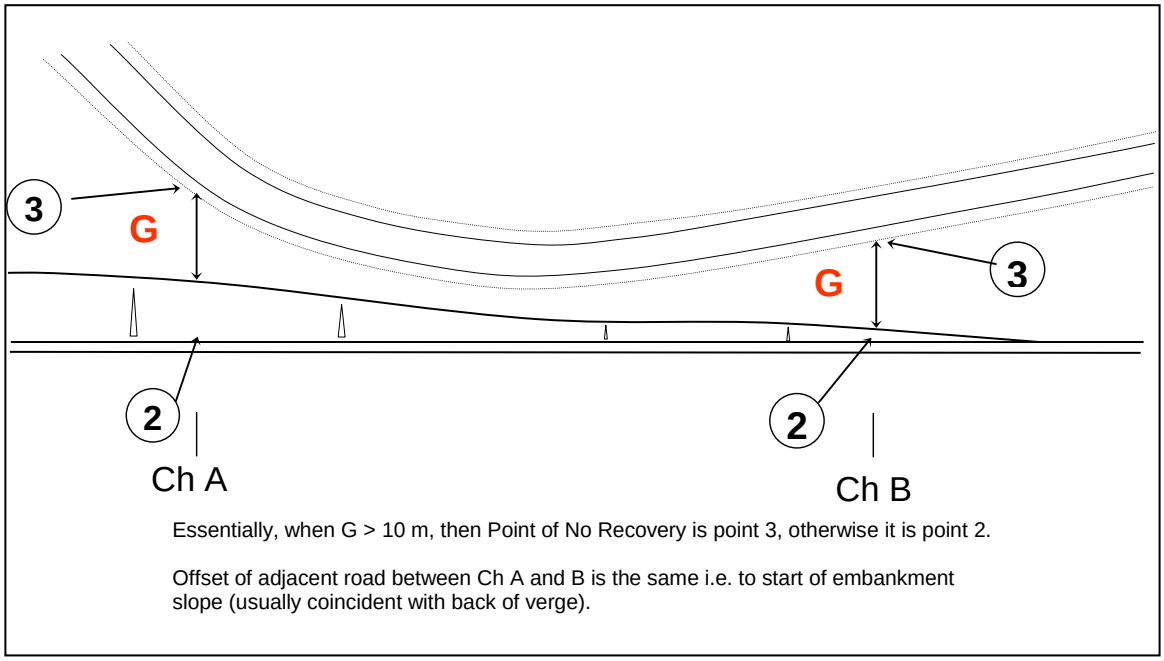


Figure 5.14 (c) Point of No Recovery for Parallel Road / Rail situation (2)

5.14.3 Note regarding parallel road / rail situations

In Section 1 of this Guidance, the way in which the RRRAP calculates requirements for VRS was outlined. At present the RRRAP cannot accurately determine the level of risk of a very long hazard, it looks at the level of protection required to protect the leading edge of the hazard at each of the various points along its length. Where the road and railway run close together over a long length, say in excess of 500 m, if the RRRAP indicates that N2 containment is required, it is worthwhile looking at the Detailed Risk results for each of the N2, H1 and H4a containment provisions, and forming a judgement on the merits of providing a higher containment. The outcome of such investigation should be recorded by retaining each of the Detailed Results outputs; details of the decision process can be added in the User Comments worksheet. Note that when Other parties are involved, as in the case of railways, there will often be a reduction of risk level by providing a higher containment, though the benefit cost of so doing may be low. If the initial risk level is low, there will be little reduction in risk from using higher containments, and in some instances the level of risk will increase with the higher containment safety barrier, as it is a hazard in itself. It is also recommended that the sensitivity of the outcome to changes in factors is investigated to provide a level of assurance that the correct level of protection has been ascertained.

5.14.4 If H1 or H4a containment is required on embankments

If the RRRAP indicates that either H1 or H4a containment level safety barrier is required on the approach embankment, the default cost of the safety barrier must be checked and altered if appropriate. This is to ensure that it accurately reflects the actual cost of installing the safety barrier in this situation where special footings may be required and the correct benefit cost ratio is obtained in the Detailed Results section

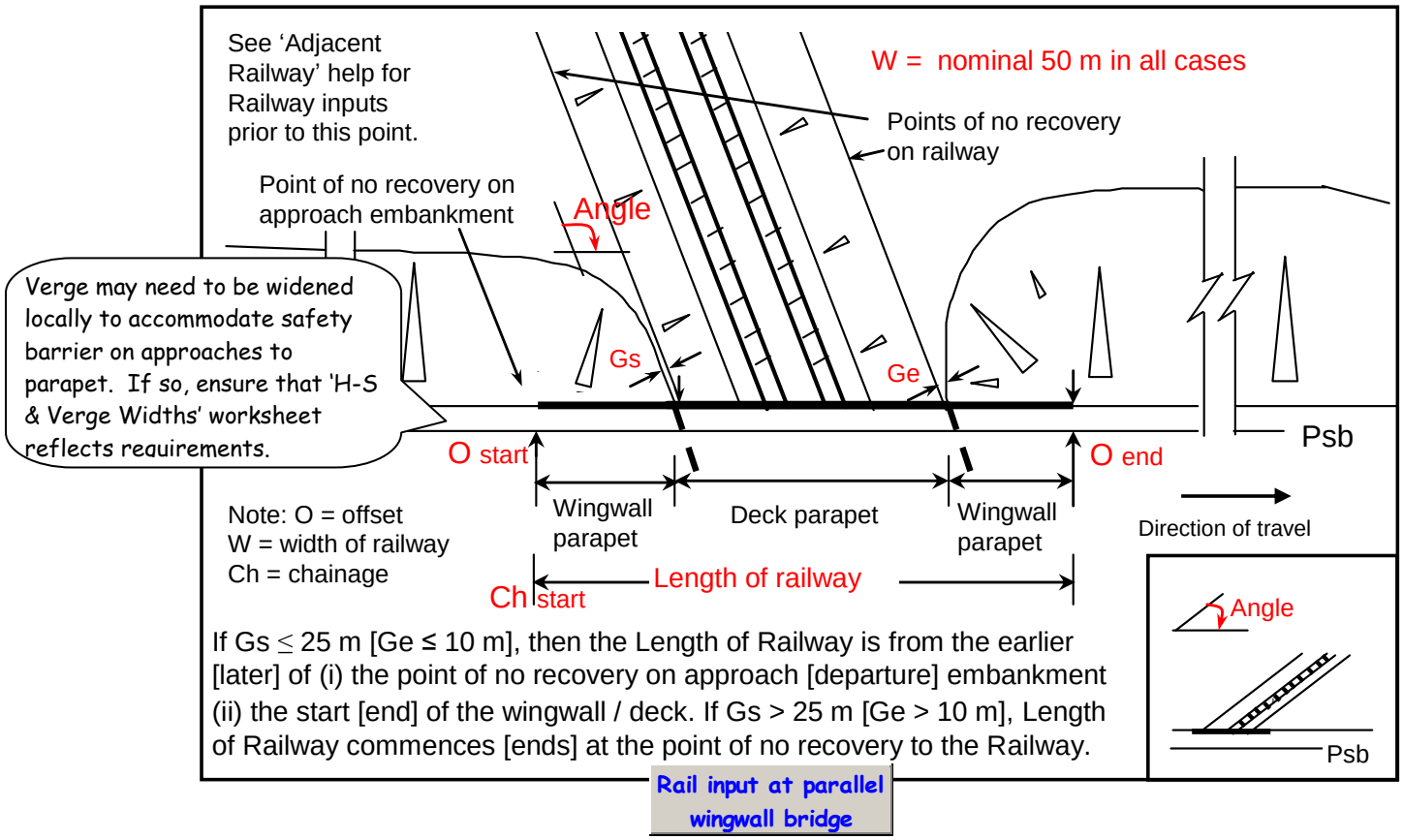


Figure 5.14 (d) Railway crossing under Road at structure with parallel wingwalls

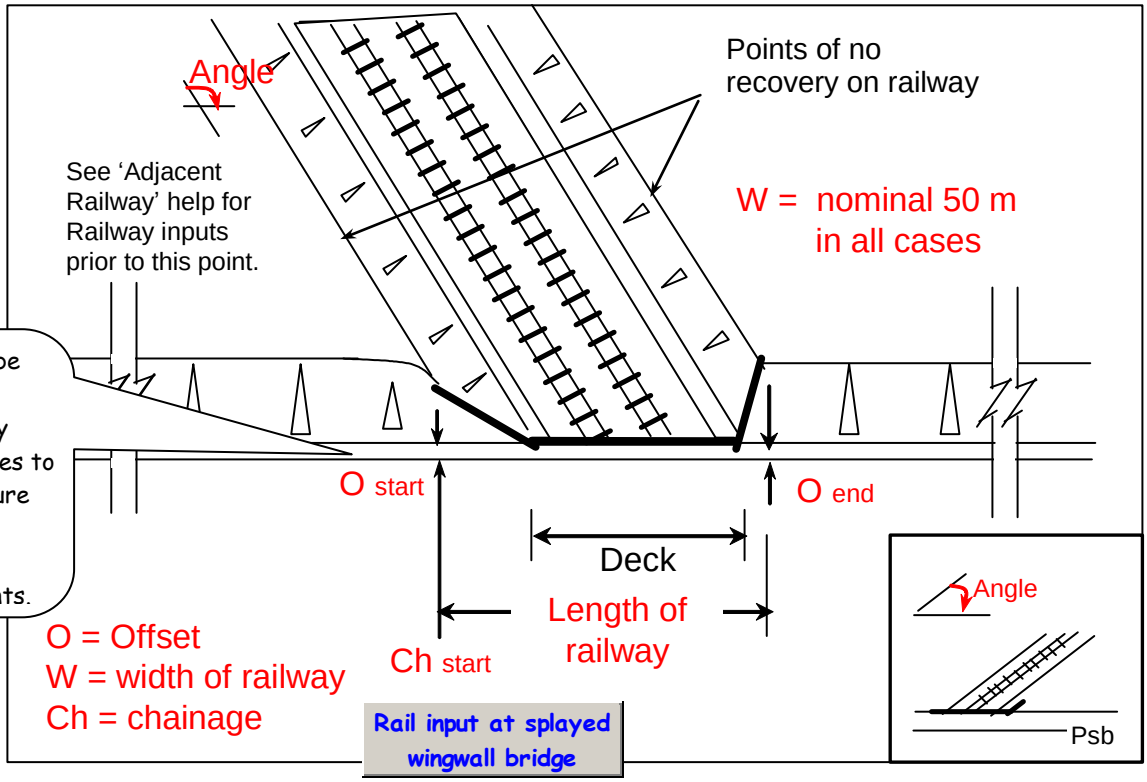


Figure 5.14 (e) Railway crossing under Road at structure with splayed wingwalls

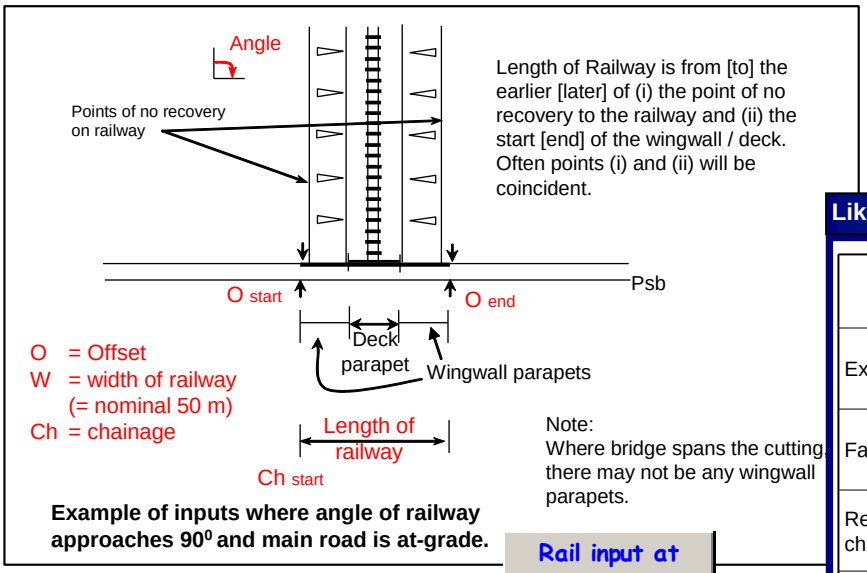


Figure 5.14 (f) Railway crossing under Road where at-grade and or at 90°

Likelihood of reaching?

Likelihood of reaching? X

Likelihood of reaching the Hazard
Typical examples / combinations of situations

Extremely likely	Slope leads directly to hazard; no intervening features to inhibit or divert vehicle passage; hazard very close.
Fairly likely	Slope tends towards hazard; intervening features may inhibit or divert passage; hazard near.
Reasonable chance	Intervening features may inhibit or divert passage, but might reach if travelling fast enough and no avoiding action.
Fairly unlikely	Intervening features make it difficult to reach; might reach in exceptional circumstances.
Cannot reach hazard	Intervening features that would prevent reaching.

The Designer must assess the circumstances and assess the likelihood of an errant vehicle reaching the hazard (i.e. the point of no recovery to the railway). Steeply sloping ground in advance of the point of no recovery will be easier to traverse than shallow sloping ground. The situations in the main part of figs 5.14 (b) and (c) will make it more likely that the hazard will be reached than the situation in the inset diagram where the railway is skewed away from the approaching vehicle and distance travelled is greater. On the structure itself, the likelihood of reaching is 'Extremely likely'.

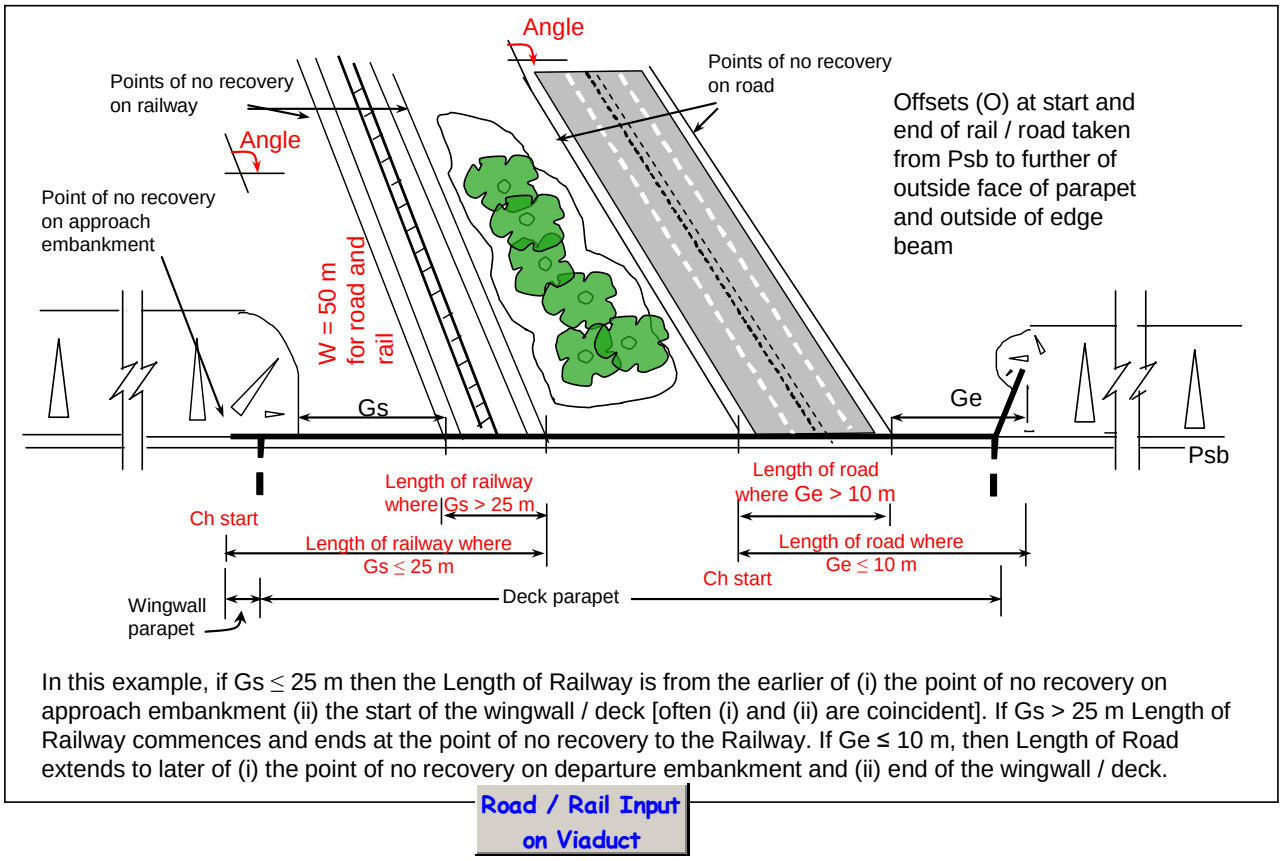
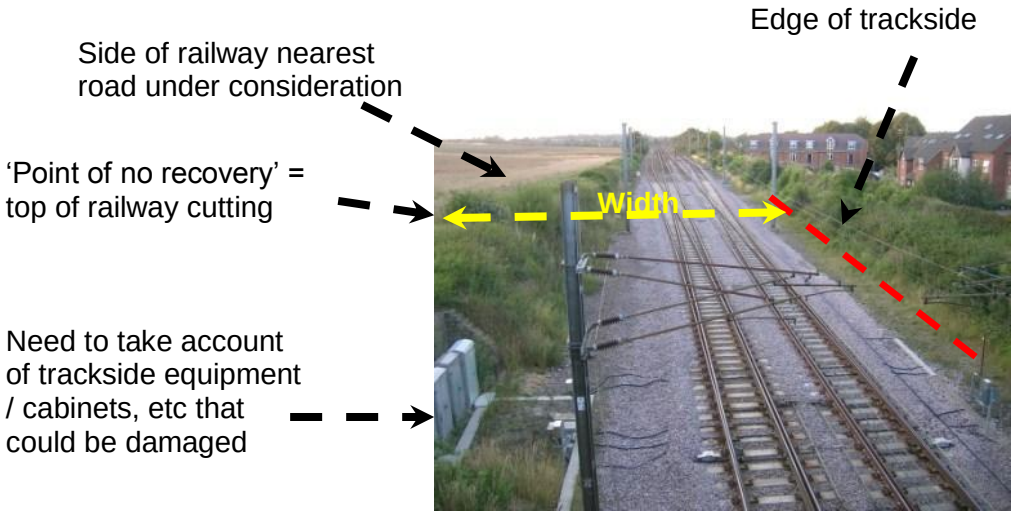


Figure 5.14 (g) Viaduct with Railway and Road crossing under the Road

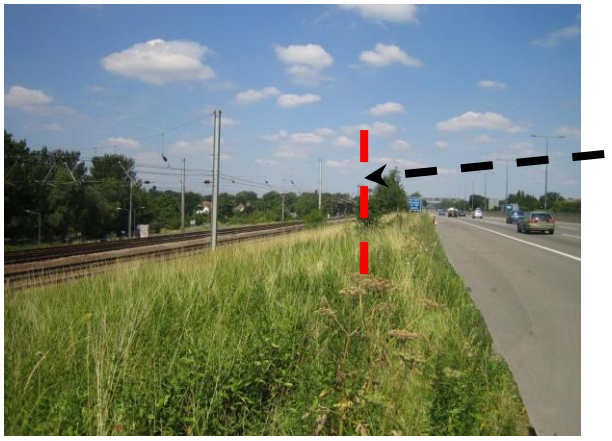
Examples of the 'point of no recovery' are given below

See also Section 5.9 of the Guidance for treatment and examples of inputs for long span structures such as viaducts that cross one or more hazards.

