Road Restraint Risk Assessment Process (RRRAP)

User Guide

Issue 5 (for RRRAP version 3.3)

The companies from the supply chain that have contributed to this document, or its previous versions are:

- Mott MacDonald Ltd
- WSP

Issue and Revision Record

Rev	Description
Trial	Initial issue for trialling by external designers
Issue 1 rev 0	General update
Issue 1 Rev 1	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 5.14 (c) and 15(c), old figs renumbered accordingly. Para 5.17.2 added note re verges.
Issue 1 Rev 2	Precis of what the RRRAP covers and does not cover added Error messages – further information added Further information and guidance on the following 8.8.1 Comms cabinets and equipment to allow for maintenance workers. 8.9.1 Crib walls and smooth faced walls 8.10.5 how parapet risk calculated; 8.10.7 specifying parapet working width, 8.10.8 pedestrian restraints; 8.10.9 ref to IAN 91, Structural Collision Loading and Collapse 8.12.1 Utility poles with stays; 8.12.2 Pylons and need to consider implication of pylon or cables falling 8.15.5 and 8.16.4 If H1 or H4a required on embankment 8.16.5 Slip roads in the vicinity of nosings;
Issue 2 Rev 0	**Feedback:** contact details changed. **Error messages** – further information added. **Helps**: and guidance relating to offset from Psb altered; additional guidance given on AADT for link and slip roads. **Fig 1-2 Basic Features of the RRRAP** spreadsheet and their significance – blue cell which is returned for some hazards in the Collation of Data together with a description (referring user to TD 19 or RRRAP Guidance Manual) added. **Chainage:** additional guidance how RRRAP handles chainage given. **Hazard in front of safety barrier:** guidance given **Hardshoulder width:** guidance on inputs given **500 Drainage:** added help for Culvert entry **600 Earthworks:** helps and guidance modified to accord with falling/rising nomenclature; critical height criteria and input requirements clarified and examples given; guidance and help on multiple slopes clarified; guidance on retaining walls supporting an embankment added. **1200 Traffic Signs and Signals and 1500 Motorway Comms**: helps updated including with references to collision loading and designs to BD 51 added, also need to TAA approval or TD 19 requirements to be followed; help giving definition of a small post and reference to EN 12767 National Annexe; better help on set-back requirements added; guidance relating to Tolerable results deleted as no longer required; additional guidance on passively safe signs and gantries; drop downs for signs and gantries expanded; added guidance section on steps and handrails; additional guidance on maintenance workers. **1600 Retaining Walls:** added reference to ISL levels for vertical walls. **1700-400 Structures and Parapets:** updated help diagrams and examples of inputs and outputs; added note about how RRRAP calculates parapet risk; added text relating to cost of low working width parapets; the need to ensure that pedestrian restraints to not interfere with action of parapets; added a reference and Help related to EN 1991-1-7 Actions on Structures: Accidental Actions. **2500 Special Structures:** added section on Police Ramps; added guidance on environmental barriers. **OHs - Poles and Pylons**: added to guidance on utility poles and pylons and need to consider potential consequences if brought down. **OHs - Trees**: added guidance on measuring girth of a tree.

	OHs - Water: clarified help on determining point of no recovery and new help added. **OHs - Railways:** added guidance on likelihood of hazard being reached; clarified and simplified helps especially relating to point of no recovery where adjacent to road. **OH's - Road**s: added guidance on likelihood of hazard being reached; clarified and simplified helps especially relating to point of no recovery where adjacent to road. **Collation of Hazards, Detailed Results**: updated screenshots; procedure help minor clarification to wording. Set-back and Barrier Types & Containment Levels helps updated. **Options testing**: improved help; deletion of sections that no longer apply. **Barrier and Option Costs:** improved and corrected guidance and figures used. **Appendix 4-1:** updated to accord with latest MCHW Notes for Guidance template. **Saving and retaining a copy of the RRRAP:** new paragraph added.
Issue 3 Rev 0	Updated and amended all sections, diagrams and examples to reflect the introduction of the web based RRRAP. Precis of what the RRRAP covers and does not cover added. New section added 'Records'. Section 'Point of Entry worksheet' revised to 'Record Status' – all content updated for website. Section 'Data Entry- Basic (Common) Details' revised to 'Data Entry - Common Details' – all content updated for website. AADT and speed limit factors clarified. Error messages – further information added. Section 2.7 – blue cell which is returned for some hazards in the Collation of Data together with a description (referring user appropriate documentation) added. Definition of Point of No Recovery (PNR) clarified and distances from Psb for PNR for adjacent road (8.16), railways (8.15, 8.10) and water hazards (8.14) altered; guidance and examples updated accordingly. Helps and guidance added / changed / improved throughout the document
Issue 4 Rev 0	Updated to reflect the introduction of CD 377 and other related new standards.
Issue 5 Rev 0	Various updates including the following: Section 1.2: Text updated. 1.4: Abbreviations and Definitions updated. Various: Highways England changed to National Highways Figure 2-1 added: RRRAP version selection page 2.9.3 Consequence: Note on hazard aggressiveness added. 2.9.7: RRRAP calculation further information added. 2.10.5: Guidance on hazard in front of barrier message updated. 2.10.6: Guidance information updated. 3.8: New section added on working copies of records. 4.3: Record status figure added. Section 5 Common details: additional guidance on mandatory fields added. 7.6: Minimum length of data for road entry section added **300 Fencing and 500 drainage**: Drainage features guidance updated. **600 Earthworks**: earthworks guidance updated. Figure 8-12: Critical slope height table guidance updated, and heights amended to match the height that RRRAP will assign a higher aggressiveness to the slope. **8.6.3 Results for gantries**: Guidance updated. 8.8.3 Steps: Guidance updated. **1600 Retaining walls**: Guidance updated. 8.10.1: Parapet minimum length guidance updated. **Other hazards - Railways**: Guidance updated. **Other hazards – Roads**: Guidance updated. 9.4 Minimum VRS lengths: guidance updated. 9.5.3 Detailed results guidance updated. 11 VRS summary: Guidance updated. 14 Saving and retaining a copy of the RRRAP: Guidance updated. 15 RRRAP calculation overview: new sections added summarising the RRRAP calculation process.

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1 Introduction

1.1 Scope

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 CD 377 which contains some mandatory requirements and, in Chapter 2, general requirements and guidance on Risk and its Mitigation.

A list of abbreviations and definitions can be found in 1.4.

1.2 A précis of what the RRRAP covers and does not cover

1.2.1 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 and the length of need in advance in the following situations.

1.2.1.1 Road type, speed and AADT

RRRAP supports 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 and only where central reserve is wider than 10 m, the off-side (O/S).
  - Motorway Slips and Link Roads – N/S and O/S verges
  - Smart Motorway modules covering D3M-HSR, D4M-HSR, D5M-HSR for hardshoulder running and D4M-ALR, D5M-ALR for all lanes running. The number of lanes refer to the actual number normally in use (so D3M with hard shoulder running is D3M-HSR, but if it is permanently converted to ALR it becomes D4M-ALR).
- **All Purpose Roads and Expressways** (D2AP, D3AP, D2-E, D3-E and single) - N/S verge and O/S but, on dual carriageways, O/S only where central reserve is wider than 10 m.
- **Other Classified Roads** (D2, D3, Single) - N/S verge and O/S but, on dual carriageways, O/S only where central reserve is wider than 10 m.
- **For single carriageways** with two-way flow the RRRAP calculates need for and the length of VRS beyond the hazard as well as that in advance.

Guidance is given in CD 377 Appendix A on how designers might deal with roads that are low flow (i.e. < 5,000 AADT) and or low speed (i.e. < 50 mph).

1.2.1.2 Temporary VRS

Temporary VRS requirements are covered in a different way to permanent hazards. The RRRAP contains a specific section for situations where Temporary VRS may be required 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. Please refer to section 13 for more information on temporary works.

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, it will only be a guide.

1.2.1.3 Gantries and Railway parapets

The RRRAP will give an indication only of the requirements for VRS provision at gantries and at Railway parapets.

For gantries reference must be made to CD 377 section 3, CD 365 and the UK National Annexe to BS EN 1991-1-7.

For railway parapets reference must be made to section 4 of CD 377 to confirm the containment level requirements.

1.2.1.4 Existing parapets

The containment requirements for existing parapets should be determined from CS 461.

1.2.2 Inappropriate Circumstances

The RRRAP does not allow or may not be appropriate for a direct assessment for the following circumstances, as detailed further below:

- Central reserves other than wide central reserves, see section 1.2.2.1 below.
- Roundabouts and junction areas, see section 1.2.2.2 below.
- Laybys and emergency areas, see section 1.2.2.3 below.

In such circumstances designers should use the Hazard 'Comment' field to describe the process they have gone through in determining the provision of VRS and their conclusions.

1.2.2.1 Central reserves

The requirements for these are detailed in CD 377 and its National Application Annexes. 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.

1.2.2.2 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.

1.2.2.3 Laybys and Emergency Areas (EA)

Provision for hazards that lie to the rear of a layby or EA. It is recommended that data is input as though the layby or EA is not there, i.e. with verge at standard width, hazards at the back of the layby or EA 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 or EA per se.

The RRRAP will calculate and show the set-back of the VRS based on its standard 1.2 m dimension (or 0.6 m if there is a hardshoulder or hardstrip). Having calculated the risk in the Collation and Reports tab, if the RRRAP shows that a VRS is required to protect a hazard at the rear of the layby or EA, the designer will then need to change the set-back of the VRS to its actual location relative to the back of the layby or EA 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 shows as necessary to give an adequate level of risk for motorists on the carriageway is adequate for users of the layby or EA as well and, if considered necessary, include additional VRS and or a pedestrian restraint to the rear of the layby or EA. Background to the decision process made in respect of the provision should be made in the Hazard 'Comment' field.

1.2.3 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 sections 8, 11 and 12 of CD 377.