5.14.5 Examples of 'Point of No Recovery'



Example 1 – Railway in cutting

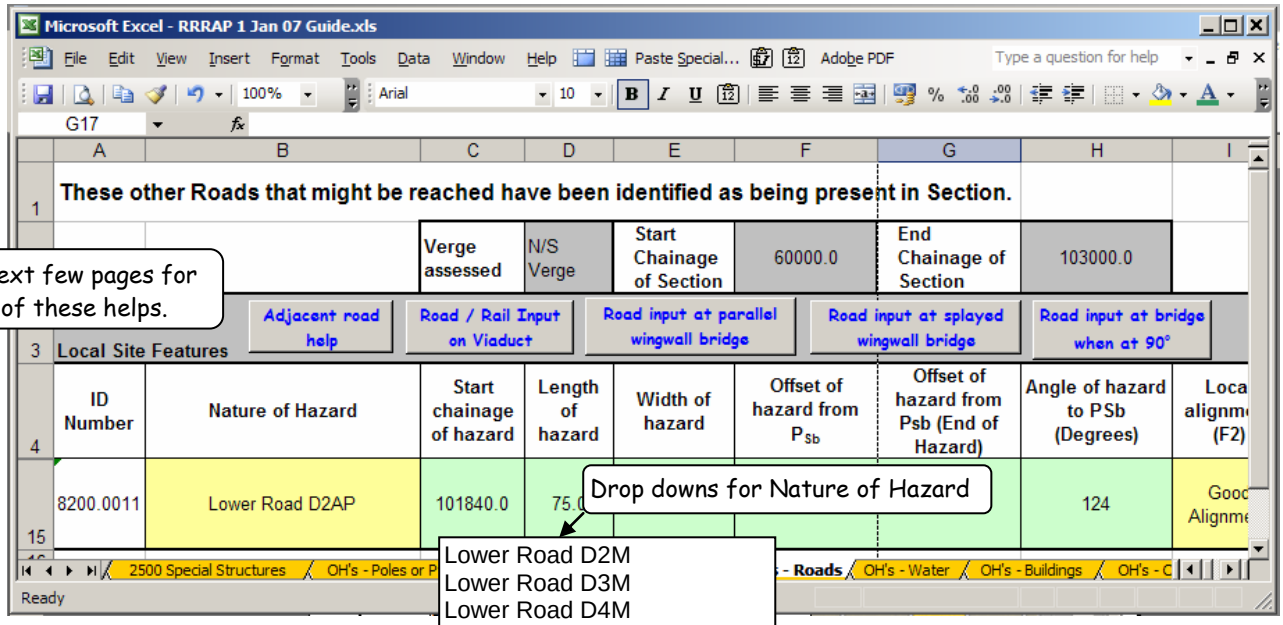


Example 2 – Railway adjacent to bottom of road embankment

If the railway is within 10 m of the bottom of such an embankment (shown in Example 2), the Point of no recovery should be regarded as the back of the road verge.

Example 3 – Railway adjacent to road at similar level

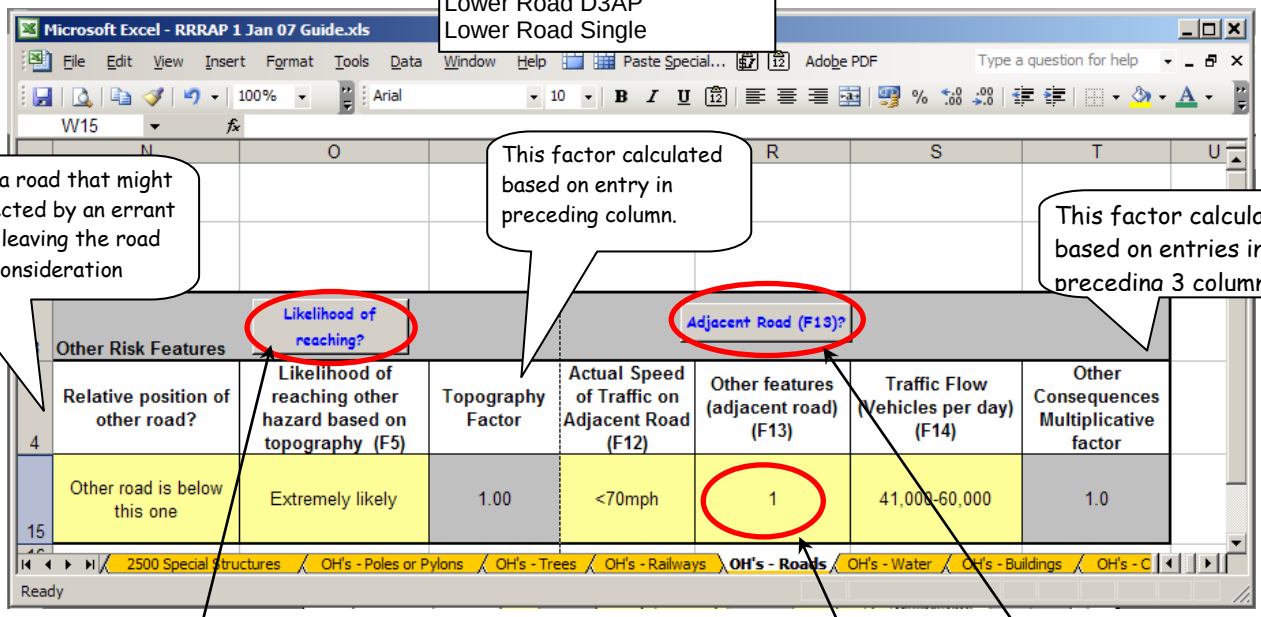
5.15 Other Hazards – Roads



See the next few pages for details of these helps.

Drop downs for Nature of Hazard

- Lower Road D2M
- Lower Road D3M
- Lower Road D4M
- Lower Road Motorway Slip
- Lower Road Motorway Link
- Lower Road D2AP
- Lower Road D3AP
- Lower Road Single



This is a road that might be affected by an errant vehicle leaving the road under consideration

This factor calculated based on entry in preceding column.

This factor calculated based on entries in preceding 3 columns.

Likelihood reaching hazard X

Likelihood of reaching the Hazard Typical examples / combinations of situations	
Extremely likely	Slope leads directly to hazard; no intervening features to inhibit or divert vehicle passage; hazard very close.
Fairly likely	Slope tends towards hazard; intervening features may inhibit or divert passage; hazard near.
Reasonable chance	Intervening features may inhibit or divert passage, but might reach if travelling fast enough and no avoiding action.
Fairly unlikely	Intervening features make it difficult to reach; might reach in exceptional circumstances.
Cannot reach hazard	Intervening features that would prevent reaching.

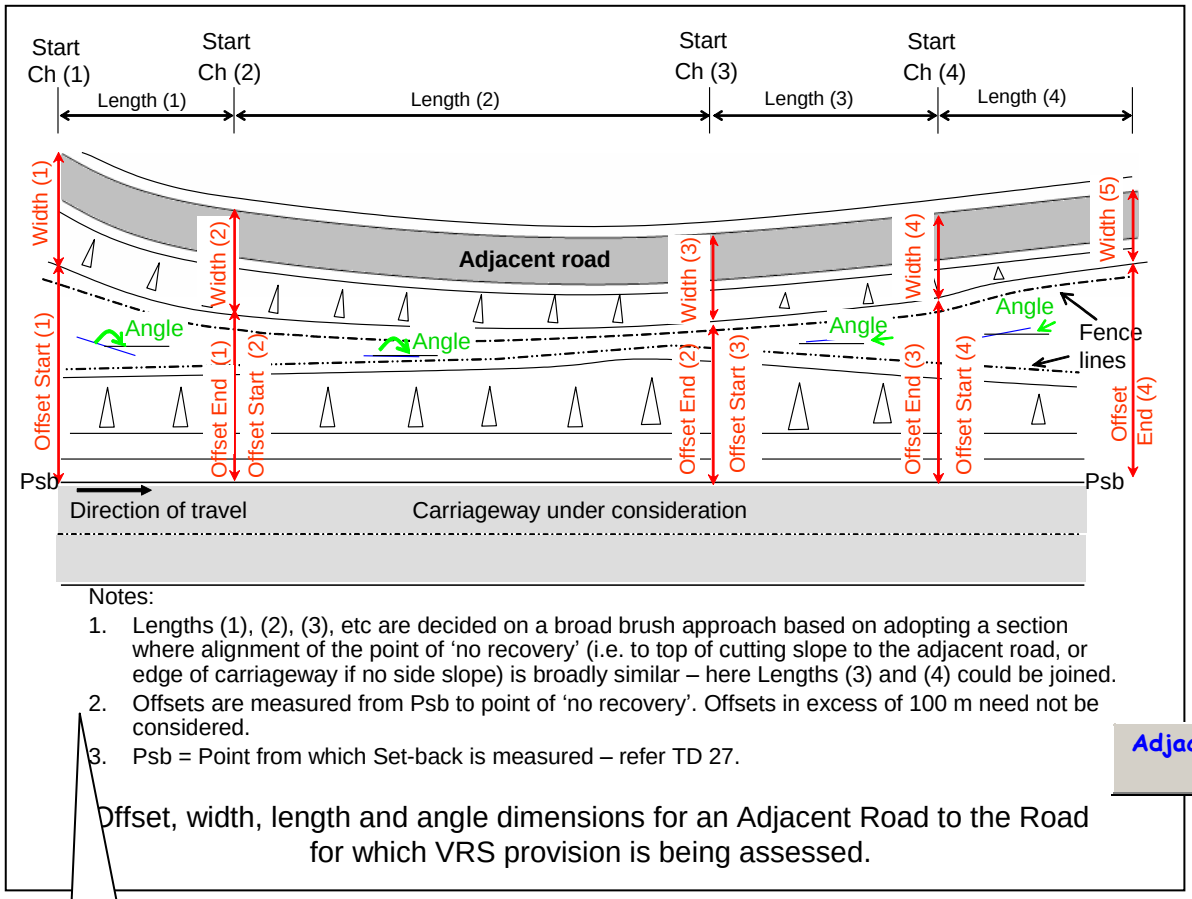
Adjacent road hazard marking X

Site Specific Hazards Increasing Consequences of Event on the Adjacent Road

	1 way roads	Two-way roads
No hazards	Score 1	Score 1
Single Hazard	Score 3	Score 5
Two hazards	Score 5	Score 7
Three or more hazards / queuing	Score 7	Score 9

The hazards on the adjacent road leading to increased consequences could include the presence of pedestrians, road and or verge width (inability to avoid a vehicle blocking the road), poor or no lighting, reduced sight lines (e.g. bends or vegetation) and adjacent land use (e.g. housing, schools), likelihood of queues, etc.

5.15.1 The Designer must assess the circumstances and assess the likelihood of an errant vehicle reaching the hazard (i.e. the point of no recovery to the road). Steeply sloping ground in advance of the point of no recovery will be easier to traverse than shallow sloping ground. The situations in the main part of figs 5.14 (b) and (c) will make it more likely that the hazard will be reached than the situation in the inset diagram where the road is skewed away from the approaching vehicle and distance travelled is greater. On the structure itself, the likelihood of reaching is 'Extremely likely'.



Notes:

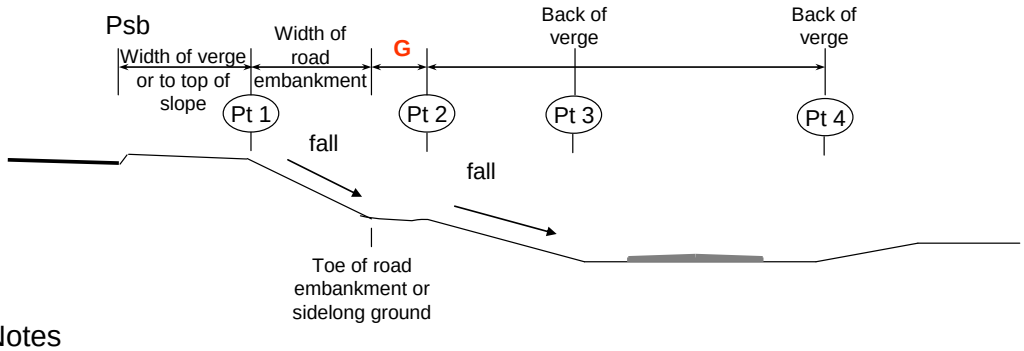
1. Lengths (1), (2), (3), etc are decided on a broad brush approach based on adopting a section where alignment of the point of 'no recovery' (i.e. to top of cutting slope to the adjacent road, or edge of carriageway if no side slope) is broadly similar – here Lengths (3) and (4) could be joined.
2. Offsets are measured from Psb to point of 'no recovery'. Offsets in excess of 100 m need not be considered.
3. Psb = Point from which Set-back is measured – refer TD 27.

Offset, width, length and angle dimensions for an Adjacent Road to the Road for which VRS provision is being assessed.

Adjacent road help

Figure 5.15 (a) Road adjacent to the Road

See fig 5.15 (b) below for further explanation

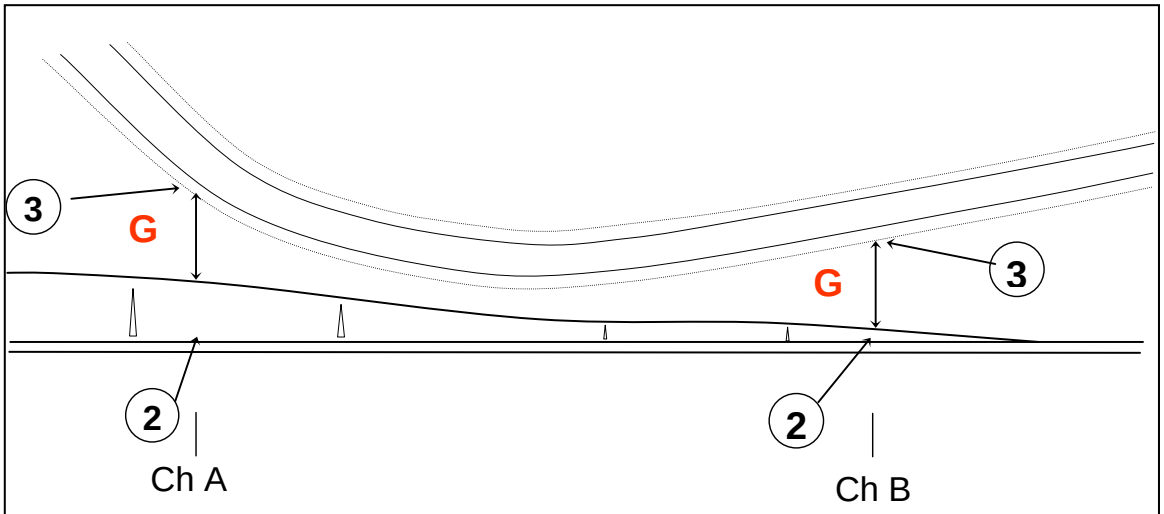


Notes

1. If G ≤ 10 m then 'Point of No Recovery' is taken from Pt 1, and width of adjacent road = distance Pt 1 to Pt 4.
2. If G > 10 m then 'Point of No Recovery' is taken from Pt 2, and width of adjacent road = distance Pt 2 to Pt 4.
3. If ground between toe of road embankment and Pt 3 is broadly level and distance toe to Pt 3 > 10 m, then 'Point of No Recovery' is taken from Pt 3, and width of adjacent road = distance Pt 3 to pt 4. If distance toe to Pt 3 ≤ 10 m, then 'Point of No Recovery' is taken from Pt 1, and width of adjacent road = distance Pt 1 to Pt 4.
4. If road is not on embankment or sidelong ground, 'Point of No Recovery' is either Pt 2 if adjacent road is in cutting, otherwise it is Pt 3.

Point of no recovery help

Figure 5.15 (b) Point of No Recovery for Parallel Road situation (1)



Essentially, when G > 10 m, then Point of No Recovery is point 3, otherwise it is point 2.

Offset of adjacent road between Ch A and B is the same i.e. to start of embankment slope (usually coincident with back of verge).

Figure 5.15 (c) Point of No Recovery for Parallel Road situation (2)

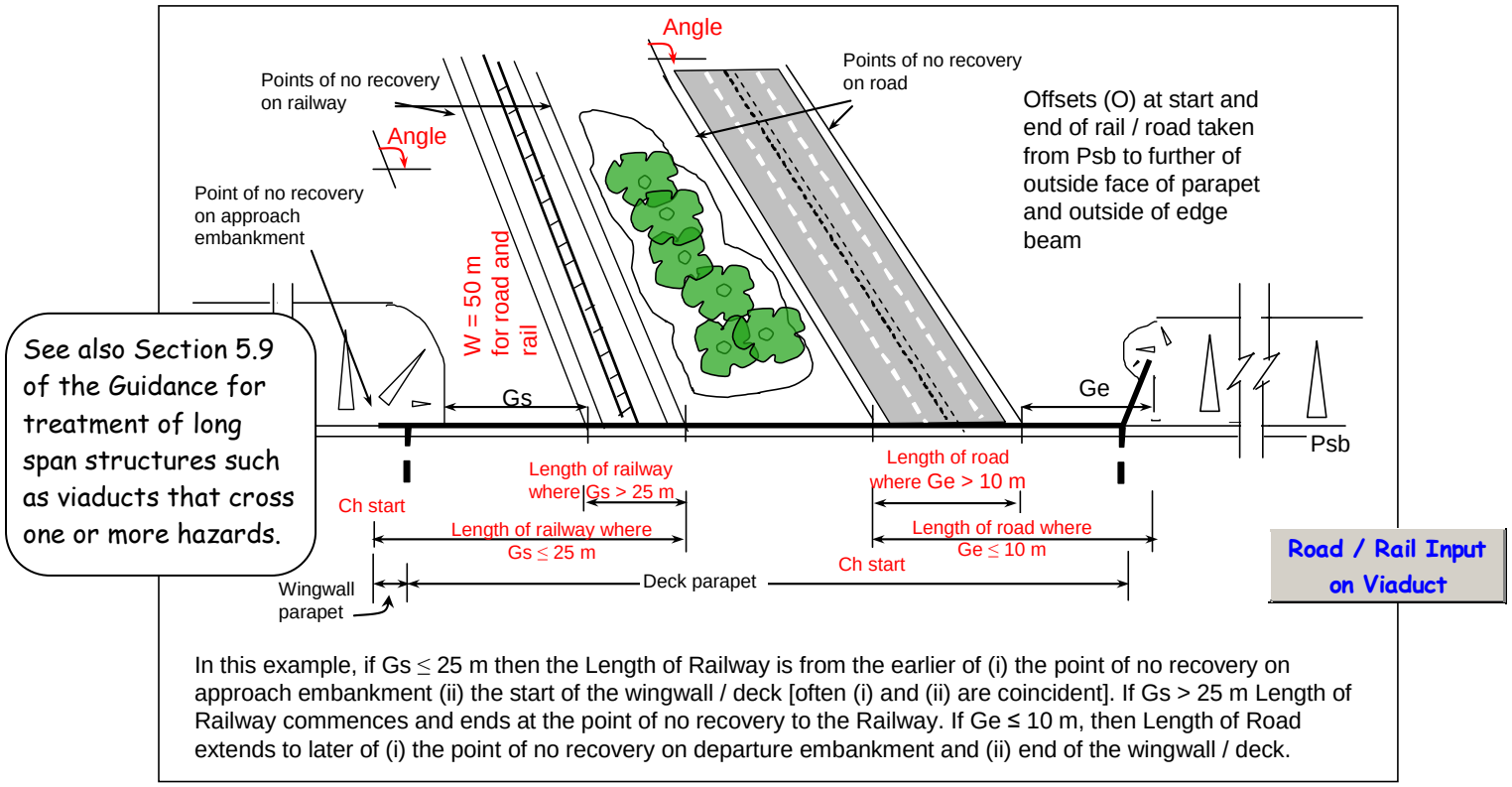


Figure 5.15 (d) Viaduct with Road and Railway crossing under the Road

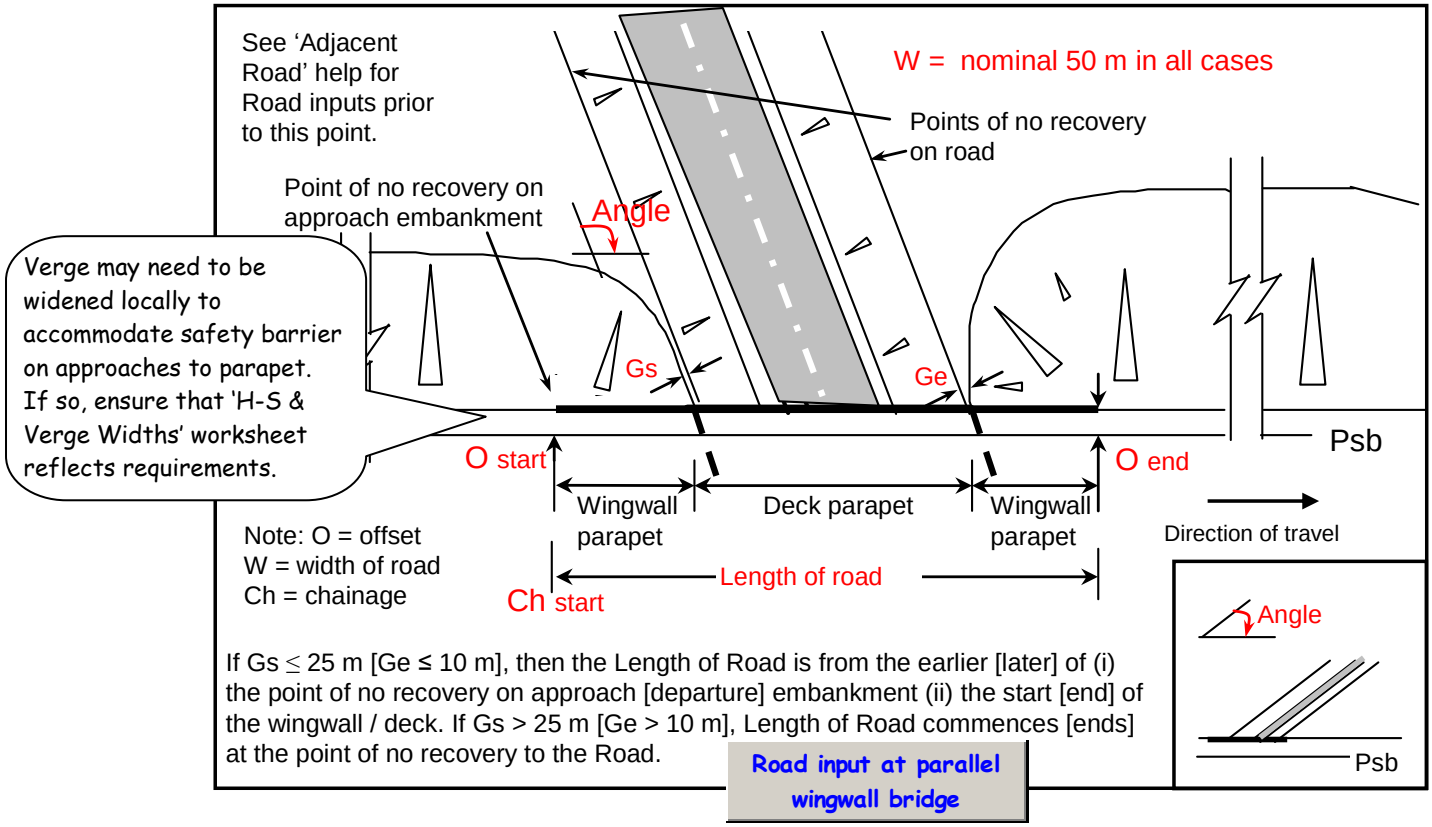


Figure 5.15 (e) Road crossing under Road at structure with parallel wingwalls

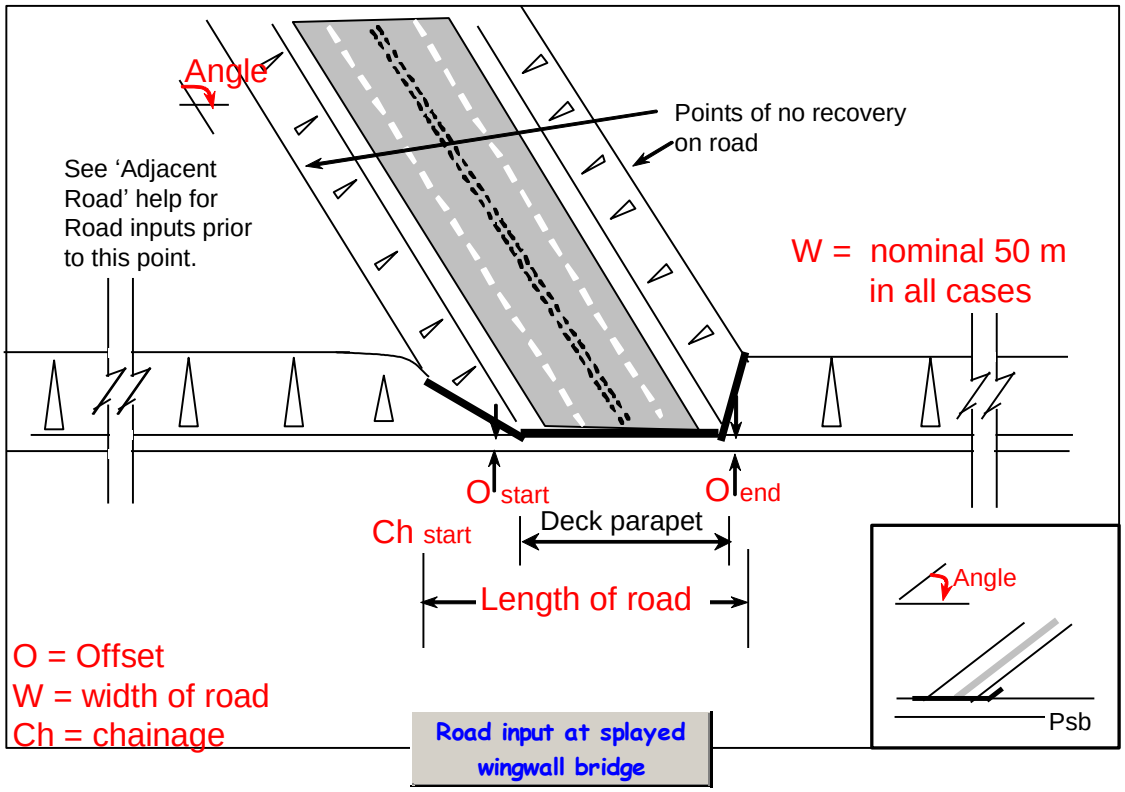


Figure 5.15 (f) Road crossing under Road at structure with splayed wingwalls

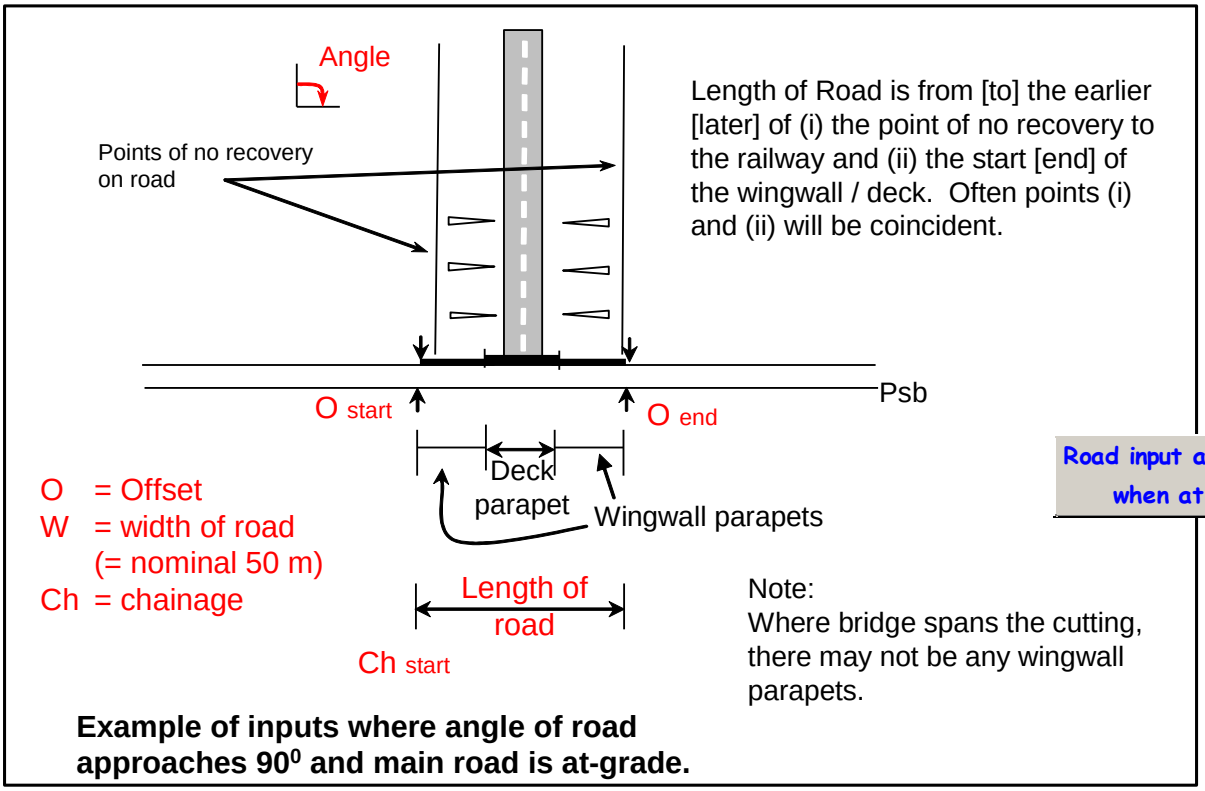


Figure 5.15 (g) Road crossing under Road where at-grade and or at 90°

5.15.2 Note regarding parallel road situations

In Section 1 of this Guidance, the way in which the RRRAP calculates requirements for VRS was outlined. At present the RRRAP cannot accurately determine the level of risk of a very long hazard, it looks at the level of protection required to protect the leading edge of the hazard at each of the various points along its length. Where the adjacent road runs close together over a long length, say in excess of 500 m, if the RRRAP indicates that N2 containment is required, it is worthwhile looking at the Detailed Risk results for each of the N2, H1 and H4a containment provisions, and forming a judgement on the merits of providing a higher containment. The outcome of such investigation should be recorded by retaining each of the Detailed Results outputs; details of the decision process can be added in the User Comments worksheet. Note that when Other parties are involved, as in the case of adjacent roads, there will often be a reduction of risk level by providing a higher containment, though the benefit cost of so doing may be low. If the initial risk level is low, there will be little reduction in risk from using higher containments, and in some instances the level of risk will increase with the higher containment safety barrier, as it is a hazard in itself. It is also recommended that the sensitivity of the outcome to changes in factors is investigated to provide a level of assurance that the correct level of protection has been ascertained.

5.15.3 If H1 or H4a containment is required on embankments

Refer to Paragraph 5.14.4 above.

5.15.4 Slip Roads in the vicinity of Nosings

In general a slip road will not pose a hazard to traffic on the main carriageway and a main carriageway will not pose a hazard to traffic on a slip road. This is the case as long as the two flows of traffic are running more or less parallel and in the same general direction. Where the alignments start to converge to produce a situation where the traffic is flowing

towards each other, then it may become a significant hazard and should be entered into the RRRAP. The figure below illustrates a typical situation.

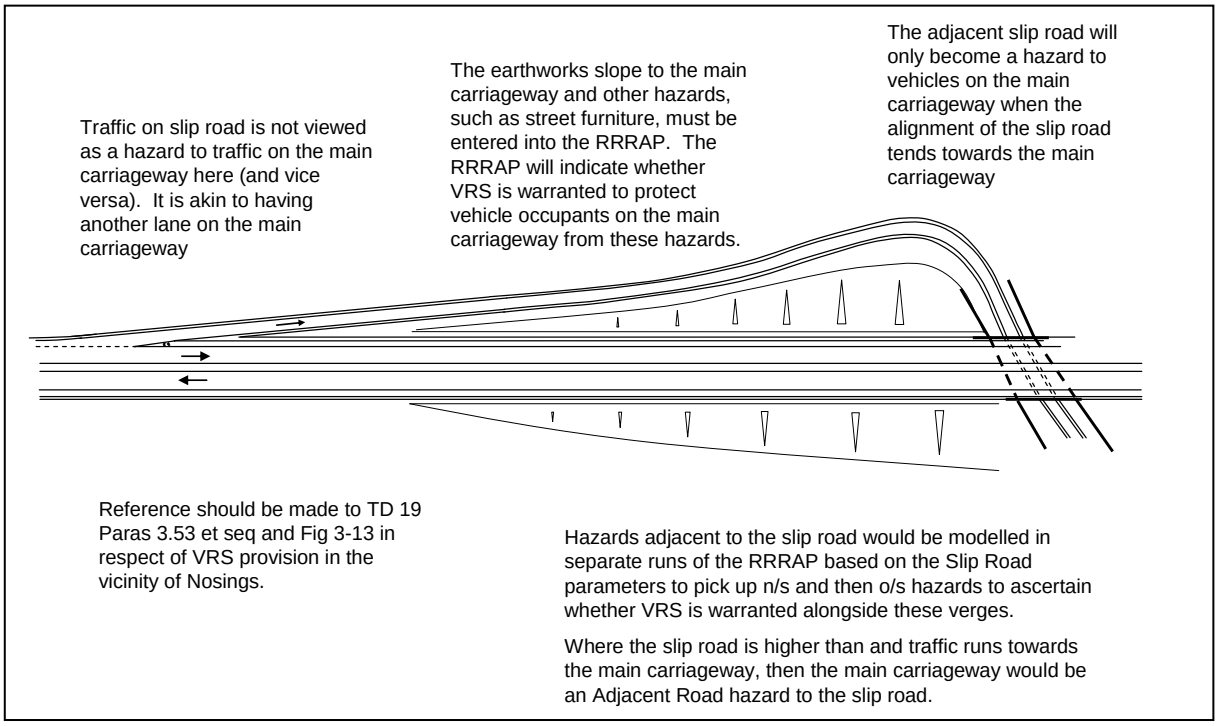
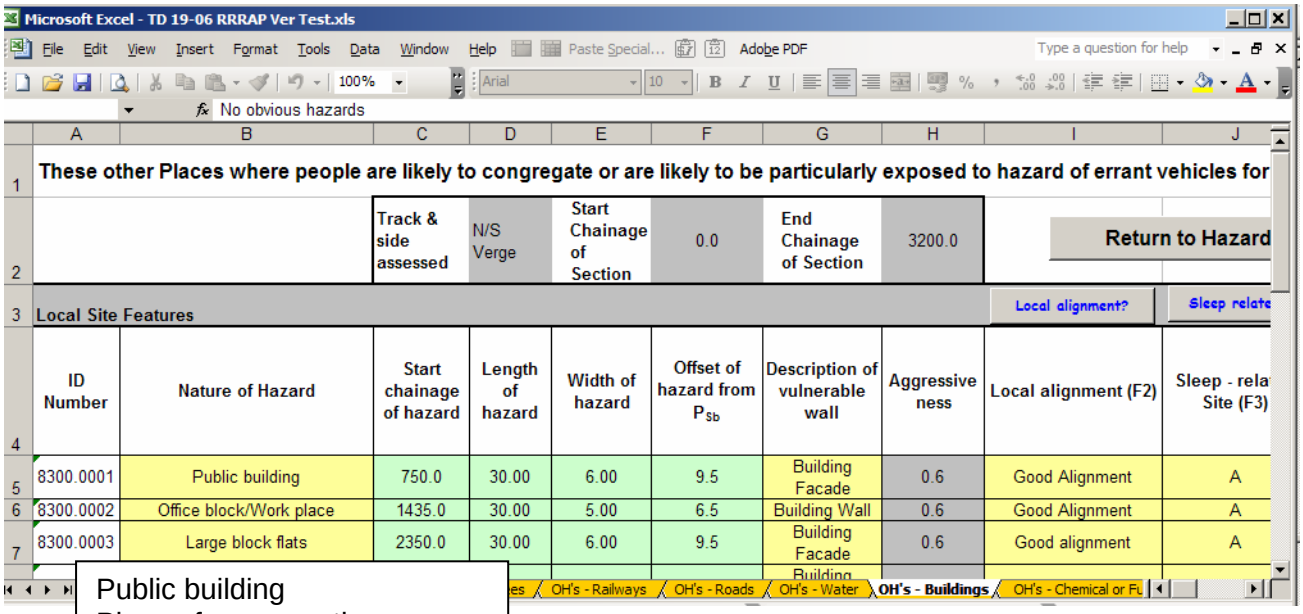
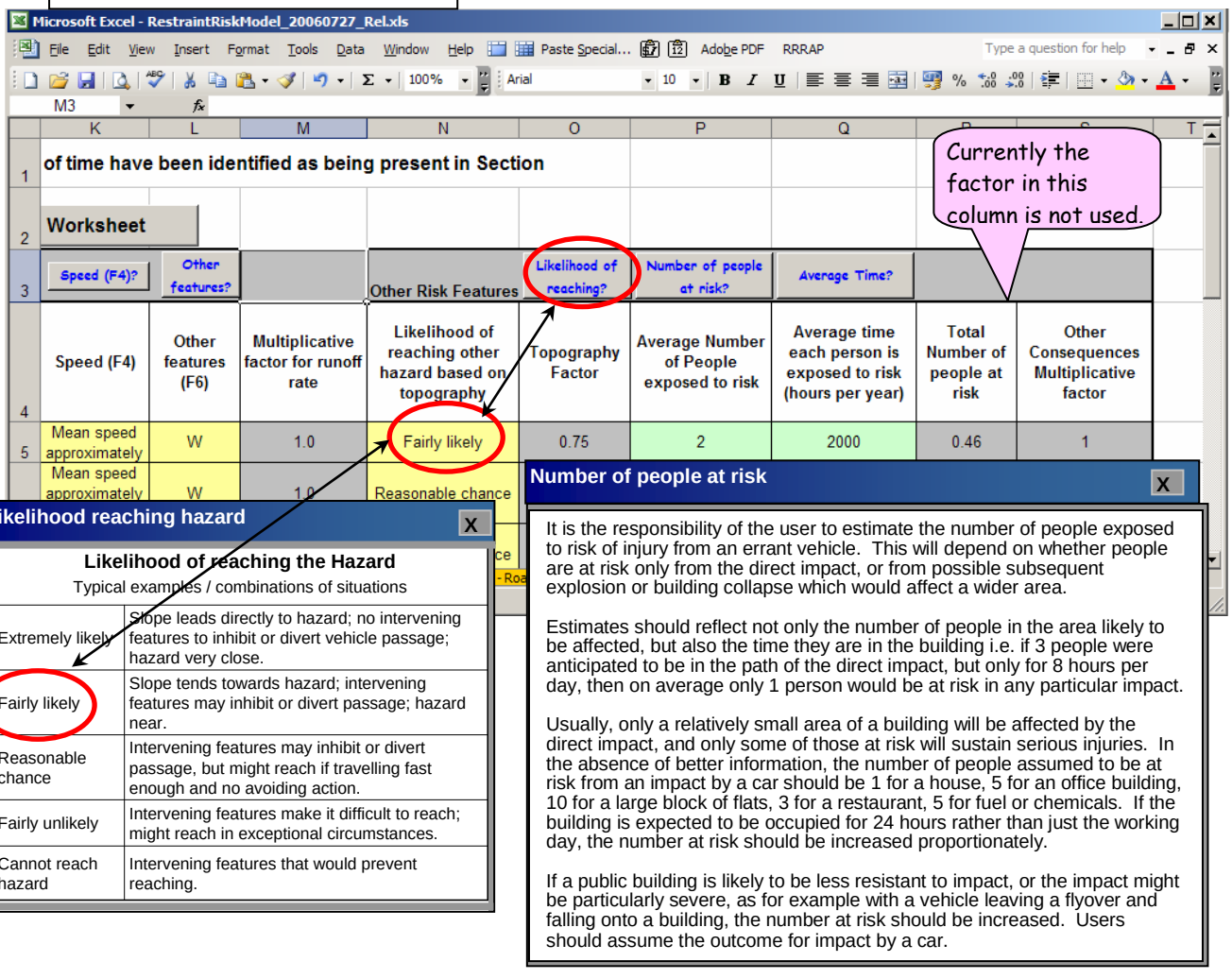


Fig 5.15(h) When a Slip Road is viewed a Hazard, and when it isn't.