1.2.4 Impact Severity Levels

The RRRAP does not calculate the difference in risk between different Impact Severity Levels (ISL). However, impact severity level A affords a greater level of safety for the occupant of an errant car than level B, and level B greater than level C. CD 377 gives the requirements for the ISL of RRS.

1.3 Feedback

We would welcome feedback on the following items.

- 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 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 it is considered that additional guidance would be of benefit.

Feedback can be sent via the link on the RRRAP website. For details on how to submit feedback, see section 2.4.7.

1.4 Abbreviations and Definitions

Reference should be made to the list of Terms and Definitions contained in of CD 377. A list of additional abbreviations and definitions used in the RRRAP or this guide is given below.

ALR	All Lane Running (as used with a Smart Motorway scenario)
CDM	Construction (Design and Management) Regulations
DBFO	Design Build Finance Operate
EA	Emergency Area (e.g. as used in Smart Motorways)
HS File	Health and Safety File required under the CDM Regulations
HSR	Hard Shoulder Running (as used with a Smart Motorway/controlled Motorway scenario)
ISL	Impact Severity Level (refer to CD 377 section 3 for further details)
TAA	Technical Approval Authority

Acceptable — Where the term 'Acceptable' or 'Acc' has been used in the text, this is equivalent to the term 'Broadly Acceptable'.

N/A or 'See CD 377' — Not applicable – either because that the term does not apply in the situation or, in the case of hazards such as Gantries, that the outcome of the RRRAP must be checked against the requirements in CD 377 or reference made to another Standard, the RRRAP Guidance Manual or to the TAA as there are factors that the RRRAP cannot take account of in determining appropriate level of VRS.

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 the vehicle hits or is diverted by an intervening hazard, is going to end up on (in) the adjacent road, railway, water hazard, etc. 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 field in the RRRAP. The likelihood of reaching the hazard may change significantly over its length. If this is the case, the inputs need to be split into sections so that the likelihood of reaching is accurately reflected along the length. Refer to the data entry section of this document for more details.

Psb — The point from which setback is measured. (Refer to CD 127 for definition).

CSV — A comma separated value (CSV) file is used for the digital storage of data structured in a tabular fashion. Each line in the CSV file corresponds to a row in the table. Within a line, fields are separated by commas, each field belonging to one table column.

2 Overview of the RRRAP

The Road Restraint Risk Assessment Process (RRRAP) is used to record features adjacent to the carriageway and assist Designers in determining the need for a vehicle restraint and its associated performance requirements for each site/scheme in its proposed layout. It allows for optimisation or refinement of solutions using a selection of design mitigation measures: i.e. removal, re-positioning, reduction in aggressiveness of the roadside feature, trade-off between these and reduced land take / offset / hazard redesign, or implementation of roadside feature protection.

2.1 Software used and Version number of the RRRAP

The RRRAP is an online web-based application. 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 to provide background details for the audit trail.

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

The RRRAP website will indicate if a new version is available. The latest version of RRRAP should be used each time that a new project or section within the project is started.

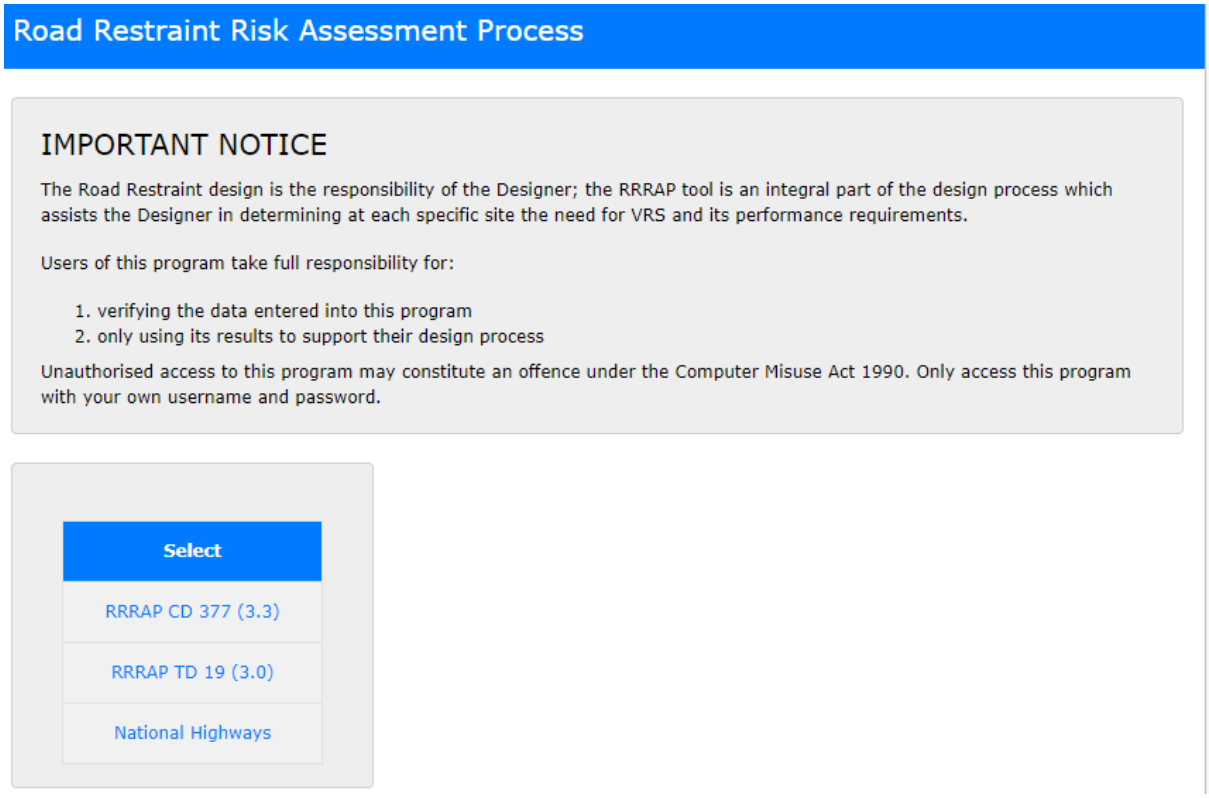


Figure 2-1 RRRAP version selection page

Existing projects will be able to continue using the existing version of RRRAP that the project was started on until that part of the project is finished.

Please note all new organisation accounts are created for the latest version of the RRRAP only. Access to legacy RRRAP versions is granted by exception upon request.

2.2 Accessing and using the RRRAP web application

To be able to access and fully use the RRRAP web application JavaScript and Pop-ups must be enabled in the browser. Depending on the browser settings, permission may have to be granted to display pop-up dialogs for this site.

Some corporate firewalls may block certain features used by the application. If any problems are experienced, please check with your local IT support that full access is configured.

The RRRAP site uses Secure Sockets Layer (SSL) to encrypt and secure all internet traffic from your browser to RRRAP.

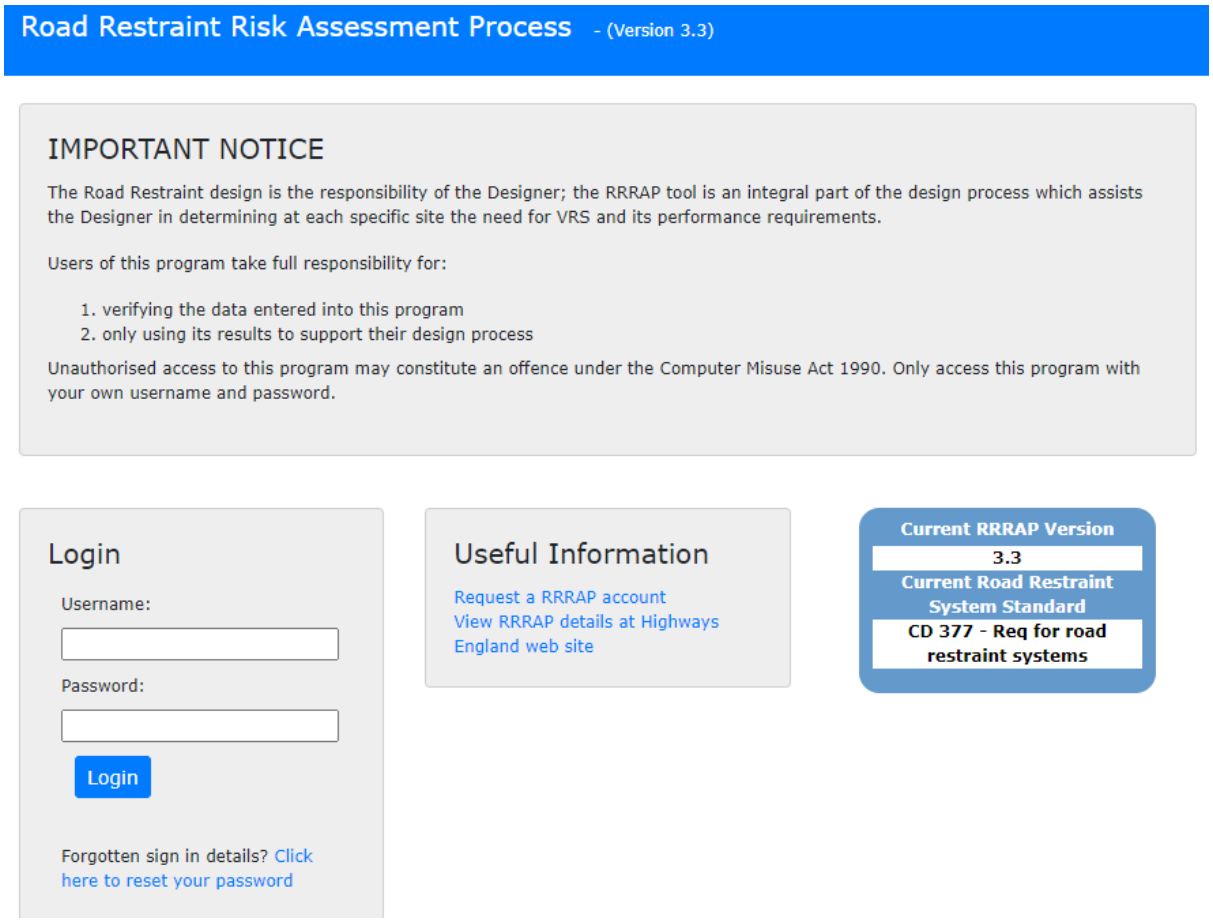


Figure 2-2 RRRAP Login Page

2.2.1 GDPR

On first time login to RRRAP, a General Data Protection Regulations (GDPR) privacy notice will be displayed. Clicking the 'Accept' button will accept the privacy notice and display the RRRAP Home tab.

Clicking the 'Decline' button will decline the privacy notice and automatically log you out of RRRAP and the Logout page will be displayed.

2.2.2 Resetting your password

If you have forgotten your password the RRRAP login page contains a link to a password reset page.

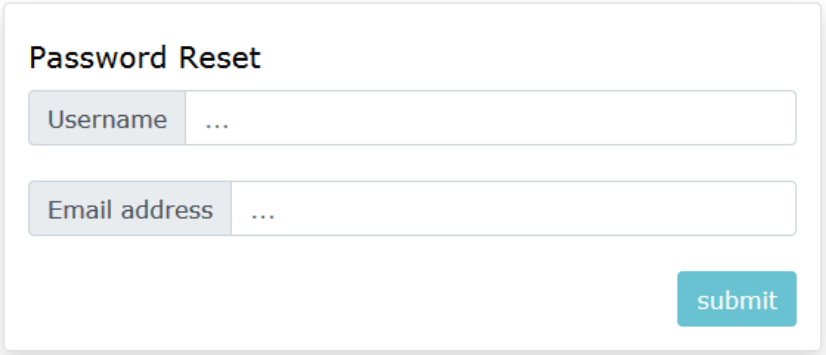


Figure 2-3 Password Reset request page

Enter your username and email address and click the 'Submit' button. A page will be displayed to confirm that an email has been sent to you.

Within the email is a link to reset your password. Clicking the link will display a reset password page in your browser. If the email has not appeared within a short period, please check your junk email folder. The reset email link is only valid for a limited time. If you exceed this time limit you will have to submit another password reset request.

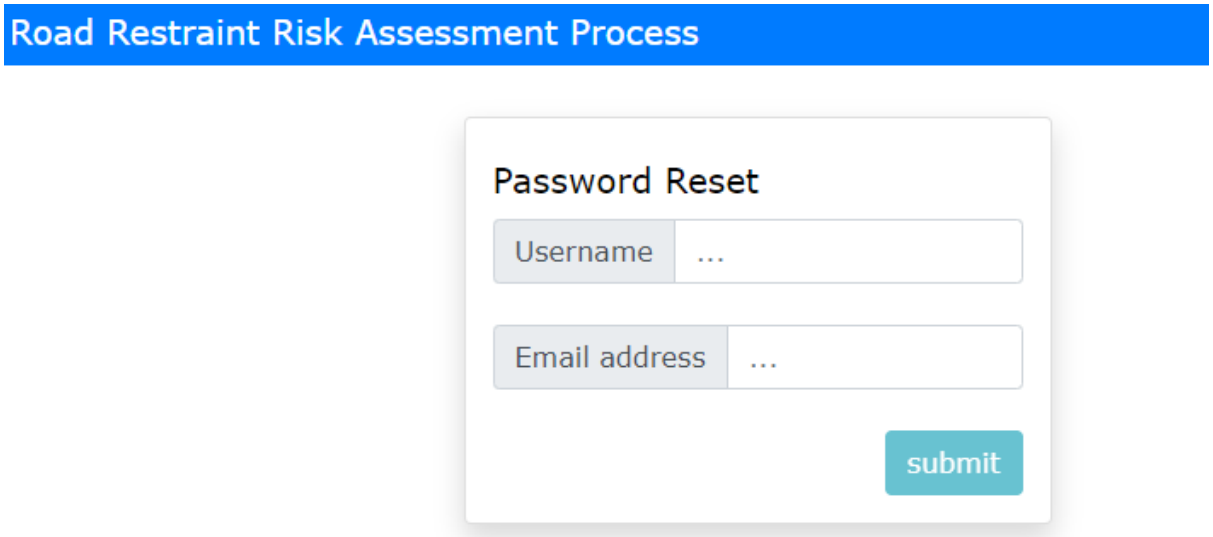


Figure 2-4 Password Reset page

Enter your new password, and then re-type your new password. See Section 2.4.6 for more details on valid password rules. Click the 'Submit' button to save your new password.

Once your new password has been saved, a password change success page will be displayed. This page has a link back to the RRRAP login page.

2.3 A Quick Guide to getting started with RRRAP

Previously, RRRAP was based on an Excel document. This web-based version is its replacement. An individual Excel file is now replaced by an individual RRRAP record.

- To create a new RRRAP record:
  1. Click the 'Create New Record' tab
  2. Enter the name for the record (think of this being equivalent to the name of a file)
  3. Select from the "Is this record related to National Highways funded work?" dropdown either Yes or No – depending on the work being undertaken. The purpose of this field is to allow the National Highways to measure how many RRRAP records are being used by its suppliers.
  4. Enter the name of the project – this should be the name of the real-world project the record is related to.
  5. If desired, an optional text description can be entered to better identify / describe the record.
  6. Click the 'Create' button and the new record will be created and opened. In the top row of tabs there is now a tab representing the open record (displaying details of the record). A second row of tabs appears underneath and represents the different parts of the RRRAP record.
  7. When a record is created / opened the record status page is always displayed. From here, the tabs are used to navigate through the different parts of the RRRAP record, e.g. Common Details, Hazards Overview, Collation and Reports, etc.

- To close an open record, click the ⊗ icon visible when moving the mouse over the top right corner of the tab representing the open record.
- To open an existing record, click the 'Records' tab in the top row of tabs. A table will list all your records. Click on a row in the table to open a record.

2.4 Key areas of the RRRAP web application

2.4.1 Home Page

When you log in to the RRRAP web application, you are always presented with the RRRAP home page. From here you can:

- View the latest news concerning RRRAP
- View 'Getting Started' introductory help
- Access RRRAP support contact details

2.4.2 Records Page

The records page allows you to locate and access all RRRAP records currently in use by your organisation. See section 3 for more details.

2.4.3 Create New Record

You can create a new RRRAP record by clicking on the 'Create New Record' tab that is available if no record is currently open. See section 3.7 for more details on creating a new RRRAP record.

2.4.4 Current Open Record

Once a RRRAP record has been opened (see section 3) or created (see section 3.7) the 'Create New Record' tab is replaced with the 'Open Record' tab.

The 'Open Record' tab is populated with the RRRAP record currently open (see section 2.5). The name of the tab is a combination of details from the record, including project name, record name, and the records road sub-type, verge and chainage details.

Only one RRRAP record can be open at any one time.

2.4.5 Help

Clicking the 'Help' link in the top right corner (available on every page) provides access to document downloads and useful links, a key to basic features, an overview of the RRRAP process and a list of Frequently Asked Questions (FAQ).

2.4.6 My Account

At the top right of every page in the RRRAP is the 'My Account' link (see Figure 2-5). Click this link to display your account details page. On this page are links that allow you to update some of your account details.

Also shown in your account page are the contact details of your organisation's main RRRAP contact. Should you have any RRRAP/CD 377 questions, this is the person you should try to contact first, before contacting the RRRAP support team (details available on the Home page).

Update details

Here, you can update some of your personal details, including forename, surname, job title, email address, and phone number.

Change password

You should change your password when you first receive your RRRAP account details.

To change your password, you must first enter your old password, and then enter your new password twice.

All RRRAP account passwords **must** adhere to the following conditions:

- Contain at least one numeric character.
- Contain at least one upper case character.
- Contain at least one lower case character.
- Finally, all passwords must be between 6 and 12 characters in length.

2.4.7 Feedback

To send feedback on the RRRAP, the guidance document, or to report any problems encountered in understanding the RRRAP or the Guidance, click the 'Feedback' link available at the top right-hand corner of the page. This assumes you have appropriate email client software pre-installed. Clicking the link will launch a new email window with the email address and subject line 'RRRAP Feedback' pre-populated.

If you have problems with this mechanism, you can go to the RRRAP Home page and send your comments to the email address listed for 'RRRAP Support Issues'. Please remember to use the subject line 'RRRAP Feedback'.

2.4.8 **Logout**

Once you have finished working with RRRAP, don't forget to Logout. Simply click the 'Logout' link and you will be logged out of the RRRAP web application. Logging out will also immediately remove any lock you have on any currently open RRRAP record.

If you do not logout of RRRAP properly and go on to close your web browser, you may not be able to log back into RRRAP for up to 15 minutes. This is because you are still logged into the RRRAP web application. After this time has elapsed, you will be able to log into the RRRAP as normal.

2.4.9 **Navigation**

The main ways to navigate round the RRRAP site and access its features include:

Figure 2-5 Web application navigation

"Breadcrumbs" provide a visual indication of which page is being viewed and its location within the site hierarchy. The breadcrumb trail is constructed of various hyperlinks allowing the end user to jump back to higher level sections.

2.4.10 **Common features on summary tables – paging and ordering**

There are many summary pages in the RRRAP that present lists of items, e.g. user records, all fencing hazards, etc. The items are presented in a paged table that can also be sorted (see figure 2-6).