5.16 Other Hazards Buildings and also Other Hazards – Chemical of Fuel



Public building
Place of congregating
Office block/Work place
Large block flats
Playground/Open sports area



Likelihood reaching hazard X

Likelihood of reaching the Hazard Typical examples / combinations of situations	
Extremely likely	Slope leads directly to hazard; no intervening features to inhibit or divert vehicle passage; hazard very close.
Fairly likely	Slope tends towards hazard; intervening features may inhibit or divert passage; hazard near.
Reasonable chance	Intervening features may inhibit or divert passage, but might reach if travelling fast enough and no avoiding action.
Fairly unlikely	Intervening features make it difficult to reach; might reach in exceptional circumstances.
Cannot reach hazard	Intervening features that would prevent reaching.

Number of people at risk X

It is the responsibility of the user to estimate the number of people exposed to risk of injury from an errant vehicle. This will depend on whether people are at risk only from the direct impact, or from possible subsequent explosion or building collapse which would affect a wider area.

Estimates should reflect not only the number of people in the area likely to be affected, but also the time they are in the building i.e. if 3 people were anticipated to be in the path of the direct impact, but only for 8 hours per day, then on average only 1 person would be at risk in any particular impact.

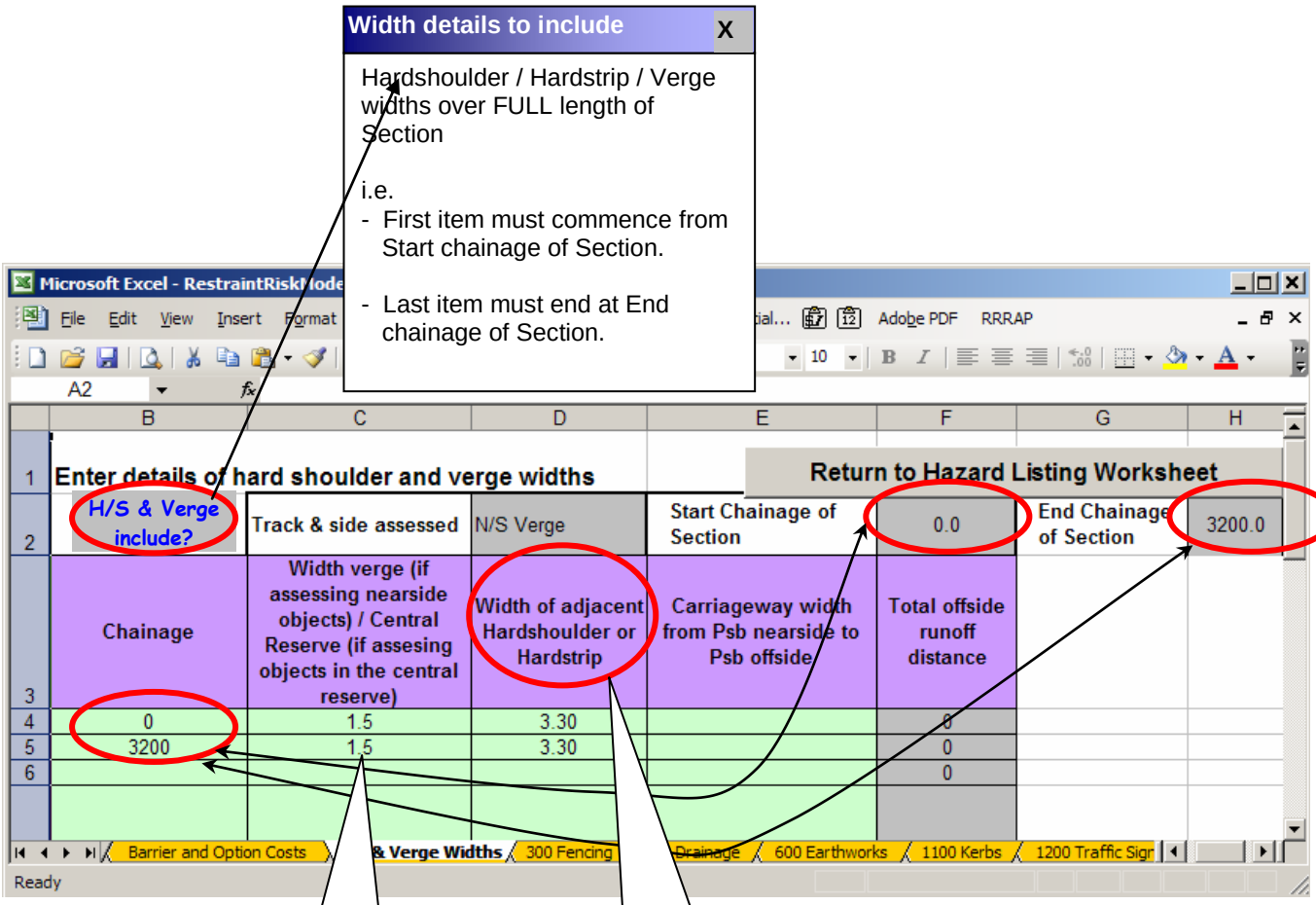
Usually, only a relatively small area of a building will be affected by the direct impact, and only some of those at risk will sustain serious injuries. In the absence of better information, the number of people assumed to be at risk from an impact by a car should be 1 for a house, 5 for an office building, 10 for a large block of flats, 3 for a restaurant, 5 for fuel or chemicals. If the building is expected to be occupied for 24 hours rather than just the working day, the number at risk should be increased proportionately.

If a public building is likely to be less resistant to impact, or the impact might be particularly severe, as for example with a vehicle leaving a flyover and falling onto a building, the number at risk should be increased. Users should assume the outcome for impact by a car.

5.17 Hardshoulder and Verge widths

5.17.1 It is important to ensure that hardshoulder and verge widths are entered for the whole length of the Section under consideration. Care should be taken to include, for instance, verge widening at parapets to ensure that any safety barrier can be properly located in accordance with TD 19 Figure 3-1.

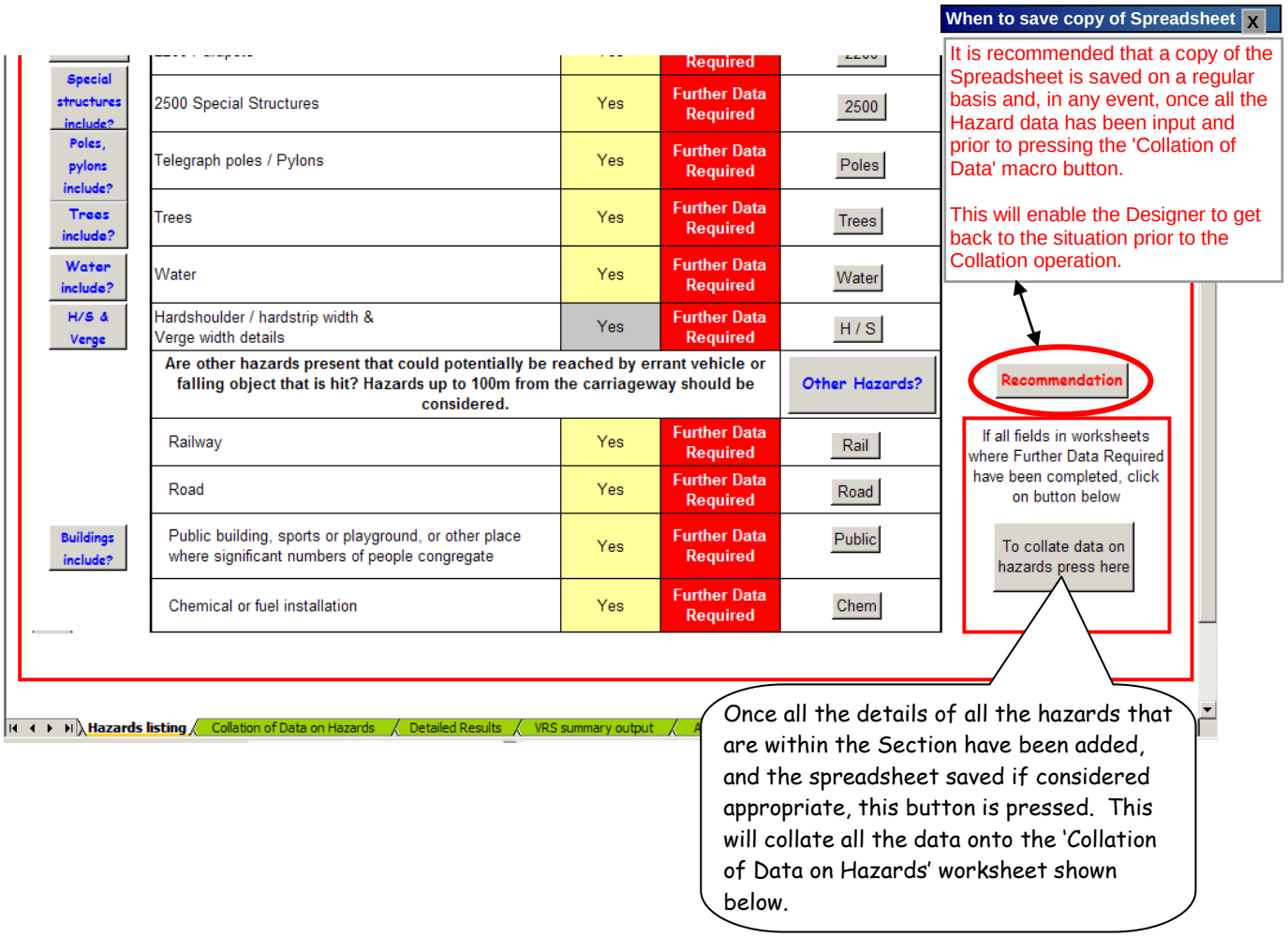
5.17.2 The RRRAP assumes that the ground between the back of verge and the start of any earthworks slope is nominally level, and that the verge width is broadly in accord with the dimensions given in TD 27. If the width of the verge is locally significantly greater than the TD 27 dimension, for instance for sight line purposes, it is better to report the nominal verge width in the H-S & Verge Widths worksheet, and to pick up the start of the earthworks slope (if any) in the Earthworks worksheet.



6. Collation of Data on Hazards

6.1 The initial collation process

6.1.1 All the data previously entered is automatically collated by pressing the button on the lower right side of the 'Hazards Listing' worksheet as shown below.

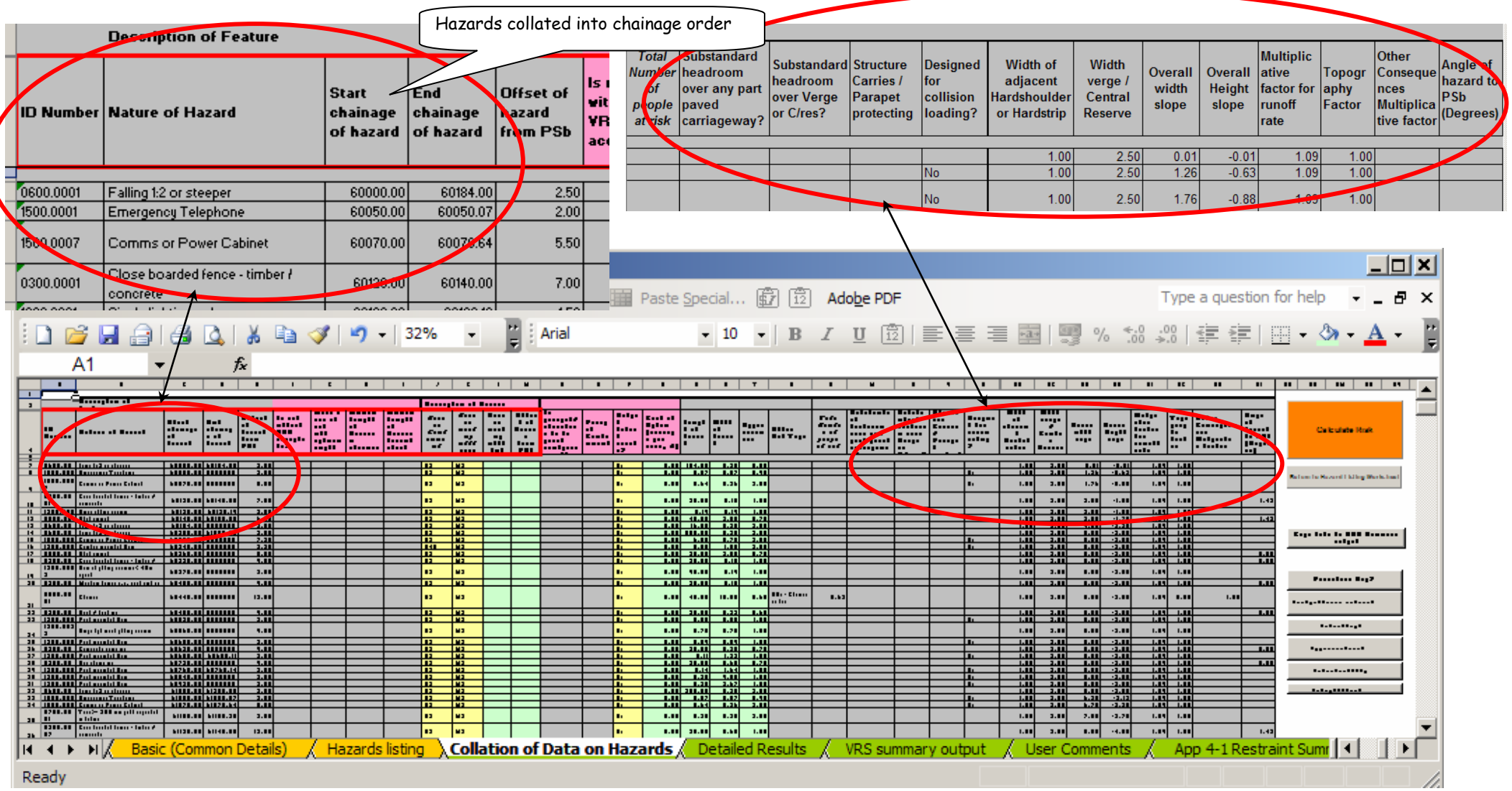


6.1.2 The collation initially puts all the hazards into increasing chainage order. In the current version, the RRRAP cannot cope with Sections that are in decreasing chainage order. It is expected that future version will be able to work with either increasing or decreasing chainage.

6.1.3 Having put the hazards into order, the 'Calculate Risk' button on the right hand side of the 'Collation of Data on Hazards' worksheet should be pressed.

6.2 Overview of Collation of Data on Hazards worksheet

6.2.1 When the 'Collate Hazards' button on the 'Hazards Listing' worksheet has been pressed, and prior to pressing the 'Calculate Risk' button, the 'Collation of Data on Hazards' worksheets look like this.