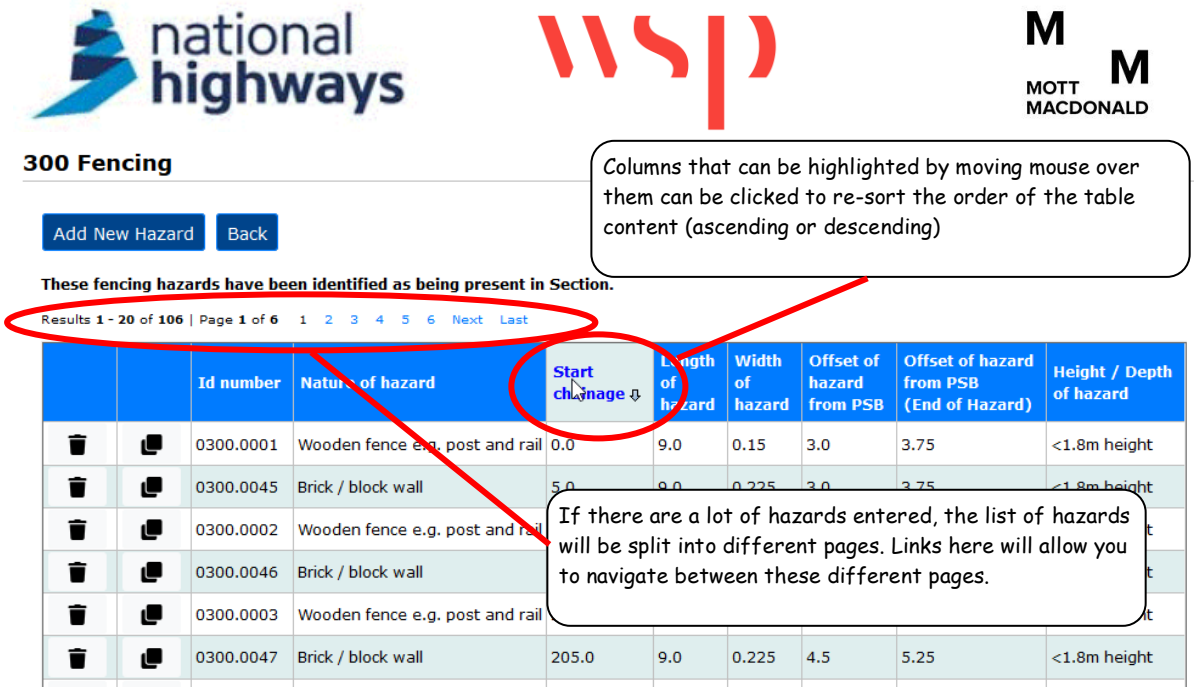


Figure 2-6 Summary table that is paged and can be sorted

2.4.11 **Data Entry**

Various data entry controls are used by the RRRAP:

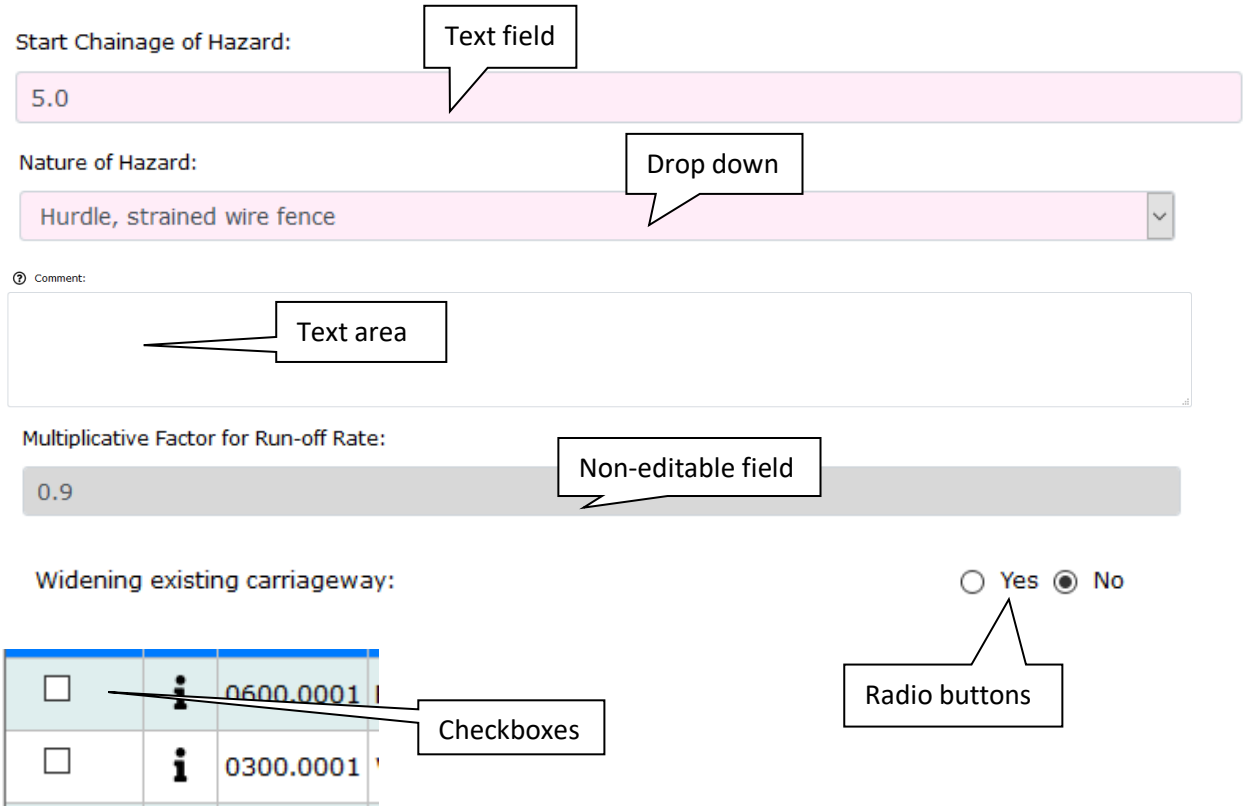


Figure 2-7 Web application data entry

- Text field – used to enter a short amount of text or numerical values.
- Text area – used to enter more than just a few words of text.
- Drop down – list of items to choose from.
- Radio button – simple choice.
- Checkbox – Either ticked or not ticked.
- Non-editable field - These fields have a grey background and the value displayed cannot be changed.
- Mandatory field - Some fields when entering data are mandatory. All mandatory fields must be completed on a form before it can be saved. A mandatory text field or drop-down is highlighted with a light red background colour. Mandatory radio buttons will be highlighted with a warning icon if not populated when saving data. Examples of a mandatory field can be seen Figure 2-8 (Start chainage of Hazard & Length of Hazard).

As you enter data, and you move between fields on the form (either via use of the mouse or keyboard shortcuts) the content of the form is re-validated. If there are problems validating the content of fields, e.g. value out of range, entered text instead of a number, field missing a mandatory value, etc; then a warning icon is displayed next to the field. Moving the mouse over this icon will display a warning message that will hint at the problem with the field. An example is shown below.

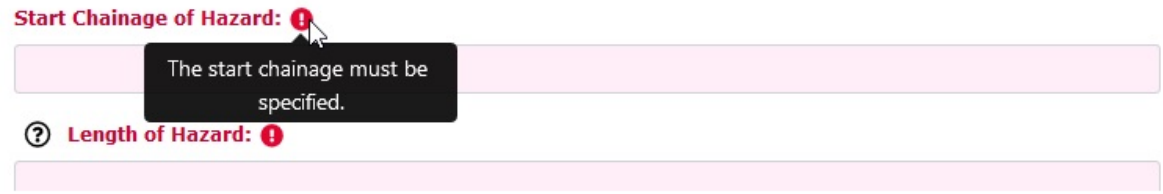


Figure 2-8 Data Entry Validation Warning

2.4.12 **RRRAP Online Help**

The RRRAP provides multiple access points to online help.

Clicking the 'Help' link in the top right corner (available on every page) provides access to useful links, a key to basic features, an overview of the RRRAP process and a list of Frequently Asked Questions (FAQ).

Clicking ⓘ will display dialogs with context sensitive help – providing details about the current page or even information about specific hazard fields. Note – depending on your browser you may have to grant permission to display pop-up dialogs for this site.

Clicking ℹ in the page title bar will display information aimed at helping new users navigate through the different parts of the RRRAP process.

Moving your mouse over ℹ will display a tooltip that contains additional descriptive text for record declarations in the Record Status page.

Clicking ℹ in the collation page will display a dialog that contains additional VRS and hazard details for a particular hazard in the Collation and Reports page. Note – depending on your browser you may have to grant permission to display pop-up dialogs for this site.

2.5 Arrangement of pages within an open RRRAP record

Once you have opened a record, a set of tabs will provide access to the different parts of the record where the information about the site and its hazards can be entered.

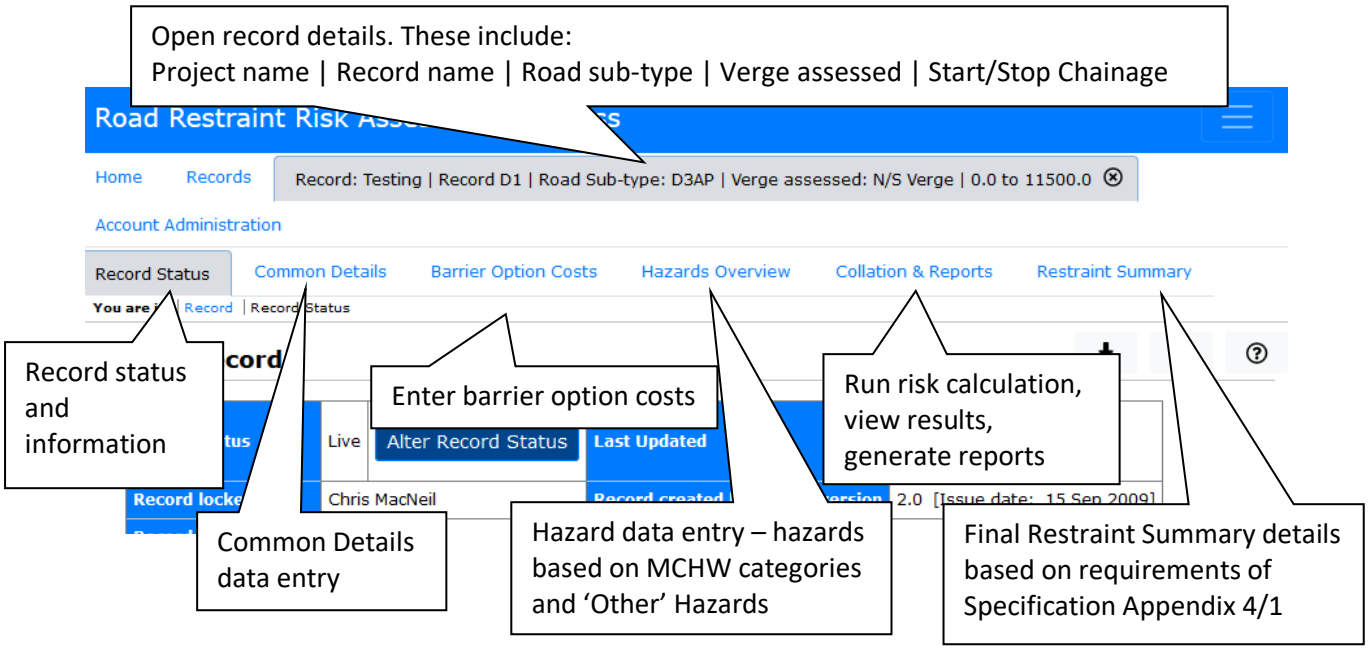


Figure 2-9 Open RRRAP Record and available sub-tabs

Included in the next page indicates how the web pages within the RRRAP inter-relate and gives an overview of the process.