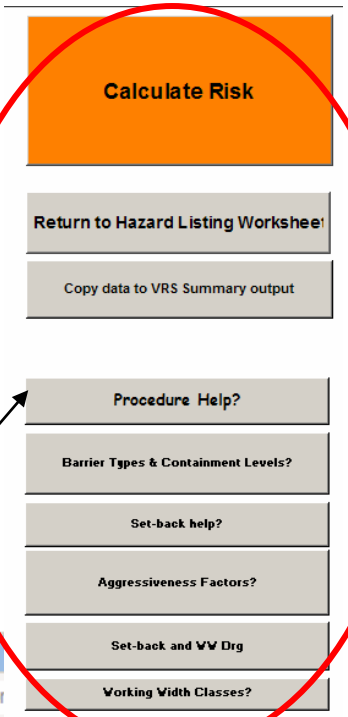
				Description of Barrier												
Is risk without VRS acceptable ?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet/structure to be placed contiguously with barrier?	Parapet Containment	Output detailed results ?	Cost of Option (average per year, £)	Length of hazard	Width of hazard	Aggressiveness	Other Risk Type	
				N2	W2					No	0.00	184.00	0.25	0.50		
				N2	W2					No	0.00	0.07	0.07	0.90		
				N2	W2					No	0.00	0.64	0.36	2.00		
				N2	W2					No	0.00	20.00	0.15	1.00		

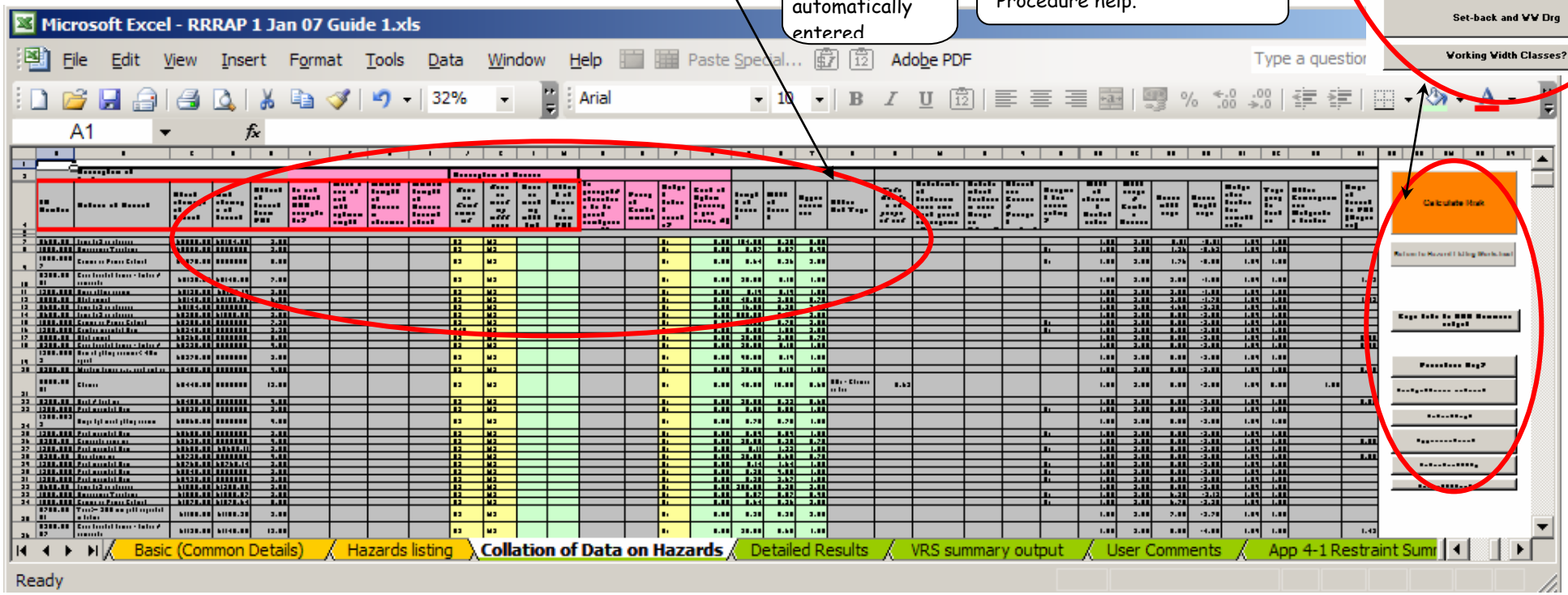
Default values of N2 and W2 initially posted

Default value of 'No' initially automatically entered

Default value of '0.00' initially automatically entered

See next page for details of Procedure help.





Procedure help X

When the 'Collation of Data' button has been pressed, the hazards are put into increasing chainage order. At this stage, no details relating to the level of risk or safety barrier requirements have been populated in the worksheet other than the default Barrier Containment N2 and working width class W2.

When the 'Calculate Risk' button is pressed for the first time, the RRRAP automatically calculates the risk level due to the presence of each hazard. If the level of risk without provision of VRS is 'acceptable', a 'Yes' is returned in column F and no VRS or safety barrier details are given in the columns further to the right. If however, the level of risk without VRS is 'unacceptable', a 'No' will be returned in column F and, in the column to the right, it will indicate whether the level of risk with optimum length VRS having the default N2 Containment Level is 'Acceptable', 'Tolerable', or 'Unacceptable'.

If 'Acceptable' has been returned, the RRRAP will indicate the minimum length of need of safety barrier in advance of the object that will give an acceptable level of risk. Note that Paragraphs 3.26 et seq. and Table 3-1 of TD 19 may require a longer minimum length be actually provided.

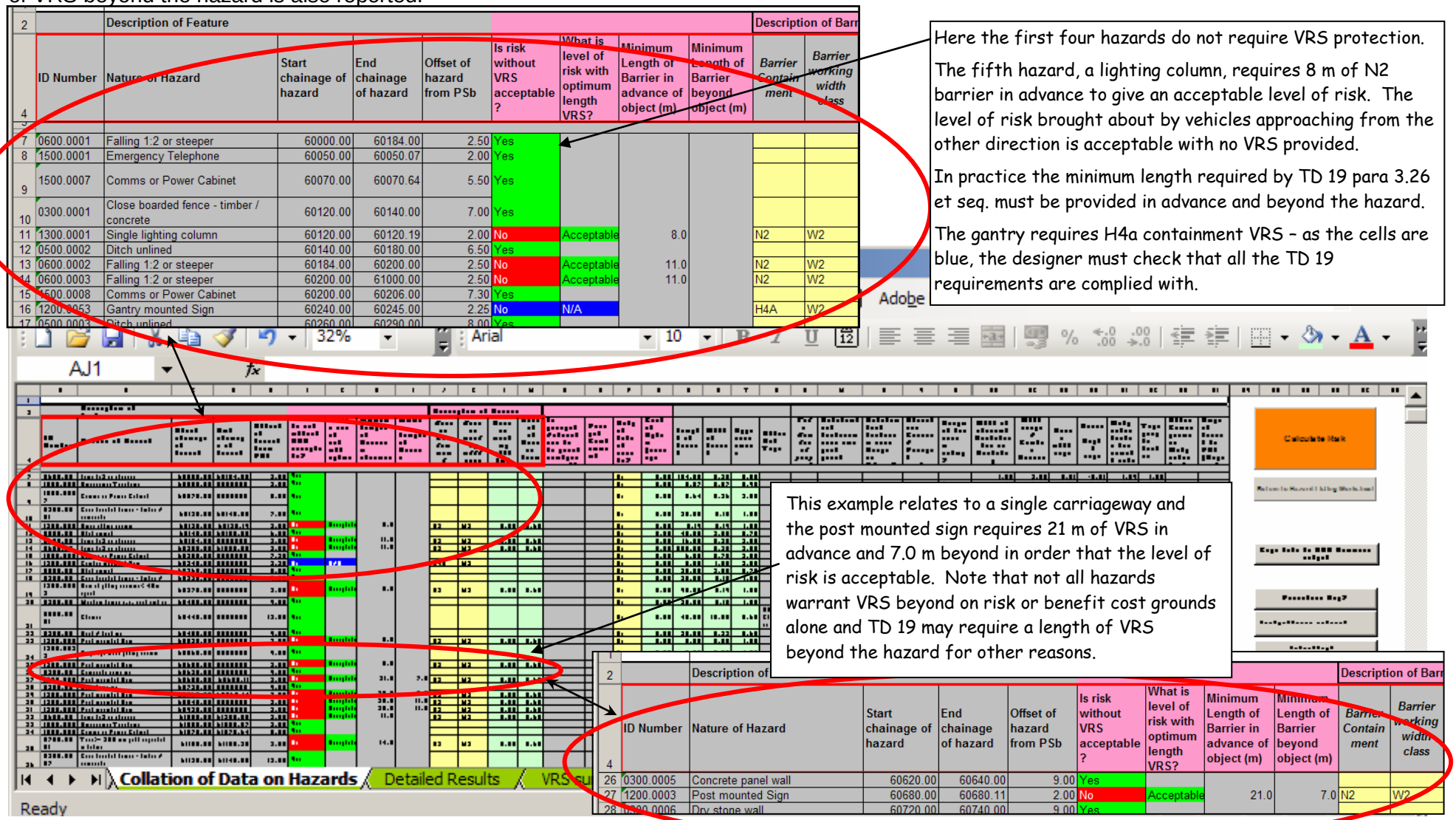
The Designer is then able to review the detailed risk and cost benefit results for any one or all of the hazards. This is done by changing the entry in column P 'Output detailed results' from 'No' to 'Yes' for the hazards to be looked at in more detail. In practice, situations where the risk level is acceptable without VRS and where the risk level with N2 containment VRS is acceptable are unlikely to warrant further investigation, leaving just those entries for which the risk is 'Tolerable' or 'Unacceptable' to be looked at. It is suggested that each hazard is looked at in turn, rather than opting to show all detailed results at the same time which can become confusing. Having indicated 'Yes' in the 'Output detailed results' column, press the 'Calculate Risk' button, whereupon the RRAP will show the risk and cost benefit results in the 'Detailed Results' worksheet. Note that the Designer is given the option of clearing all previous detailed results and only posting the latest set of results.

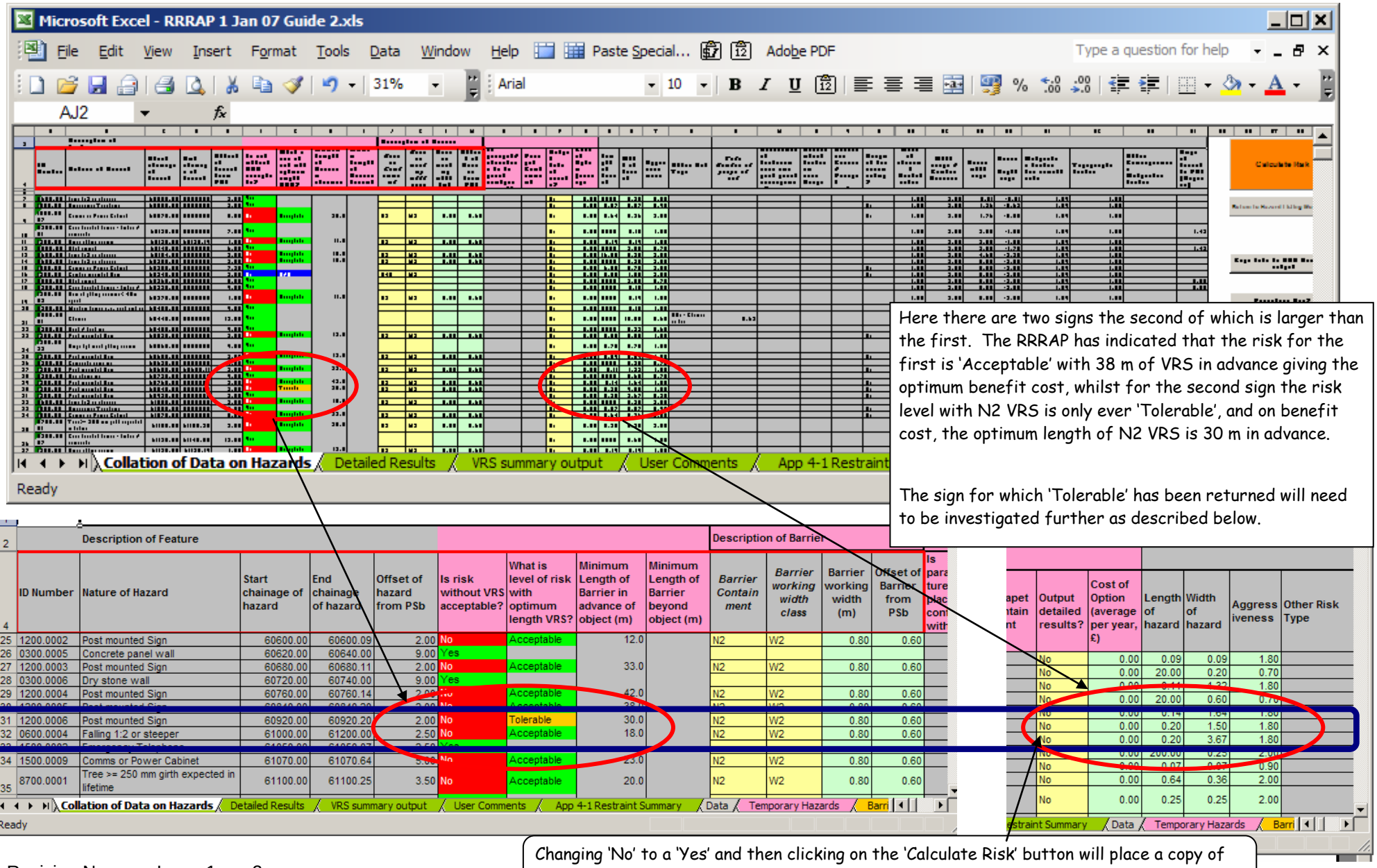
Where the risk is either 'Tolerable' or 'Unacceptable', the Designer can investigate the effect of changing the containment level of the safety barrier from N2 to either H1 or H4a in Column J. The change in barrier containment level can be entered in column J and, when 'Calculate risk' is pressed, the RRRAP will calculate the new risk level with the optimum length of VRS. Note that the detailed results are only provided if the entry in column P 'Output detailed results' is showing 'Yes'. Note also that when the 'Copy data to VRS Summary output' button is pressed, the figures that are showing in the 'Collation of data on Hazards table are transferred across.

If, based on the data in the 'Detailed Results' worksheet, the Designer proposes to use a VRS length in advance of the hazard that is different from the minimum transferred across, the proposed length must be manually changed in the VRS summary output worksheet and the reasoning added in the 'Comments' column. Similarly with any other changes, such as to working width class, that are made. The Designer should check that the location of the safety barrier and proposed working width class meet the requirements of Set-back and minimum distances to top or toe of slope (TD19 Figures 3-1, 3-2 and 3-4 refer).

The Designer must ensure that the 'Calculate risk' button has been pressed subsequent to making any changes to the information in the 'Collation of Data on hazards' worksheet and prior to pressing the 'Copy data to VRS Summary output' button to ensure that the data transferred accurately reflects the final situation.

6.2.2 Pressing the 'Calculate Risk' button for the first time automatically calculates whether the risk level at the hazard is acceptable without VRS protection, displaying the information in the 'Collation of Hazards' worksheet. If it is not, the risk level with the optimum length of N2 containment level VRS in advance of the hazard is shown as either 'Acceptable', 'Tolerable', or 'Unacceptable'. For single carriageways only, the optimum length of VRS beyond the hazard is also reported.





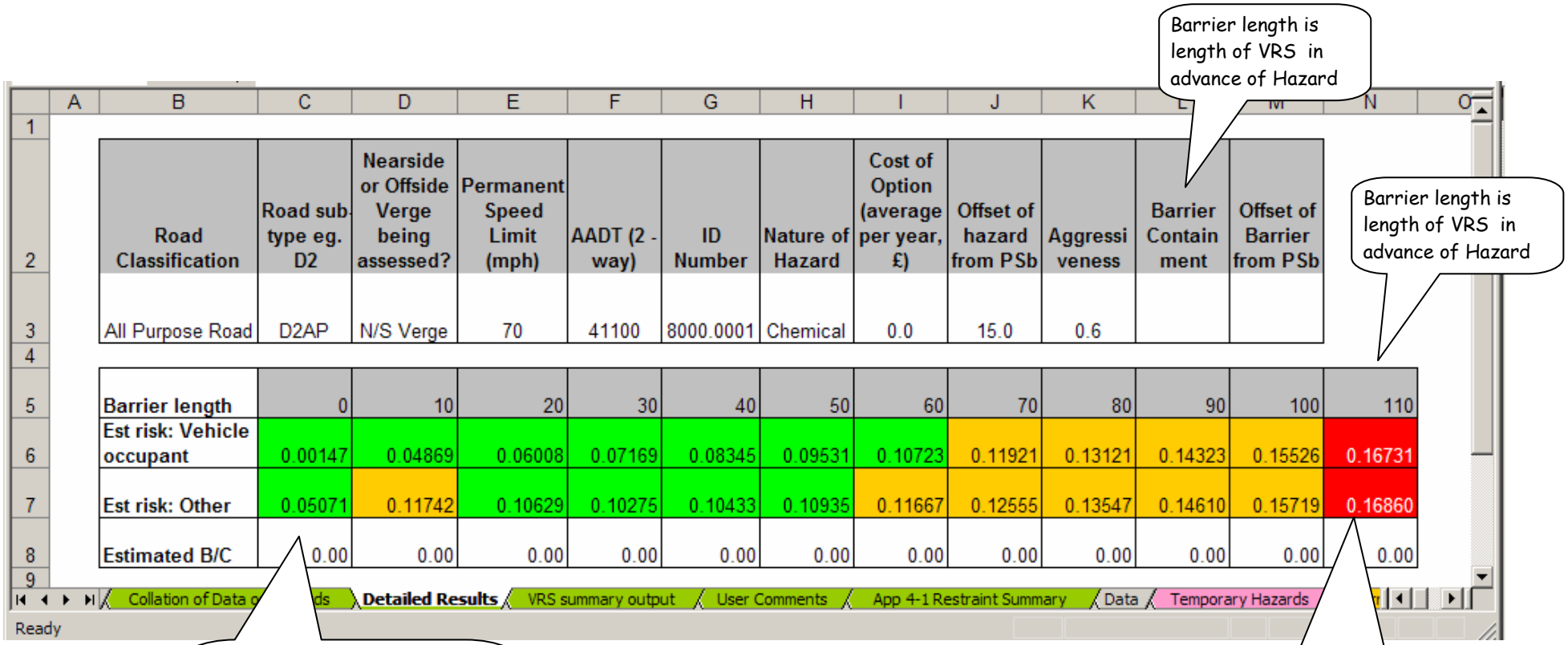
Here there are two signs the second of which is larger than the first. The RRRAP has indicated that the risk for the first is 'Acceptable' with 38 m of VRS in advance giving the optimum benefit cost, whilst for the second sign the risk level with N2 VRS is only ever 'Tolerable', and on benefit cost, the optimum length of N2 VRS is 30 m in advance.

The sign for which 'Tolerable' has been returned will need to be investigated further as described below.

Changing 'No' to a 'Yes' and then clicking on the 'Calculate Risk' button will place a copy of the risk and benefit cost calculation information into the 'Detailed Results' worksheet.

6.2.3 Detailed Results worksheet

If the level of risk without VRS is 'Tolerable' or 'Unacceptable', the detailed risk and cost benefit levels of VRS provision must be looked at. This is done by changing the 'Output detailed results' line from 'no' to 'yes' as shown on the previous page and pressing the 'Calculate Risk' button to the right hand side of the worksheet for the second time. The example shown is for a railway that is running parallel to the road under consideration.