Note that the 'Record Status' tab gives basic information about the RRRAP record. This includes the version number of the RRRAP the record was created with and the date that version of the RRRAP was released, the time data in the record was last updated, and the status level of the RRRAP record.

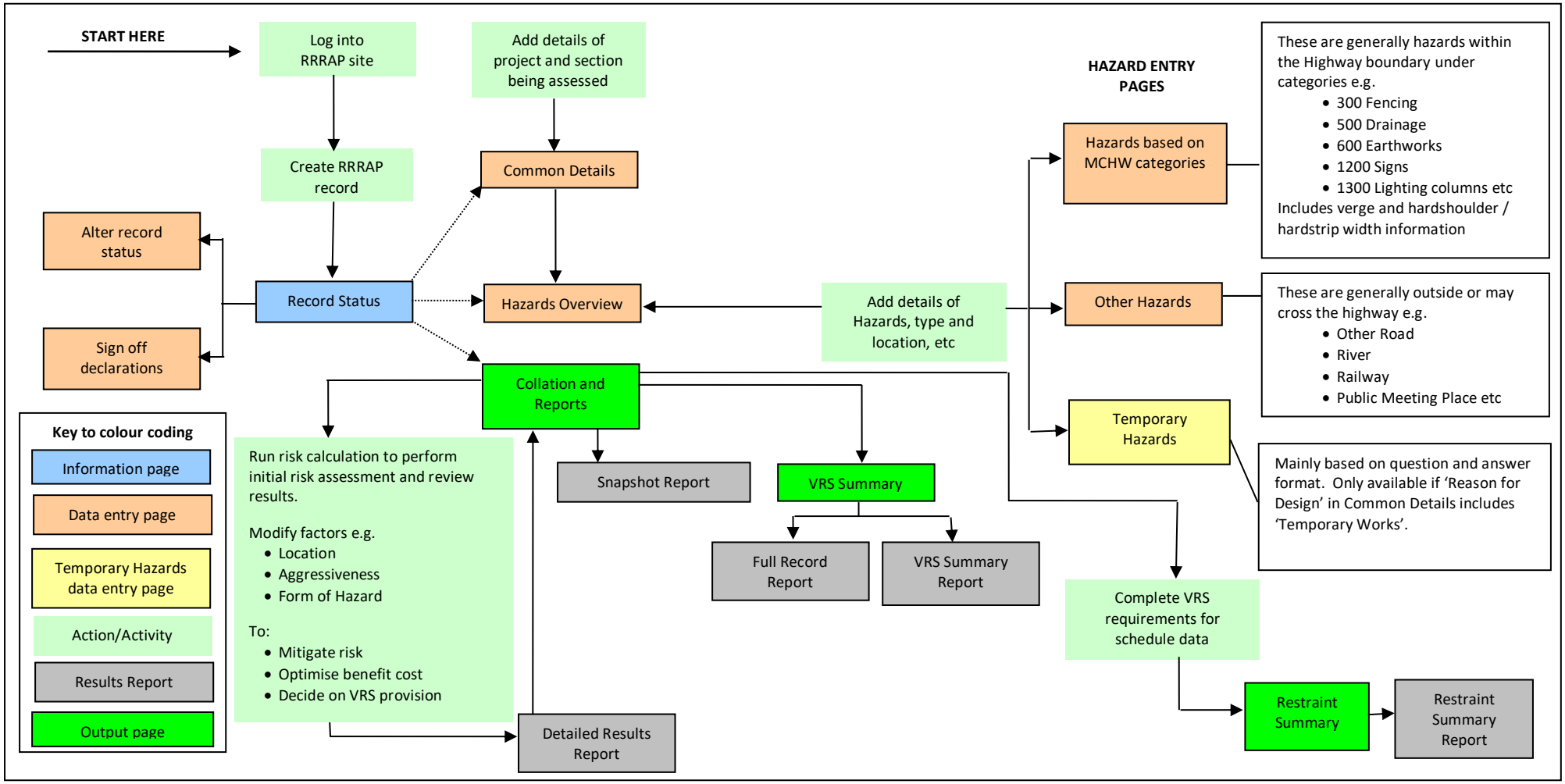


Figure 2-10 Overview of the RRRAP

2.6 How Permanent Hazards have been Categorised within the Various Worksheets

In the 'Hazards Overview' tab, the listing of all the Hazards typically likely to be found within the Highway and the individual pages for entering details of these Hazards are arranged around the MCHW Series numbers.

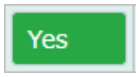
The hazards have been categorised in this way as it is considered that most design drawings will have been arranged around this numbering system, rather than being composite drawings that would show most or all of the hazard features. It is expected that it will speed up input of the data relating to each hazard.

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 in a separate series of pages e.g. Roads.

2.7 Colour coding of results on Collation page

After calculating risk for hazards several extra values are populated.

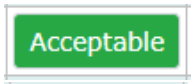
'Is the risk without VRS acceptable?'



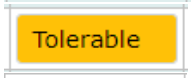
- no VRS is required

- a VRS is required to protect this hazard

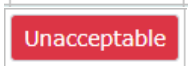
'Level of risk with optimum length VRS'



- Risk is in the broadly acceptable region



- Risk is in the tolerable region



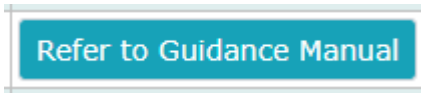
- Risk is in the unacceptable region

There are special cases where the hazard has mandatory requirements as detailed below. In this example, the RRRAP gives a Containment Level based on the risk to vehicle occupants only and the Designer must refer to the indicated Standard, e.g. CD 377, as appropriate and ensure that the level of provision that they specify is appropriate for this hazard. The Designer must detail the factors that they have considered in the Comments field of the hazard.

'Is risk without VRS acceptable?'

- a VRS is required to reduce the level of risk to an acceptable level

'Level of risk with optimum length VRS'



- The name of the document or guide that should be referred to for requirements or guidance

Another special case example of 'Level of risk with optimum length VRS' includes:

- This can affect Gantries, e.g. for 1200 and 1500 hazard types. The Designer must detail the factors they have considered and the outcome of TAA agreements in the "Comment" field of individual hazards.

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

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 need to be considered, weighed up and taken account of in deciding whether a temporary Road Restraint System is warranted. See section 13 for more details on how to enter temporary hazards into the RRRAP.

2.9 How the RRRAP works

2.9.1 General guidance

General guidance on the RRRAP is given in CD 377. 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.

2.9.2 Risk

Risk is assessed by looking at a combination of likelihood (see section 2.9.3) and consequences (see section 2.9.4) and is expressed in equivalent fatalities per 100 million vehicle km.

1 fatal = 10 serious = 100 slight injuries.

2.9.3 Likelihood

(a) Probability of vehicle leaving road – this is based on road type and 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.

2.9.4 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

The aggressiveness value assigned to a hazard by the RRRAP is a measure of the hazard's ability to do harm to the occupants of an errant vehicle. The default values have been assigned to each hazard based on previous research, accident data and engineering judgement. Note that costs relating to the hazard itself or consequences arising due to the failure of the hazard were it to be impacted are not included in the RRRAP risk calculation.

2.9.5 **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

2.9.6 **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 the RRRAP are also curved. They are set such that the need for a VRS is independent of the flow on the road. 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 aggressiveness and will give rise to unacceptable levels of risk over different ranges of offsets.

Heavy vehicles may breach N2 containment safety barriers. H1 or H4A containment level may be needed where one or more of the following conditions holds:

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

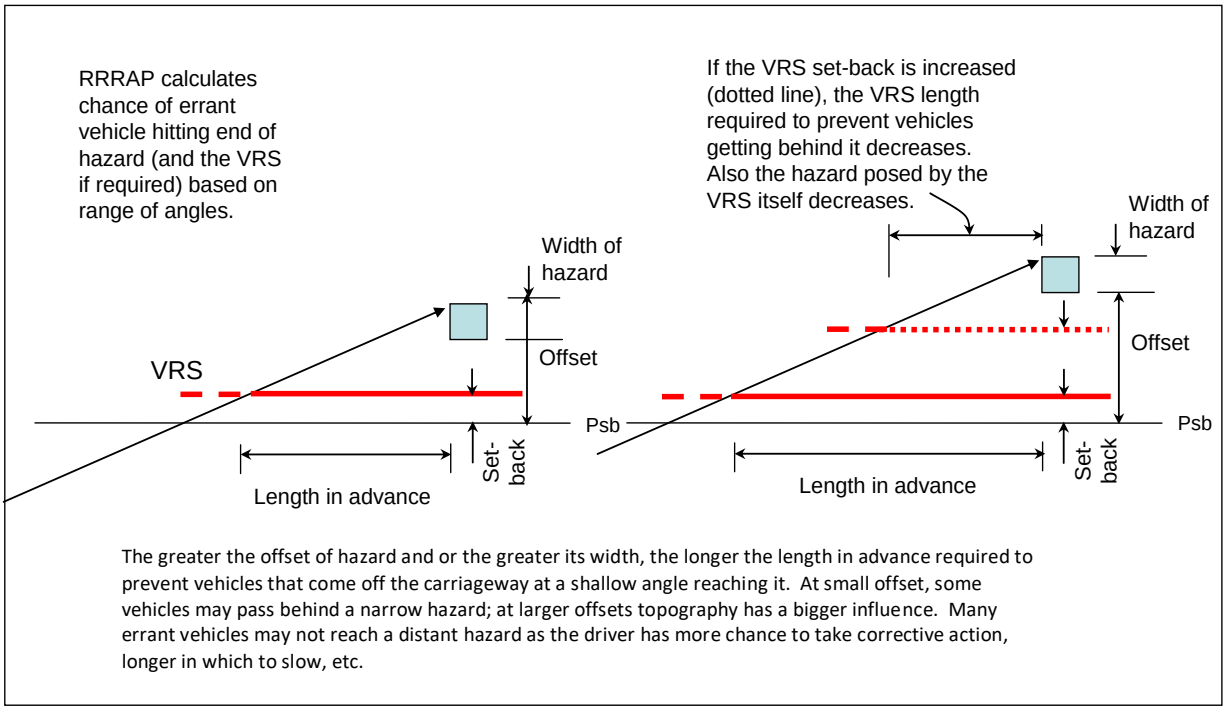


Figure 2-11 Relationship between Offset of Hazard and VRS, and length of VRS

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.

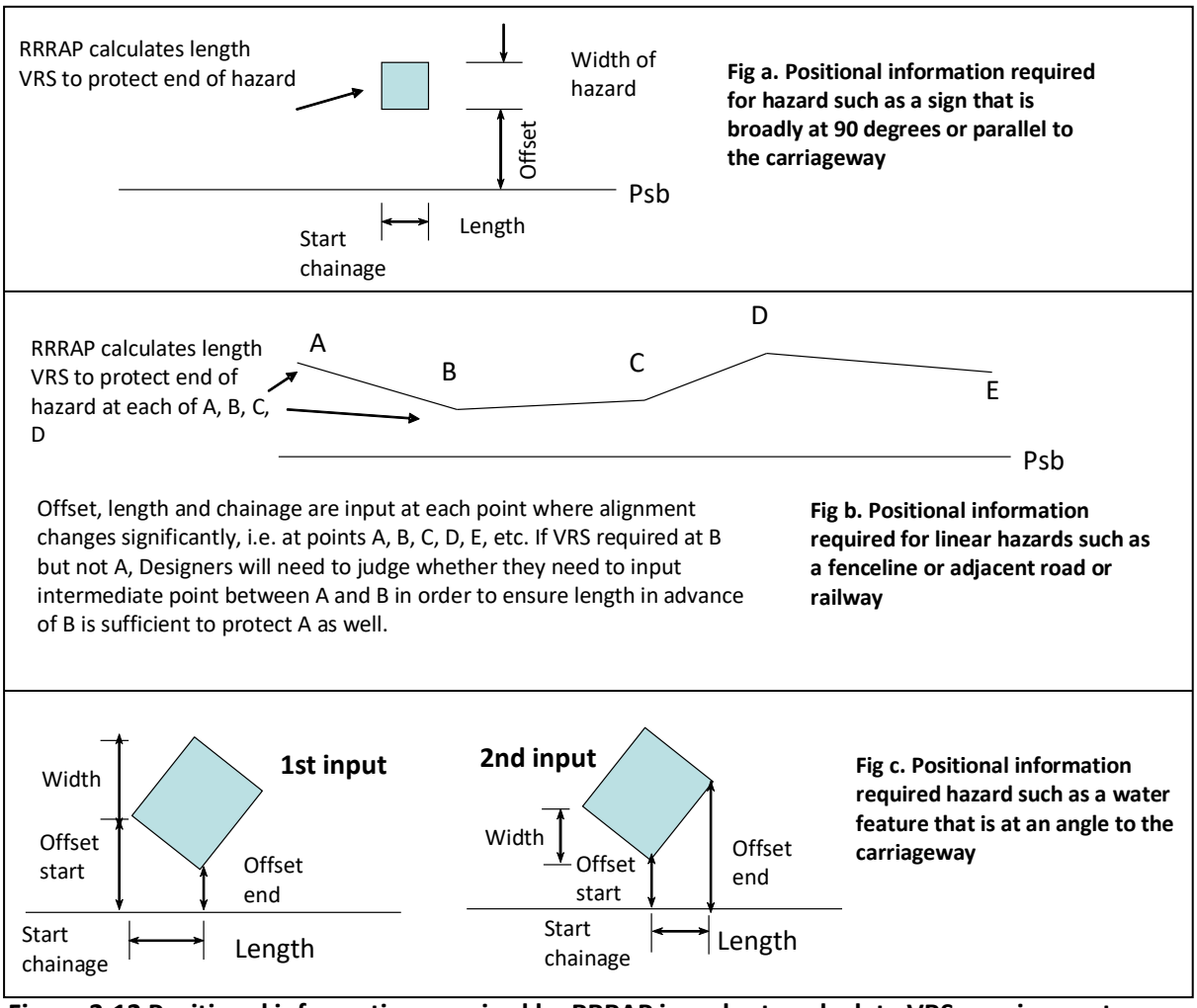


Fig a. Positional information required for hazard such as a sign that is broadly at 90 degrees or parallel to the carriageway

Fig b. Positional information required for linear hazards such as a fenceline or adjacent road or railway

Fig c. Positional information required hazard such as a water feature that is at an angle to the carriageway

Figure 2-12 Positional information required by RRRAP in order to calculate VRS requirements

Note that this diagram 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.

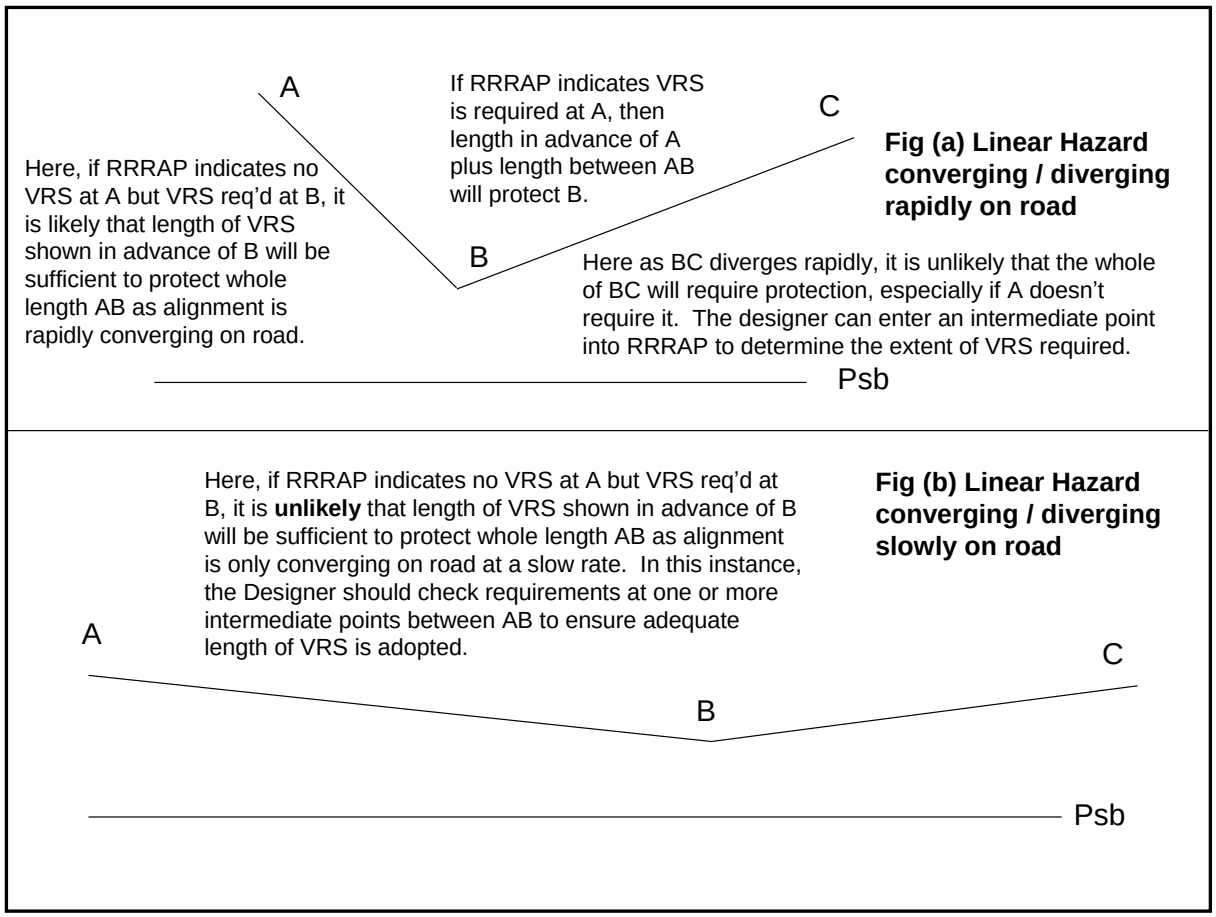


Figure 2-13 Influence of rate of convergence / divergence of hazard to Psb on VRS requirement calculation

2.9.7 RRRAP Calculation – further information

Further information on how the RRRAP calculation is performed can be found within the RRRAP website by clicking on the 'Calculator' button within the 'Collation and Reports' tab as indicated in figure 2-14. The calculation information is also contained in section 15 of this document.