Road Classification	Road sub-type eg. D2	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT (2 - way)	ID Number	Nature of Hazard	Cost of Option (average per year, £)	Offset of hazard from PSb	Aggressiveness	Barrier Containment	Offset of Barrier from PSb
All Purpose Road	D2AP	N/S Verge	70	41100	8000.0001	Chemical	0.0	15.0	0.6		

Barrier length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.00147	0.04869	0.06008	0.07169	0.08345	0.09531	0.10723	0.11921	0.13121	0.14323	0.15526	0.16731
Est risk: Other	0.05071	0.11742	0.10629	0.10275	0.10433	0.10935	0.11667	0.12555	0.13547	0.14610	0.15719	0.16860
Estimated B/C	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

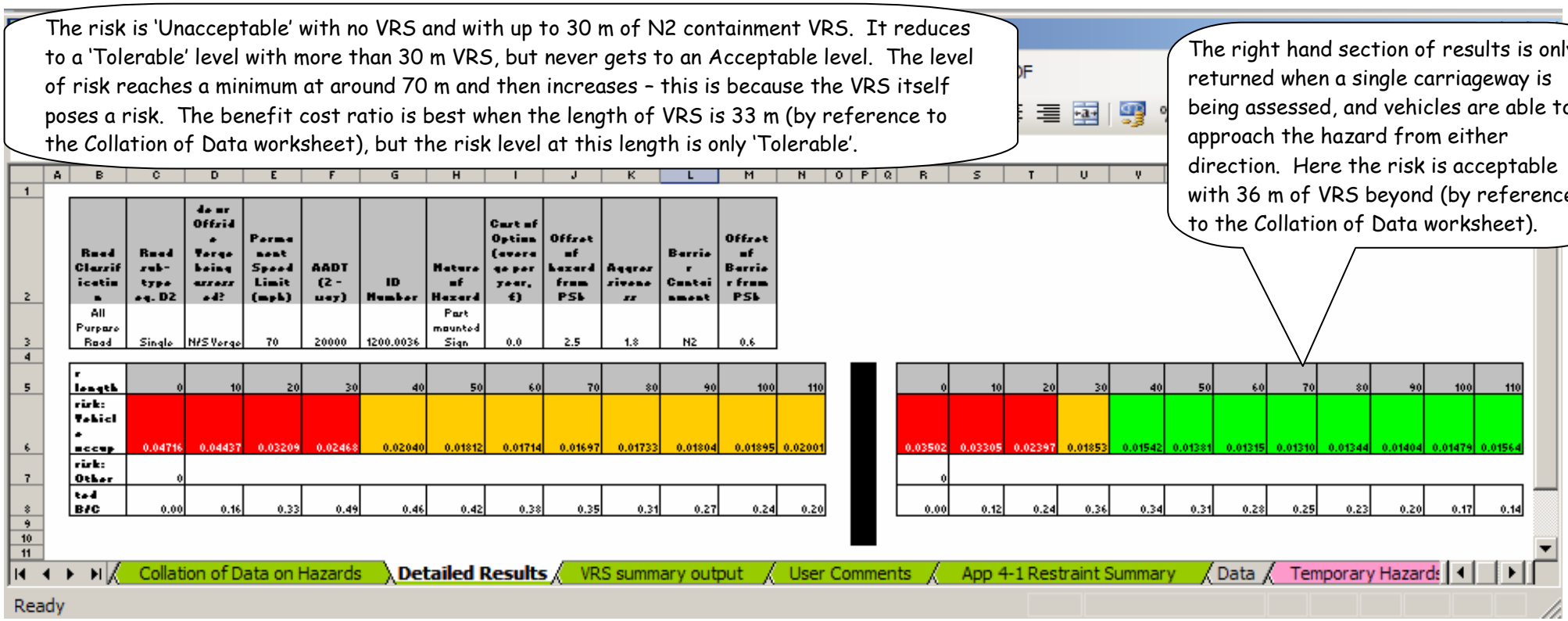
6.2.4 Clearing Detailed Results

The second and subsequent times that the 'Calculate Risk' button is pressed, the user will be given the option of clearing previous 'Detailed Results', or appending the latest set of 'Detailed Results' relating to the items where 'Output detailed results?' has been shown as 'yes'. For ease of comparison, it is recommended that either one solution is investigated and resolved at a time, or that the row immediately below the last set of outputs in the 'Detailed Results' worksheet is highlighted to indicate where one set of detailed results starts and the next begins. It is also recommended that copies of the spreadsheet are saved under different filenames at key stages / detailed results copied into the 'User Comments' worksheet, so that information and results can be revisited if necessary to confirm the appropriate solution.

6.2.5 Example of Detailed Results output on a single carriageway

The risk is 'Unacceptable' with no VRS and with up to 30 m of N2 containment VRS. It reduces to a 'Tolerable' level with more than 30 m VRS, but never gets to an Acceptable level. The level of risk reaches a minimum at around 70 m and then increases – this is because the VRS itself poses a risk. The benefit cost ratio is best when the length of VRS is 33 m (by reference to the Collation of Data worksheet), but the risk level at this length is only 'Tolerable'.

The right hand section of results is only returned when a single carriageway is being assessed, and vehicles are able to approach the hazard from either direction. Here the risk is acceptable with 36 m of VRS beyond (by reference to the Collation of Data worksheet).



7. Calculation of Risk – Detailed Results and Option Selection

Here, 'Tolerable' has been returned for a post mounted sign of width 3.67 m length 0.2 m that is offset 2.0 m from Psb when it has 30 m of N2, W2 vehicle restraint in advance and the barrier is offset 0.6 m from Psb. (Note that where 'Unacceptable' is returned, no barrier length is given). There are a number of possible solutions that could be investigated to ensure that an 'Acceptable' risk is obtained. They might be e.g. (a) moving the barrier further from the carriageway; (b) moving the sign post, possibly in conjunction with (a); and (c) changing the sign to be passively safe. These options are explored in detail below. Investigation may also be warranted if the risk is 'Acceptable but the barrier length is considered too long and savings could be made by e.g. moving the hazard, or changing its characteristics.

Parts of these lines of output are continued below.

2	Description of Feature									Description of Barrier			
4	ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb
31	1200.0006	Post mounted Sign	60920.00	60920.20	2.00	No	Tolerable	30.0		N2	W2	0.80	0.60
32	0600.0004	Falling 1:2 or steeper	61000.00	61200.00	2.50	No	Acceptable	18.0		N2	W2	0.80	0.60
33	1300.0002	Emergency Telephone	61050.00	61050.07	2.50	Yes							
34	1500.0009	Comms or Power Cabinet	61070.00	61070.64	5.00	No	Acceptable	23.0		N2	W2	0.80	0.60
	8700.0001	Tree >= 250 mm girth expected in	61100.00	61100.25	3.50	No	Acceptable	20.0		N2	W2	0.80	0.60

Description of Barrier																	
Barrier Containment	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb	Is parapet/structure to be placed contiguously with barrier?	Parapet Containment	Output detailed results?	Cost of Option (average per year, £)	Length of hazard	Width of hazard	Aggressiveness		Width of adjacent Hardshoulder or Hardstrip	Width verge / Central Reserve	Overall width slope	Overall Height slope	Multiplicative factor for runoff rate	Topography Factor
N2	W2	0.80	0.60			No	0.00	0.20	3.67	1.80		1.00	2.50	5.00	-2.50	1.09	1.00
N2	W2	0.80	0.60			No	0.00	200.00	0.25	2.00		1.00	2.50	5.00	-2.50	1.09	1.00

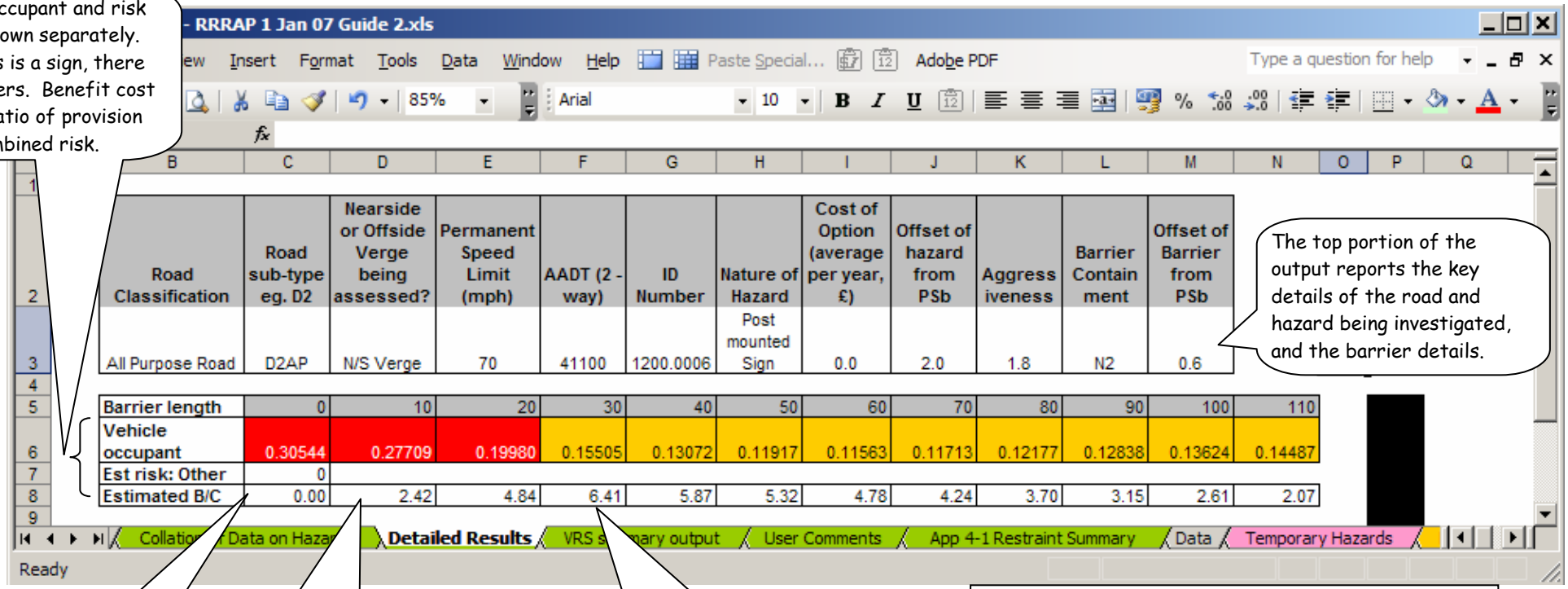
Changing 'No' to a 'Yes' and then clicking on the 'Calculate Risk' button will place a copy of the risk and benefit cost calculation information into the 'Detailed Results' worksheet.

Note that on earthworks only, a nominal width of hazard has been returned and this figure should not be altered.

A return of 0.00 here indicates that the default costs are being used in the RRRAP. If better VRS cost information is available, the default average value can be changed. Back up on new costing must be provided in the table on the 'Barrier and Options' worksheets.

7.1 Detailed Results for the Post Mounted Sign example

Risk to Vehicle occupant and risk to Others are shown separately. Note that as this is a sign, there is no risk to Others. Benefit cost is benefit cost ratio of provision based on the combined risk.



Road Classification	Road sub-type eg. D2	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT (2 - way)	ID Number	Nature of Hazard	Cost of Option (average per year, £)	Offset of hazard from PSb	Aggressiveness	Barrier Containment	Offset of Barrier from PSb
All Purpose Road	D2AP	N/S Verge	70	41100	1200.0006	Post mounted Sign	0.0	2.0	1.8	N2	0.6

Barrier length	0	10	20	30	40	50	60	70	80	90	100	110
Vehicle occupant	0.30544	0.27709	0.19980	0.15505	0.13072	0.11917	0.11563	0.11713	0.12177	0.12838	0.13624	0.14487
Est risk: Other	0											
Estimated B/C	0.00	2.42	4.84	6.41	5.87	5.32	4.78	4.24	3.70	3.15	2.61	2.07

The top portion of the output reports the key details of the road and hazard being investigated, and the barrier details.

This column shows the risk level and benefit cost level if no VRS is present.

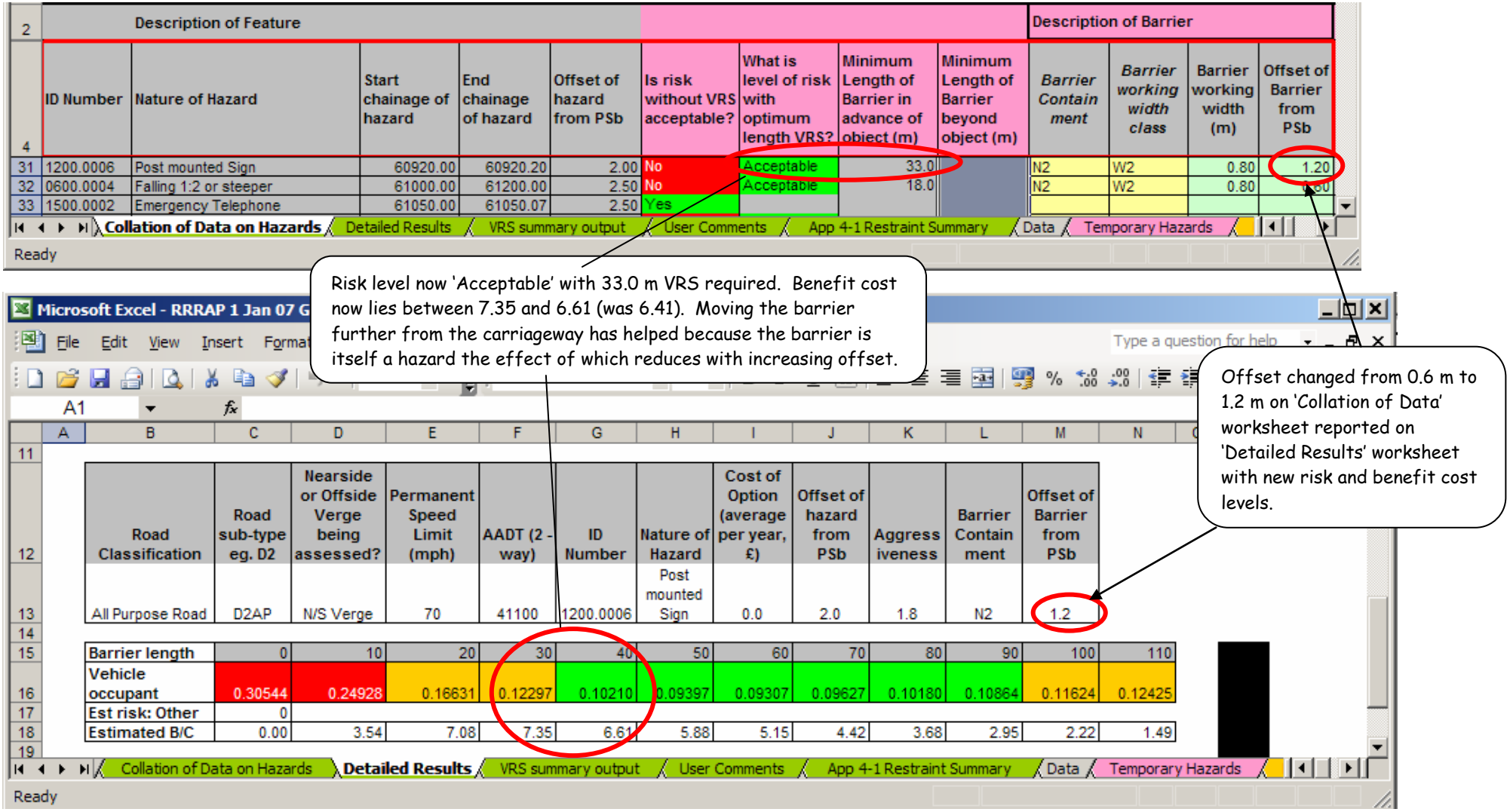
This column and those to the right show the respective levels with 10 m, 20 m, etc of VRS in advance of the hazard.

The optimum length of VRS indicated in the 'Collation of Data' worksheet was 30 m with the risk being 'Tolerable'.

Note that a positive benefit cost can be achieved by putting in a VRS even where the RRRAP indicates that a VRS is not necessary on risk grounds alone. This is especially the case in borderline situations e.g. on comms cabinets.

7.2 Possible solutions investigated for sign

(a) Moving barrier from 0.6 m offset (default value when there is a hardstrip or hardshoulder present) to 1.2 m offset. Note that this option is possible here due to the verge width of 2.5 m being adequate to allow VRS to be moved – see Fig 3-1 and 3-2 of TD 19 for details of constraints.



	Description of Feature									Description of Barrier			
4	ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb
31	1200.0006	Post mounted Sign	60920.00	60920.20	2.00	No	Acceptable	33.0		N2	W2	0.80	1.20
32	0600.0004	Falling 1:2 or steeper	61000.00	61200.00	2.50	No	Acceptable	18.0		N2	W2	0.80	0.60
33	1500.0002	Emergency Telephone	61050.00	61050.07	2.50	Yes							

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready

Risk level now 'Acceptable' with 33.0 m VRS required. Benefit cost now lies between 7.35 and 6.61 (was 6.41). Moving the barrier further from the carriageway has helped because the barrier is itself a hazard the effect of which reduces with increasing offset.

Offset changed from 0.6 m to 1.2 m on 'Collation of Data' worksheet reported on 'Detailed Results' worksheet with new risk and benefit cost levels.

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A1

12	Road Classification	Road sub-type eg. D2	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT (2 - way)	ID Number	Nature of Hazard	Cost of Option (average per year, £)	Offset of hazard from PSb	Aggressiveness	Barrier Containment	Offset of Barrier from PSb
13	All Purpose Road	D2AP	N/S Verge	70	41100	1200.0006	Post mounted Sign	0.0	2.0	1.8	N2	1.2

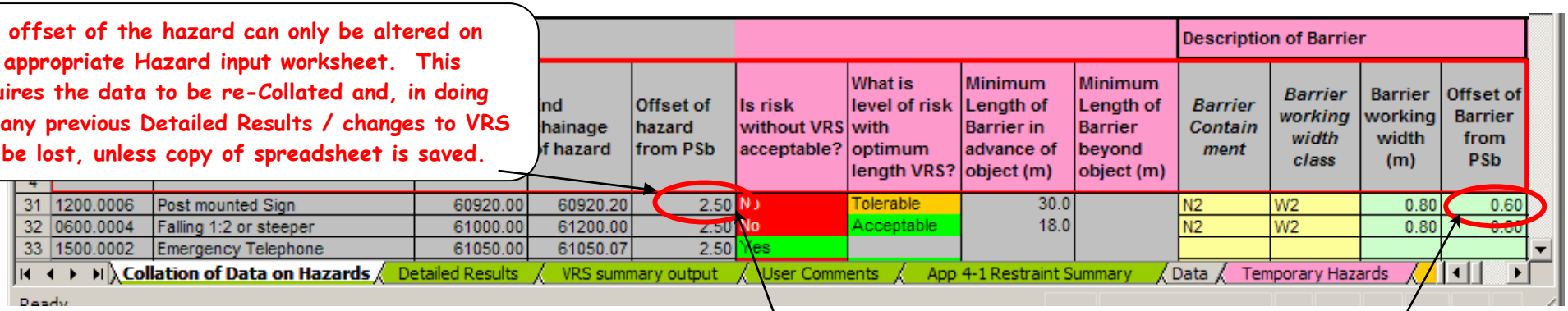
15	Barrier length	0	10	20	30	40	50	60	70	80	90	100	110
16	Vehicle occupant	0.30544	0.24928	0.16631	0.12297	0.10210	0.09397	0.09307	0.09627	0.10180	0.10864	0.11624	0.12425
17	Est risk: Other	0											
18	Estimated B/C	0.00	3.54	7.08	7.35	6.61	5.88	5.15	4.42	3.68	2.95	2.22	1.49

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready

(b1) Moving hazard further from carriageway (from 2.0 m offset to 2.5 m offset).