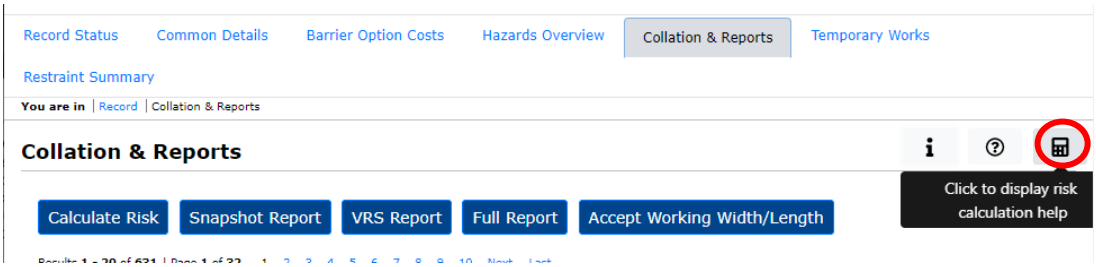


Figure 2-14 Location of further details on the RRRAP calculation within the website

2.10 Error and Warning messages

This section describes the various error / warning messages that may be returned at the various stages of the RRRAP.

2.10.1 Data Entry

When entering data into the RRRAP and as you move between fields on a page, the content is re-validated. If there are problems validating the content of fields, e.g. value out of range, entered text instead of a number, field missing a mandatory value, etc; then a warning icon is displayed next to the field. Moving the mouse over this icon will display a warning message that will hint at the problem with the field. An example is shown below.

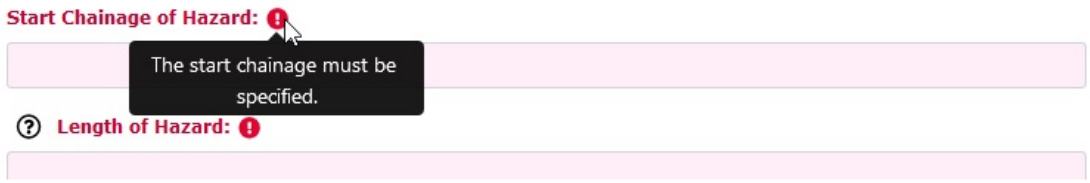


Figure 2-15 Data Entry Warning Message

All mandatory field data on a page must be entered before the page can be saved.

2.10.2 Record / Hazard Import

When importing either a RRRAP record (see section 3.9) or a CSV file (see section 1.4 for description of a CSV) with hazard data (see section 8.1.9) for an individual hazard category, any issues encountered will be displayed after the import process has completed.

There are two types of issue message that can appear:

- Error messages – For importing individual CSV files (e.g. hazard import, see section 8.1.9) these messages will stop the import from proceeding any further. For RRRAP record import (see section 3.9), only the affected file giving rise to the error message within the RRRAP record ZIP file (e.g. fencing hazard file) will be ignored, and the import process will try to import the rest of the files in the ZIP that define the RRRAP record.
- Warning messages. These indicate import issues for individual hazards. These issues may need to be resolved before the risk calculation can be run.

Error messages can include:

- File size too large (2Mb for RRRAP records, 1Mb for individual CSV's)
- Unexpected file type (ZIP for RRRAP record import, CSV for individual hazard import)
- ZIP missing files (the ZIP for RRRAP record import is missing CSV files for either hazards or common details)
- Invalid RRRAP version (only affects RRRAP record ZIP files)
- Unexpected number of columns in CSV import file
- Hazard has no start chainage
- Parse error (this occurs when the wrong format of data is encountered, e.g. text is found where a number is expected)

Warning messages can include:

- Drop-down values that have not been populated (reported for both mandatory and non-mandatory fields).
- Drop-down text could not be matched to those options currently available for that field.
- Error(s) validating new hazard.

'Error(s) validating new hazard' can occur if an imported hazard fails the standard validation applied before saving a hazard. Validation commonly fails if mandatory fields are incomplete. The new hazard is still saved but is marked as invalid. Invalid hazards are indicated on the hazard view pages and the 'Collation & Reports' tab with the ❗ icon next to the Hazard Id, as shown in figures 2-16 and 2-17 below.

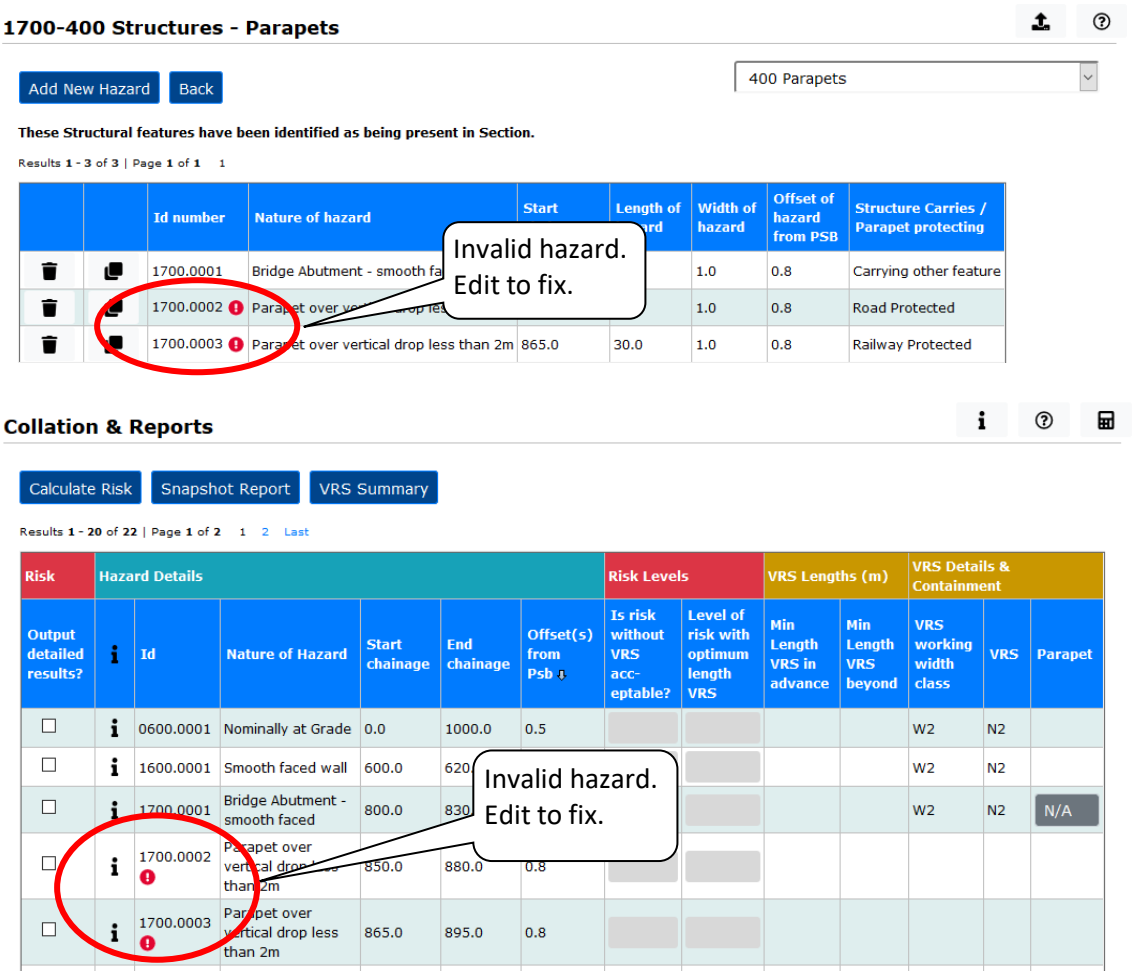


Figure 2-16 Invalid Hazard after Import indicator

The risk calculation will not run while there are invalid hazards in the record.

To remove the invalid hazard marker, edit the hazard and fix any fields with highlighted issues. Once the corrected hazard has been saved, the invalid hazard marker should disappear.

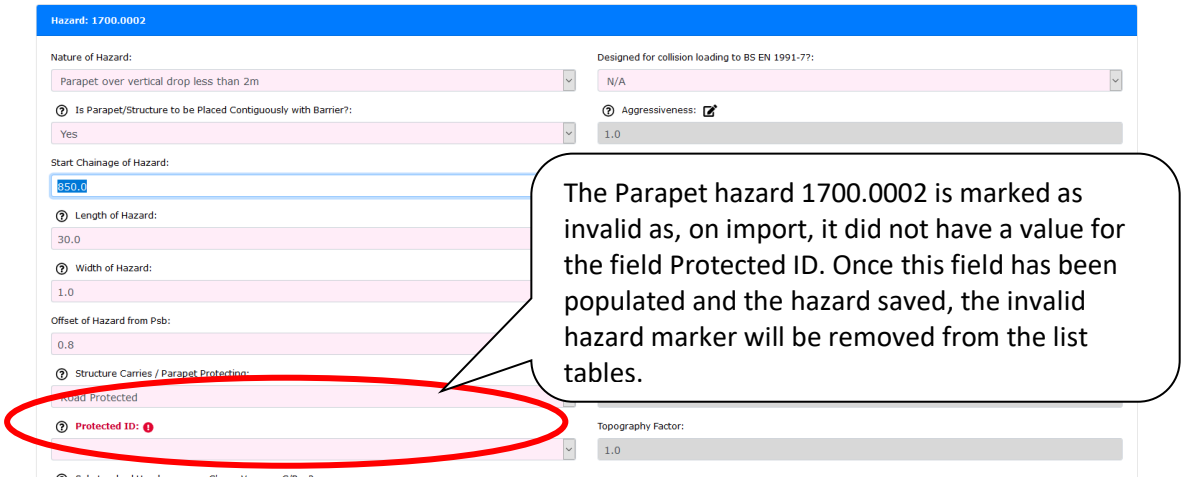


Figure 2-17 Correcting Invalid Hazard marker

2.10.3 Calculating Risk

Any issues when calculating risk will be displayed on the 'Risk Calculation Issue' page. There are three types of messages that can appear:

- Error messages – these will stop the risk calculation from proceeding any further. For the risk calculation to complete, these issues must be resolved. See sections 2.10.3.1 to 2.10.3.4 below.
- Warning messages – these indicate issues for individual hazards. Some issues stop risk being calculated for an individual hazard (e.g. hazard in front of barrier). Other issues, such as when hazard is too close to barrier, don't stop risk being calculated. See section 2.10.3.5 below.
- Tall hazard message – these relate to hazards that could give rise to a significant secondary incident should they be impacted (see section 2.10.3.6 below). You are then asked to select either 'Yes' if you accept or 'No' if you reject the calculated risk level. The question does not have to be answered here but can be answered by editing the hazard via the 'Collation' tab (see section 9.3).