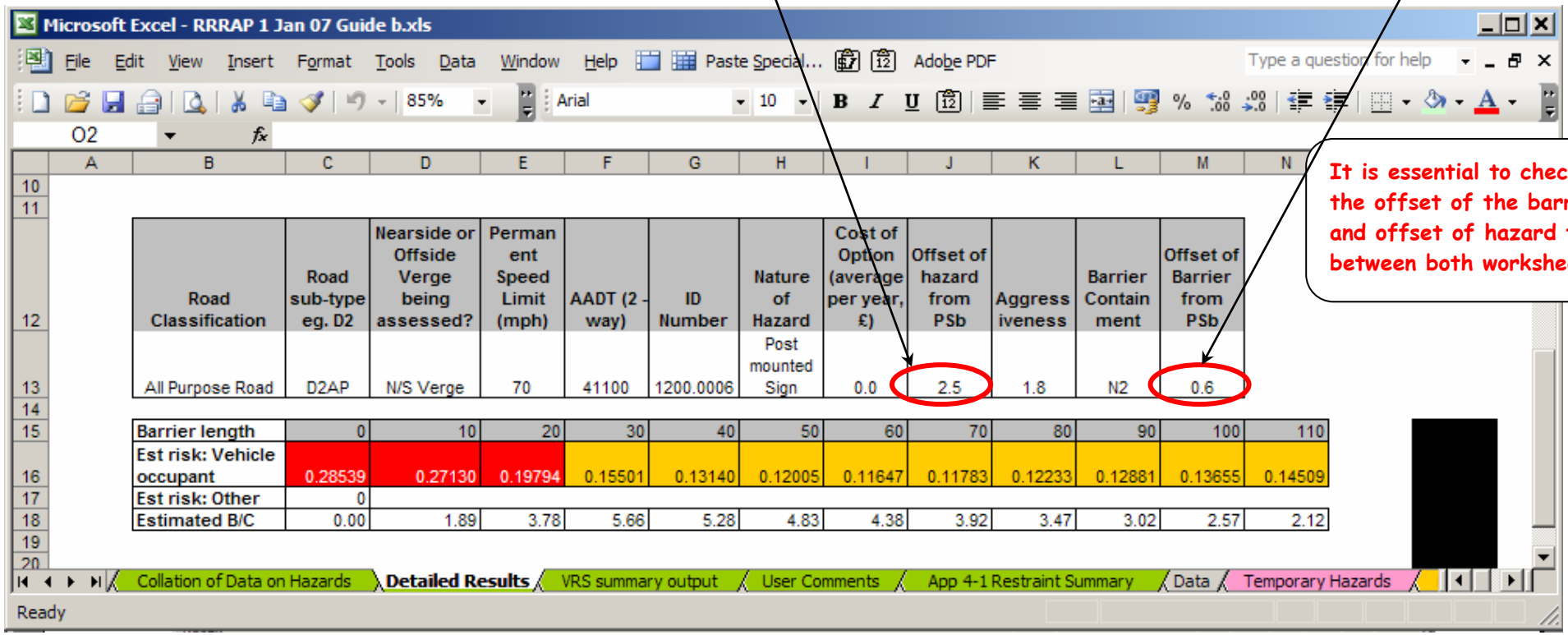
The offset of the hazard can only be altered on the appropriate Hazard input worksheet. This requires the data to be re-Collated and, in doing so, any previous Detailed Results / changes to VRS will be lost, unless copy of spreadsheet is saved.



										Description of Barrier			
				nd hainage f hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb
31	1200.0006	Post mounted Sign	60920.00	60920.20	2.50	N	Tolerable	30.0		N2	W2	0.80	0.60
32	0600.0004	Falling 1:2 or steeper	61000.00	61200.00	2.50	No	Acceptable	18.0		N2	W2	0.80	0.60
33	1500.0002	Emergency Telephone	61050.00	61050.07	2.50	Yes							

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready



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O2

Road Classification	Road sub-type eg. D2	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT (2-way)	ID Number	Nature of Hazard	Cost of Option (average per year, £)	Offset of hazard from PSb	Aggressiveness	Barrier Containment	Offset of Barrier from PSb
All Purpose Road	D2AP	N/S Verge	70	41100	1200.0006	Post mounted Sign	0.0	2.5	1.8	N2	0.6

Barrier length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.28539	0.27130	0.19794	0.15501	0.13140	0.12005	0.11647	0.11783	0.12233	0.12881	0.13655	0.14509
Est risk: Other	0											
Estimated B/C	0.00	1.89	3.78	5.66	5.28	4.83	4.38	3.92	3.47	3.02	2.57	2.12

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready

It is essential to check that the offset of the barrier and offset of hazard tally between both worksheets.

(b2) Moving hazard further from carriageway (from 2.0 m offset to 2.5 m offset) and moving VRS from 0.6 m to 1.2 m.

	Description of Feature									Description of Barrier			
4	ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Is risk without VRS acceptable?	What is level of risk with optimum length VRS?	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	*Barrier Containment*	*Barrier working width class*	Barrier working width (m)	Offset of Barrier from PSb
31	1200.0006	Post mounted Sign	60920.00	60920.20	2.50	No	Acceptable	35.0		N2	W2	0.80	1.20
32	0600.0004	Falling 1:2 or steeper	61000.00	61200.00	2.50	No	Acceptable	18.0		N2	W2	0.80	0.60
33	1500.0002	Emergency Telephone	61050.00	61050.07	2.50	Yes							
34	1500.0009	Comms or Power Cabinet	61070.00	61070.64	5.00	No	Acceptable	23.0		N2	W2	0.80	0.60
		Tree >= 250 mm girth expected in											

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready

Moving the sign to 2.5 m offset has marginally reduced risk with 'no VRS' from what it was when offset was 2.0 m. However risk 'with VRS' has marginally increased and benefit cost decreased. Refer to summary of possible solutions below for further comment and explanation.

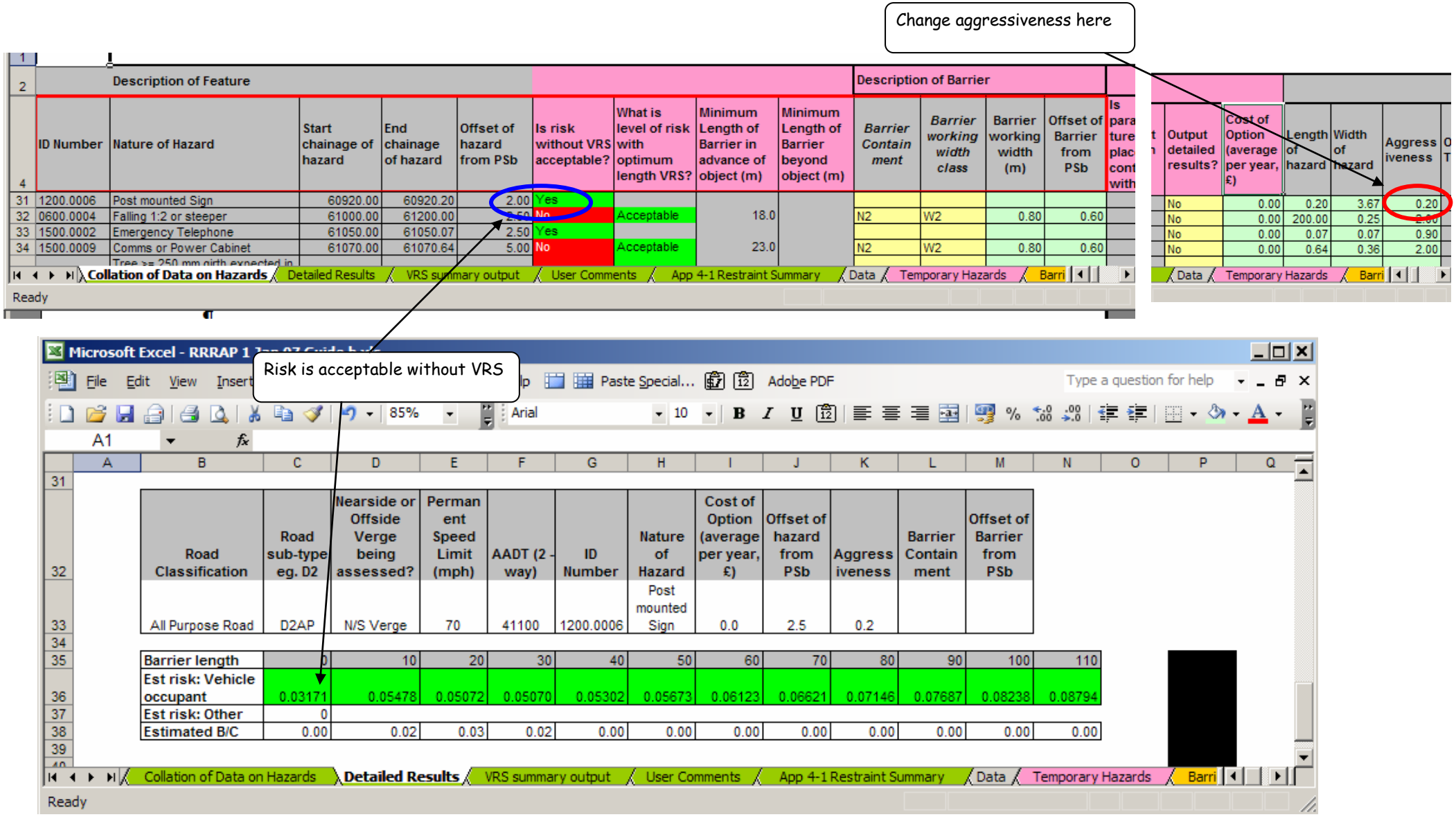
Road Classification	Road sub-type eg. D2	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT (2-way)	ID Number	Nature of Hazard	Cost of Option (average per year, £)	Offset of hazard from PSb	Aggressiveness	Barrier Containment	Offset of Barrier from PSb
All Purpose Road	D2AP	N/S Verge	70	41100	1200.0006	Post mounted Sign	0.0	2.5	1.8	N2	1.2

Barrier length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.28539	0.24766	0.16898	0.12658	0.10537	0.09654	0.09495	0.09758	0.10268	0.10923	0.11662	0.12450
Est risk: Other	0											
Estimated B/C	0.00	2.65	5.31	6.55	5.96	5.37	4.78	4.19	3.61	3.02	2.43	1.84

Collation of Data on Hazards | Detailed Results | VRS summary output | User Comments | App 4-1 Restraint Summary | Data | Temporary Hazards

Ready

(c) Changing sign to passively safe (Aggressiveness of normal sign 1.8 and that of passively safe sign is 0.2).



7.3 Résumé of options investigated for sign

	Original situation			(a) move VRS to 1.2 m offset			(b1) move hazard to 2.5 m offset			(b2) move hazard to 2.5 m offset, VRS at 1.2 m			(c) Use Passively safe sign
Offset of sign from Psb	2.0 m			2.0 m			2.5 m			2.5 m			2.0 m
Offset of VRS from Psb	0.6 m			1.2 m			0.6 m			1.2 m			
Optimum VRS length	30.0 m			33.0 m			30.0 m			35.0 m			Not req'd
Barrier length (m)	0	30	40	0	30	40	0	30	40	0	30	40	0
Est risk: Vehicle occupant	0.30544	0.15505	0.13072	0.30544	0.12297	0.10210	0.28539	0.15501	0.13140	0.28539	0.12658	0.10537	0.03171
Est risk: Other	0	0	0	0	0	0	0	0	0	0	0	0	0
Estimated B/C	0.00	6.41	5.87	0.00	7.35	6.61	0.00	5.66	5.28	0.00	6.55	5.96	0.00

Original situation and Option (b1) are not acceptable.
Option (b2) moving both sign and VRS may be a good option, although longer VRS is required than in Option (a), a large working width is possible which may give cost savings. Local constraints e.g. available land, adjacent VRS locations, etc may not allow this option.
Option (c) may overall give best solution.

Note that risk with 40 m of VRS with Option (b2) is greater than with same length of VRS in Option (a) because there is more chance of errant vehicles on a shallow diverge angle getting behind the barrier if there is a bigger gap between the barrier and the hazard than there is with a smaller gap. As the length of VRS increases, the difference in risk between the two situations diminishes as there is less and less opportunity for errant vehicles to reach the hazard despite the increased gap width.

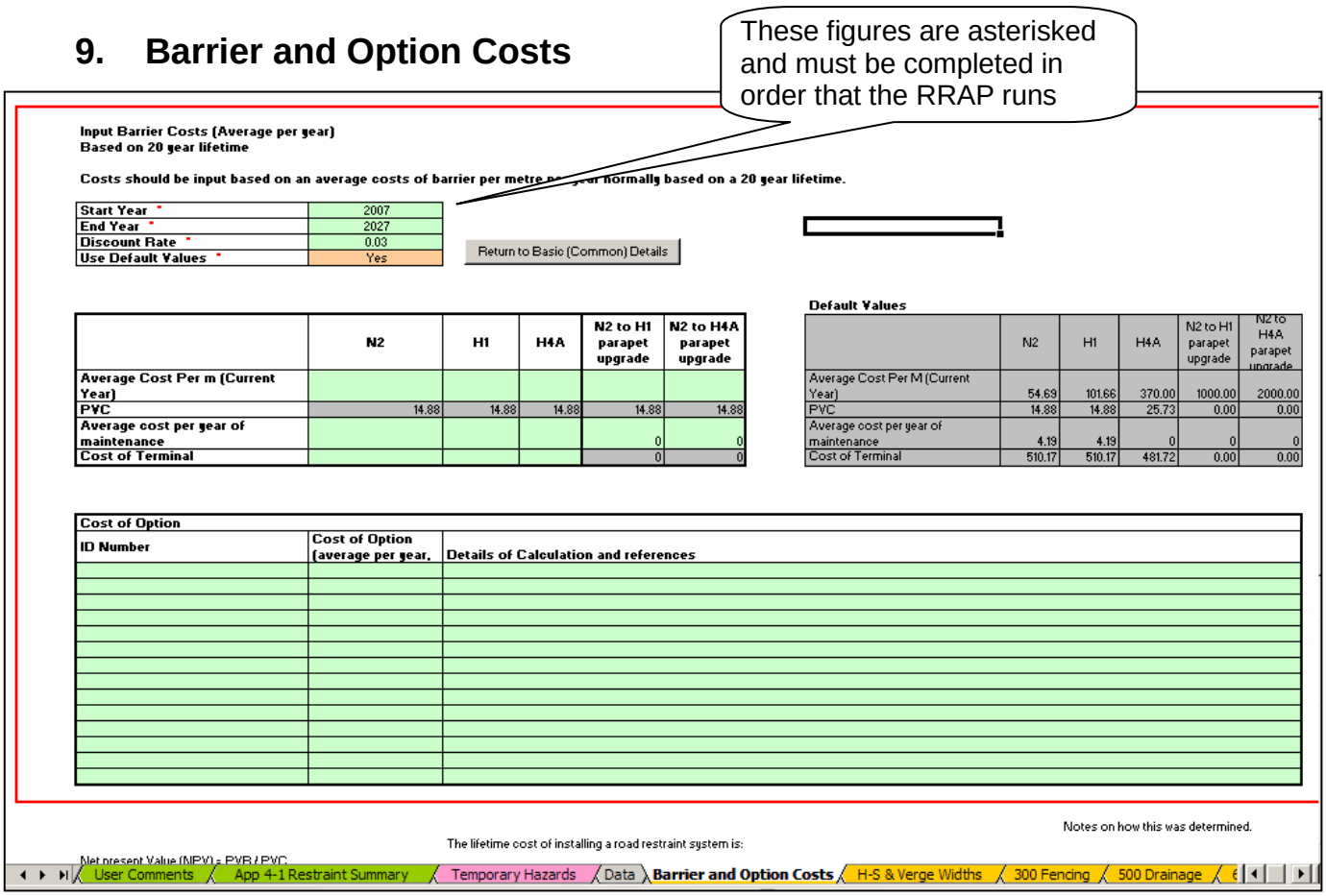
8. The Designer must Check and Ensure

(i) All the data and fields showing in the 'Collation of Data' worksheet represent the final chosen option,

(ii) The 'Detailed results' worksheet has been populated with all the relevant data to back up the decision made, and

(iii) The Output detailed results rows are all showing 'no'. If necessary, the Calculate Risk button must be pressed again, without clearing the previous Detailed Results information already posted.

9. Barrier and Option Costs



See also Para 3.10 of this Guidance

Net present Value (NPV) = PVB / PVC

PVB is the present value of benefits
PVC is the present value of costs.

$PVC = C + M\,(1-(1+D)^{-n})/D) + Q$

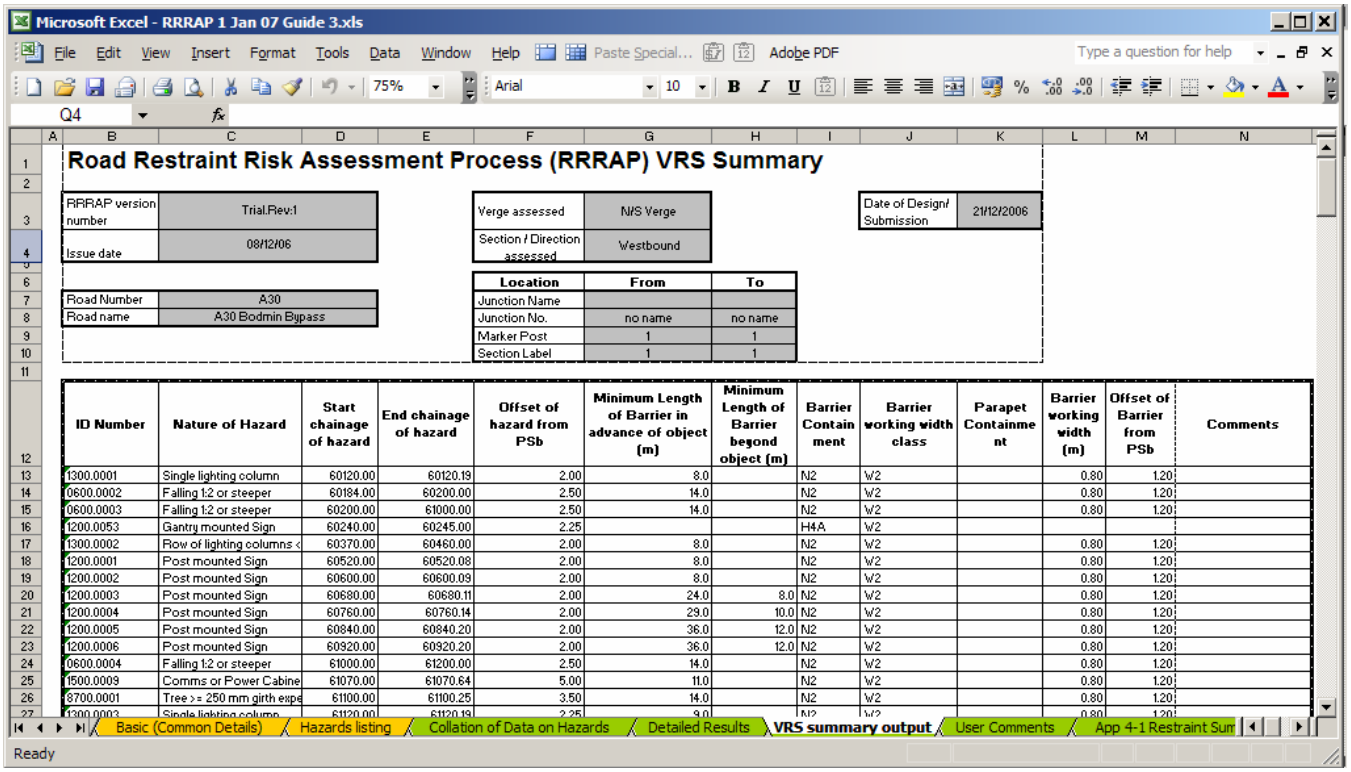
C is the installation cost (default £580 for the terminal and £5 per m for the restraint)
M is the annual maintenance cost (default £4.2 per m)
D is the discount rate (default 0.03)
N is the life of the restraint system (default 20 years)
Q is the installation delays (default 0)

Formula used for PVC in spreadsheet is
(1-(1+$D$10)^(-1*($N$57)))/$D$10 = 14.877 when N57 = 20 yrs and D10 = 0.03 = discount rate

If the default values are not used, then details of the basis behind alternative costings must be provided.

10. VRS Summary Sheet

This worksheet is automatically populated when the 'copy data to VRS summary output' button on the 'Collation of Data on Hazards' worksheet is pressed. The Designer can add comments to support the design choices.



ID Number	Nature of Hazard	Start chainage of hazard	End chainage of hazard	Offset of hazard from PSb	Minimum Length of Barrier in advance of object (m)	Minimum Length of Barrier beyond object (m)	Barrier Containment	Barrier working width class	Parapet Containment	Barrier working width (m)	Offset of Barrier from PSb	Comments
1300.0001	Single lighting column	60120.00	60120.19	2.00	8.0		N2	W2		0.80	1.20	
0600.0002	Falling 1:2 or steeper	60184.00	60200.00	2.50	14.0		N2	W2		0.80	1.20	
0600.0003	Falling 1:2 or steeper	60200.00	61000.00	2.50	14.0		N2	W2		0.80	1.20	
1200.0053	Gantry mounted Sign	60240.00	60245.00	2.25			H4A	W2				
1300.0002	Row of lighting columns <	60370.00	60460.00	2.00	8.0		N2	W2		0.80	1.20	
1200.0001	Post mounted Sign	60520.00	60520.08	2.00	8.0		N2	W2		0.80	1.20	
1200.0002	Post mounted Sign	60600.00	60600.09	2.00	8.0		N2	W2		0.80	1.20	
1200.0003	Post mounted Sign	60680.00	60680.11	2.00	24.0	8.0	N2	W2		0.80	1.20	
1200.0004	Post mounted Sign	60760.00	60760.14	2.00	29.0	10.0	N2	W2		0.80	1.20	
1200.0005	Post mounted Sign	60840.00	60840.20	2.00	36.0	12.0	N2	W2		0.80	1.20	
1200.0006	Post mounted Sign	60920.00	60920.20	2.00	36.0	12.0	N2	W2		0.80	1.20	
0600.0004	Falling 1:2 or steeper	61000.00	61200.00	2.50	14.0		N2	W2		0.80	1.20	
1500.0009	Comms or Power Cabine	61070.00	61070.64	5.00	11.0		N2	W2		0.80	1.20	
8700.0001	Tree >= 250 mm girth expe	61100.00	61100.25	3.50	14.0		N2	W2		0.80	1.20	

11. User Comments

This is a worksheet that can be used to record decisions made, copy detailed results and other information that has been used in the process.

12. Appendix 4-1 Restraint Summary

Restraint Summary

Schedule of Road Restraint Systems (Vehicle and Pedestrian)

This is based on the requirements of Specification Appendix 4/1

[Note to Compiler: Complete the schedule below and include in Appendix 4/1. Incorporate in the schedule all the Road Restraint Systems (i.e. safety barriers, terminals, transitions, vehicle parapets, crash cushions, pedestrian parapets and pedestrian guardrails) and any associated anti-glare screens required. Cross-reference should be made to the Drawings where appropriate. The Road Restraint Systems should be listed in order of occurrence, irrespective of type, and the respective start and end chainages of the proposed systems listed. All the Performance Class requirements appropriate for the Road Restraint System and other details such as parapet height should be included. The difference between the End and Start Chainages should be at least the Length of Need of the Road Restraint System as defined in TD 19.

Location & Start Chainage * (m)	Finish Chainage (m)	Position on Cross-Section +	Type of Road Restraint System** (Safety barriers, vehicle parapets, transitions, terminals, crash cushions, pedestrian parapets, pedestrian guardrails)	Set-back (m)	Containment Level ** (Safety barriers, vehicle parapets, transitions) Performance Class (P) (Terminals) **	Impact Severity Level (ISL) ** (Safety barriers, vehicle parapets, transitions, terminals, crash cushions)	Working Width Class** (Safety barriers, vehicle parapets, transitions)	Performance Level and whether Redirective (R) or Non-redirective (NR) (Crash Cushions)	Permanent Lateral Displacement Zone (PLDZ) characterisic ** (Terminals) Permanent Lateral Displacement Zone Class (D) (Crash Cushions)	Exit Box Class ** (Terminals) Redirection Zone Class (Z) (Crash Cushions)	Other Requirements / Comments ** ++ +++

NOTE:

*	e.g. Road name, verge, central reserve, slip road etc.
**	Enter temporary safety barrier where required.
+	e.g. LH verge; central reserve, RH hand verge etc.
++	Height requirements etc.
+++	Anti-glare Screens

Information will need to be transferred to this sheet manually from the VRS summary output. The details contained on this worksheet will be included in any Works Information provided to the Contractor.

13. Temporary Hazards

13.1 Details of typical situations that might be encountered during temporary works are listed down the left hand side of a table contained within the Temporary Hazards worksheet. as shown below.

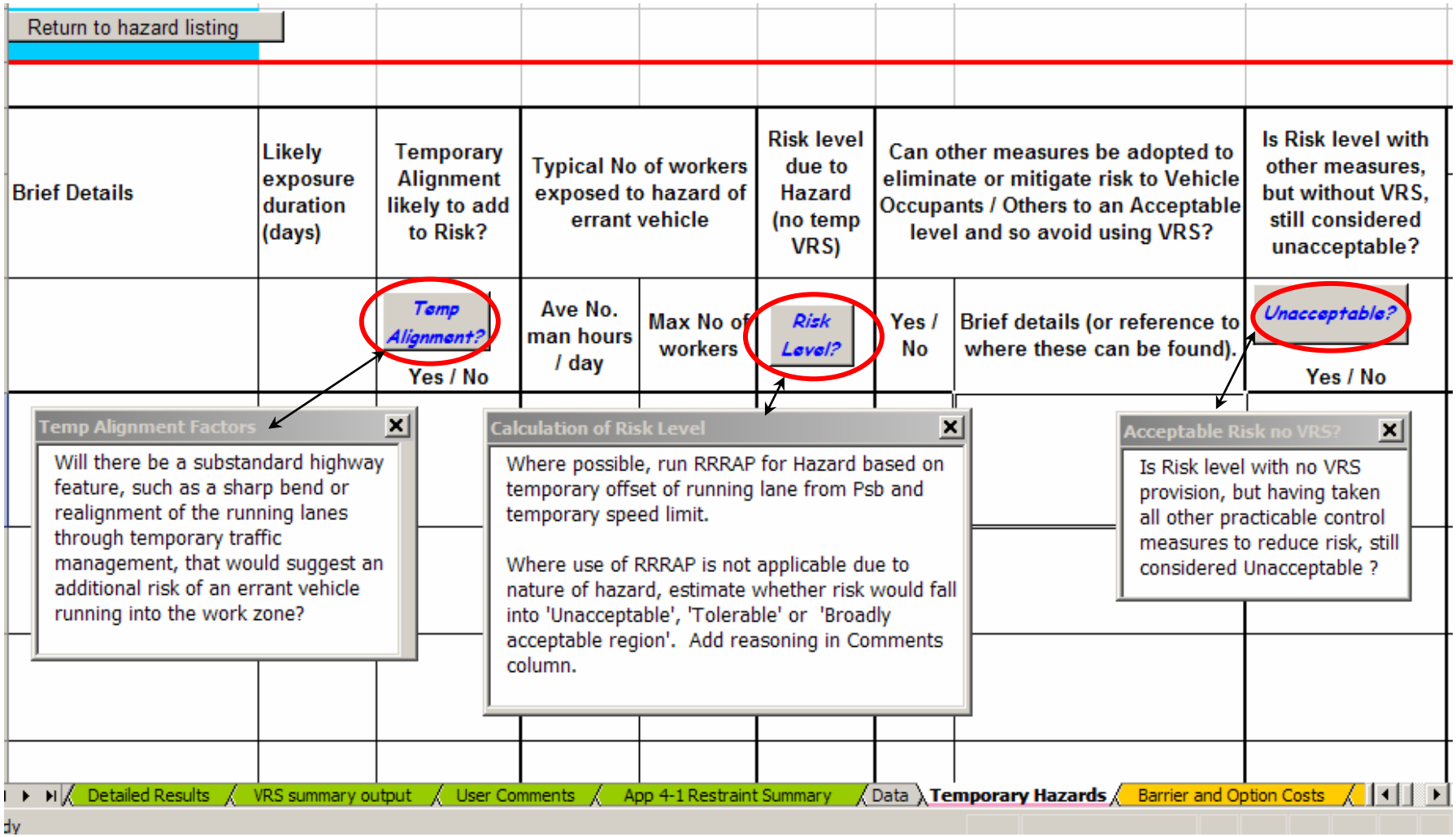
Ref	During works	Y / N	Brief Details	Likely exposure duration (days)
1	Will there be temporary or permanent bridge supports or other vulnerable structures which have a low resistance to impact and where the consequences of such an impact may be severe?			
2	Will traffic run adjacent to scaffolding or temporary access works where workers or non-motorised road users would be unable to take evasive action?			
3	Will works to overhead power cables be undertaken and Skycradles and deployed within or adjacent to the Highway Boundary?			
4	Will there be other temporary hazards that could result in a high risk of injury to travelling public if they run into the work zone (such as excavations more than 300 mm deep adjacent to the traffic lane)?			
5	Will existing VRS be removed temporarily leaving a hazard unprotected?			
6	Will contraflow be used?			
7	Will the work zone be adjacent to a carriageway open to traffic?			
8	Other situation posing temporary hazard to road users?			
9	Other situation posing temporary hazard to workers?			
10	Other situation posing temporary hazard to Others?			
	List below details for second and subsequent instances of above where these are expected			

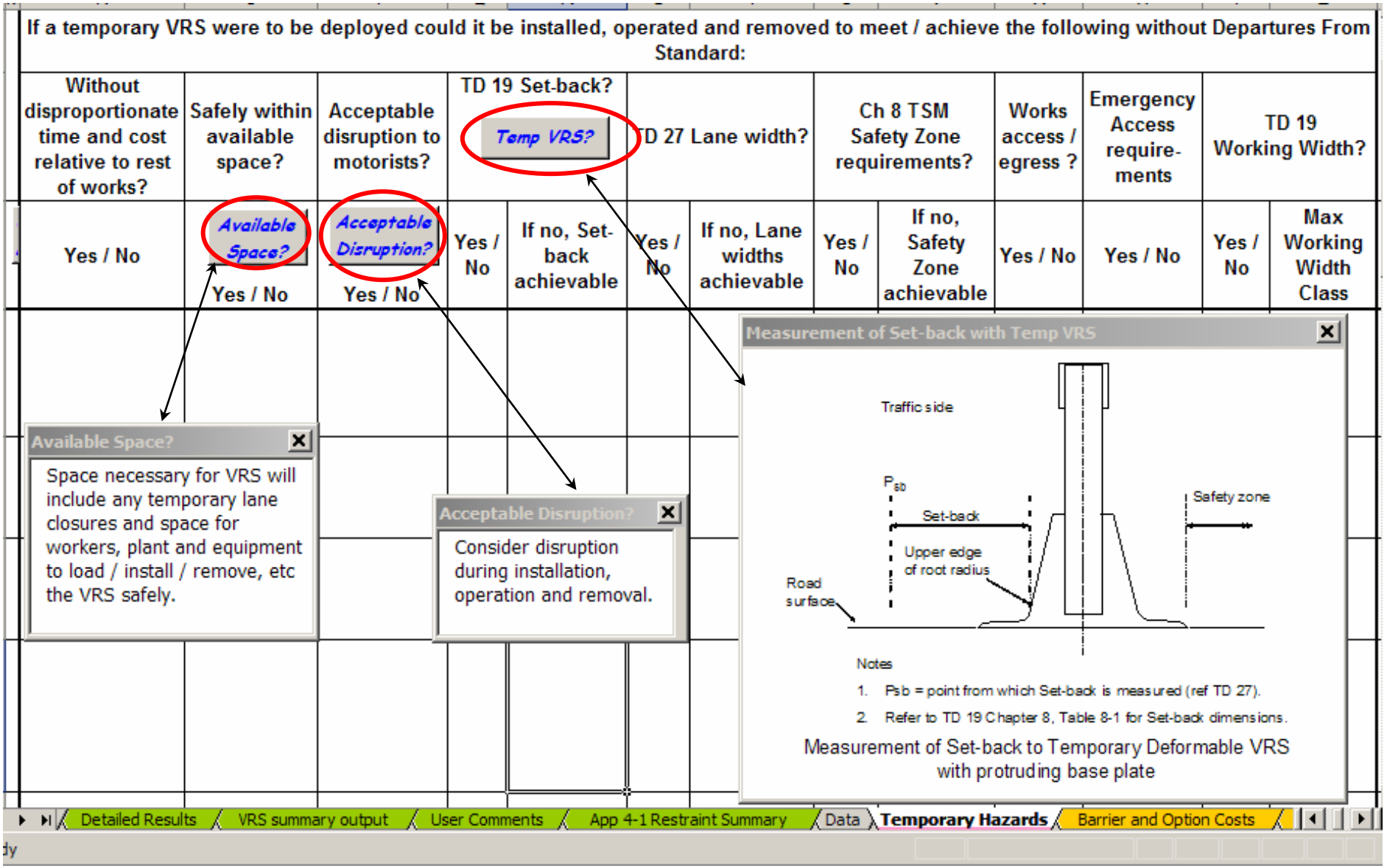
13.2 The Designer indicates against each question in the Yes / No column whether or not each of the circumstances applies in the situation being assessed.

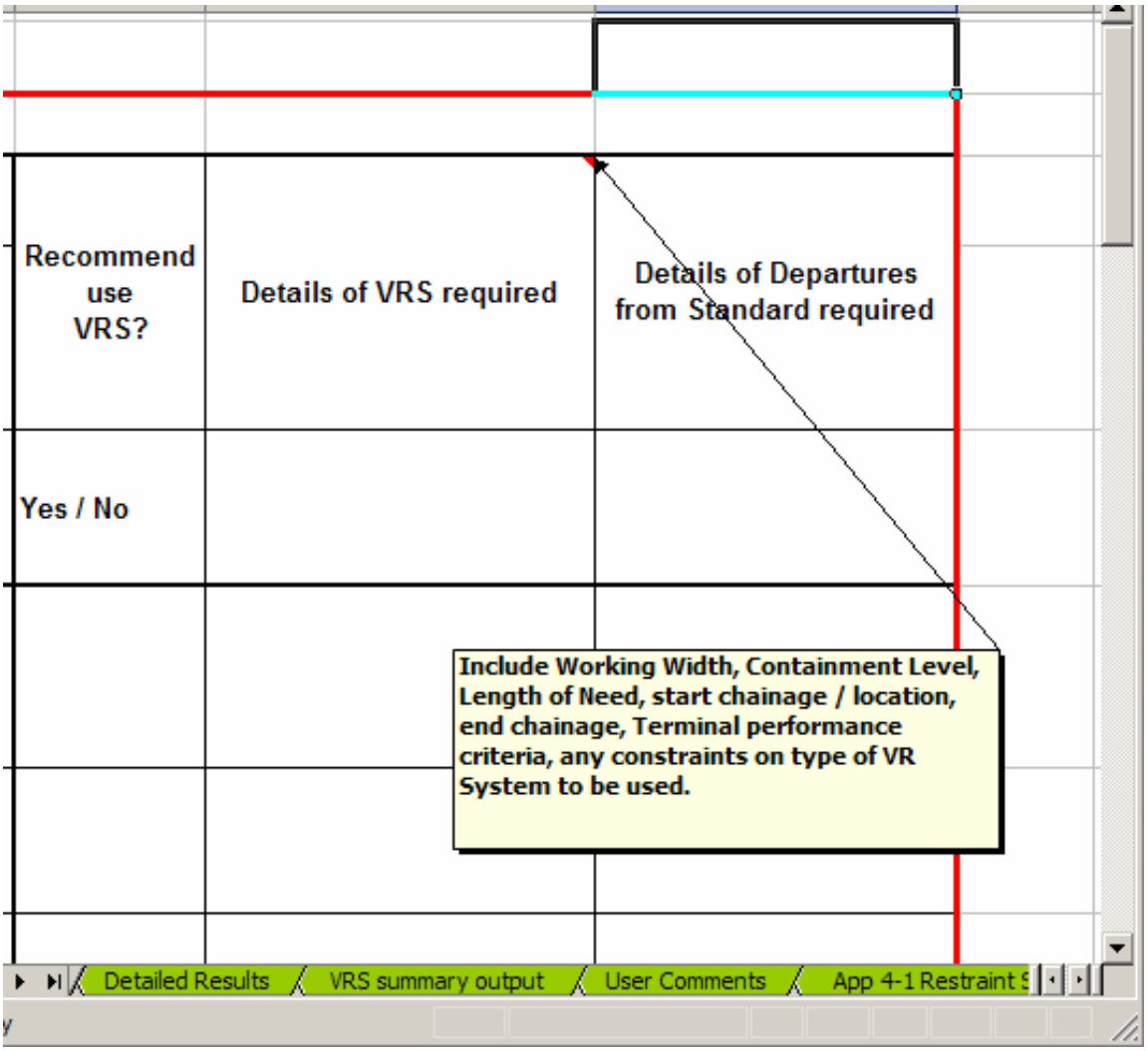
If the answer is 'No', the situation does not apply, then there will be no need to investigate that situation further.

If the answer is 'Yes', the situation does apply, then brief details are entered and the Designer then considers each of the questions in the remainder of the table. These questions are shown on the following pages.

13.3 The extracts below indicate the questions and help menus. Completion of these details will assist the Designer in determining whether provision of a temporary vehicle restraint system(s) is appropriate in each of the circumstances and act as a record for the factors considered. It should be noted that whilst it may not be considered cost effective to provide temporary safety barrier for a single situation, it may be cost effective when the combination of circumstances is considered. Where the response is 'No' to the questions, brief details as to why should be added in the cell.




If a temporary VRS were to be deployed could it be installed, operated and removed to meet / achieve the following without Departures From Standard:
Without disproportionate time and cost relative to rest of works?
Safely within available space?
Acceptable disruption to motorists?
TD 19 Set-back?
Temp VRS?
TD 27 Lane width?
Ch 8 TSM Safety Zone requirements?
Works access / egress ?
Emergency Access require-ments
TD 19 Working Width?
Yes / No
Available Space?
Yes / No
Acceptable Disruption?
Yes / No
Yes / No
If no, Set-back achievable
Yes / No
If no, Lane widths achievable
Yes / No
If no, Safety Zone achievable
Yes / No
Yes / No
Yes / No
Max Working Width Class
Available Space?
Space necessary for VRS will include any temporary lane closures and space for workers, plant and equipment to load / install / remove, etc the VRS safely.
Acceptable Disruption?
Consider disruption during installation, operation and removal.
Measurement of Set-back with Temp VRS
Traffic side
Psb
Set-back
Safety zone
Upper edge of root radius
Road surface
Notes
1. Psb = point from which Set-back is measured (ref TD 27).
2. Refer to TD 19 Chapter 8, Table 8-1 for Set-back dimensions.
Measurement of Set-back to Temporary Deformable VRS with protruding base plate
Detailed Results
VRS summary output
User Comments
App 4-1 Restraint Summary
Data
Temporary Hazards
Barrier and Option Costs


Recommend use VRS?
Details of VRS required
Details of Departures from Standard required
Yes / No
Include Working Width, Containment Level, Length of Need, start chainage / location, end chainage, Terminal performance criteria, any constraints on type of VR System to be used.
Detailed Results
VRS summary output
User Comments
App 4-1 Restraint S