2.10.3.1 Error Messages – Common Details

These can include:

- Mandatory fields in Common Details have not been completed.
- In Common Details 'Scheme Duration and Barrier Costs', non-default safety barrier and parapet costs are being used but have not all been specified.

2.10.3.2 Error Messages – Full Chainage Definition

These messages can include:

- Full section chainage must be entered for Earthwork hazards
- Full section chainage must be entered for Verge hazards
- Full section chainage must be entered for Kerb hazards

These messages will be reported if the start and end chainages for Verge, Earthwork, or Kerbs do not match the start and end chainages for the Section (as entered in Common Details).

2.10.3.3 Error Messages – Hazard Categories

The following error message will appear for hazard categories that have been input as being present in the record (by editing 'Category Configuration' on 'Hazards Overview' tab) but have not been marked as 'Completed':

- Hazards are required for hazard type 'X' - but the hazard type is not marked as 'Completed' (Edit 'Category Configuration' on 'Hazards Overview' tab).

X can be any of the hazard categories listed in the 'Hazards Overview' tab.

To mark a hazard category as 'Complete' (i.e. all hazard data has been entered for that category), navigate to the 'Hazards Overview' tab and click the 'Edit Category Configuration' button. Make the necessary changes and click the 'Save' button. For more details on 'Category Configuration' see section 7.1.

2.10.3.4 Error Messages – Hazards

These can include:

- An Earthwork hazard cannot have zero length.
- Hazard has validation issues (due to issues during hazard import).
- Hazards start chainage outside the section 'from' / 'to' chainage as defined in 'Common Details'.

2.10.3.5 Warning Messages

These can include:

- 'End of long object - object is located in front of barrier. Note: this has prevented risk from being calculated for this hazard.'
- 'Object is located in front of barrier. Note: this has prevented risk from being calculated for this hazard.'
- 'End of long object - object is located within working width of barrier.' The correction may be to move the hazard, change the working width class, barrier working width, set-back of barrier from Psb, or a combination of these. It may also be advisable to split the hazard into two or more parts. In this calculation run, the effect of the barrier will be overestimated. You may need to apply for a Departure from Standard if, having investigated the above changes, the hazard is to remain within the working width. Please refer to CD 377.
- 'Object is located within working width of barrier.' The correction to apply may be to move the hazard, change the working width class, barrier working width, set-back of barrier from Psb, or a combination of these. In this calculation run the effect of the barrier will be overestimated. You may need to apply for a Departure from Standard if, having investigated the above changes, the hazard is to remain within the working width. Please refer to CD 377.
- 'The object has an invalid working width. The working width value is less than that expected for the current working width class.' This may be due to the risk calculation updating the working width value to show the maximum working width available as the object is located within the working width of VRS.

For more details concerning objects located within the working width of the barrier see section 2.10.4, and for objects located in front of the barrier see section 2.10.5.

2.10.3.6 Tall Hazards

The tall hazard message is:

- 'This hazard could give rise to a secondary incident should it be impacted. The calculated risk level does not cover the secondary risk. If you consider the risk level of a secondary incident to be significant, you may wish to consider moving the hazard, or use a higher level of containment, or both.'

For more information on tall hazards that can give rise to a significant secondary incident see section 9.6.1.

2.10.4 Hazard located too close to barrier

If the hazard is located too close to the safety barrier, a warning message (as highlighted in the previous section) will be displayed on the Risk Calculation Issue page:

- Object is located within working width of barrier. The correction to apply may be to move the hazard, change the working width class, barrier working width, set-back of barrier from Psb, or a combination of these. In this calculation run the effect of the barrier will be overestimated. You may need to apply for a Departure from Standard if, having investigated the above changes, the hazard is to remain within the working width. Please refer to CD 377.

The risk calculation is completed for hazards that have this issue. When returning to the list of hazards in the 'Collation & Reports' tab, a highlight will be visible for hazards that have this issue.

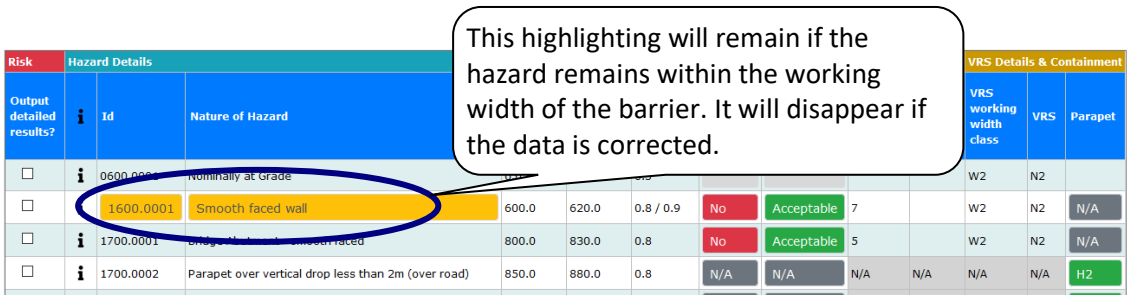


Figure 2-18 Hazard located too close to barrier warning on Collation page

When viewing and editing hazards through the 'Collation & Reports' tab this highlight is also visible, along with an additional highlight on the 'Barrier Working Width' field (see below).

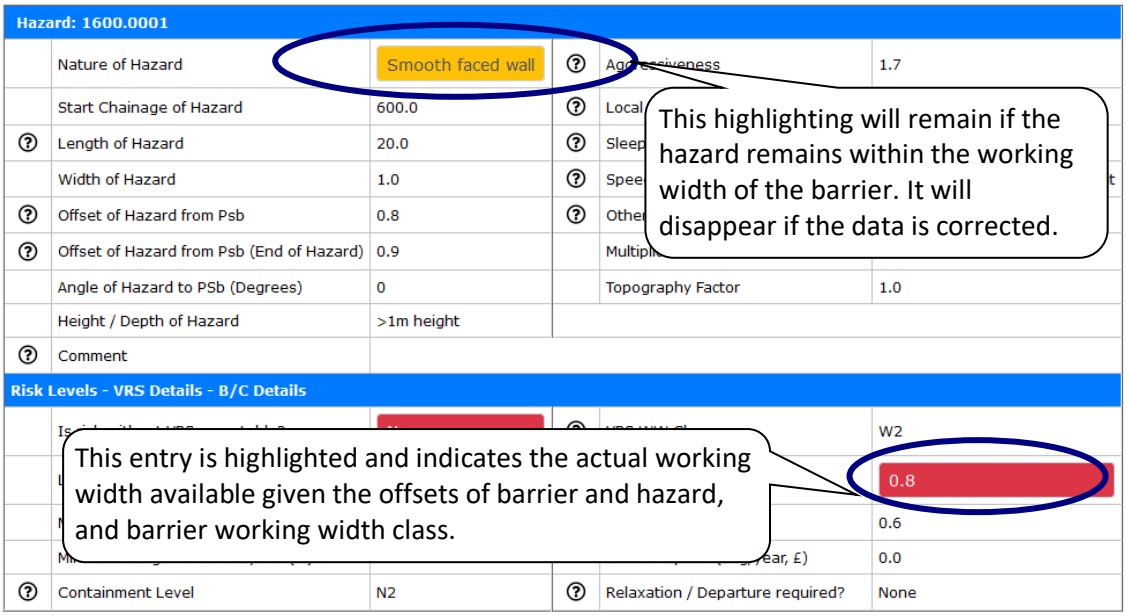


Figure 2-19 Hazard located too close to barrier warning on View Hazard page

If the warning has been caused by a mistype in the appropriate data entry page, the data entry should be corrected and the risk calculation re-run.

If there was no mistype, you may wish to alter the VRS Working Width Class, VRS Working Width, Set-back of VRS from Psb, or a combination of these. If the offset of the item is changed or the VRS Working Width Class is changed in order to rectify the problem, the calculated value in VRS Working Width column (highlighted red) MUST also be deleted, otherwise RRRAP will not re-calculate the new working width, and the object will still be reported as within working width.

You may need to apply for a Departure from Standard if, having investigated the above changes, the hazard is to remain within the working width. Please refer to CD 377.

2.10.5 **Hazard located in front of barrier**

If the hazard is located in front of the safety barrier, a warning message will be displayed on the Risk Calculation Issues page:

- Object is located in front of barrier. Note: this has prevented risk from being calculated for this hazard.

This issue will cause the risk calculation to stop evaluating this hazard (and move on to the next hazard). When viewing the hazard via the 'Collation' page because no calculated risk values have been generated, none are visible (see Figure 2-20).

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	0.0	100.0	2.5	Yes						N/A
☐	i	0600.0002	Falling at 50%	100.0	140.0	2.5	Yes						N/A
☐	i	0600.0003	Falling at 50%	140.0	160.0	2.5	No	Acceptable	46		W2	N2	N/A
☐	i	1300.0011	Row of catenary lighting columns < 40m apart	355.0	355.0	0.5					W2		
☐	i	0600.0004	Falling at 50%	160.0	200.0	2.5	No	Acceptable	47		W2	N2	N/A
☐	i	0600.0005	Nominally at Grade	200.0	11500.0	2.5	Yes						

No risk results are available

Figure 2-20 Hazard located in front of barrier on Collation page

The error might have been caused by a mistype of data, in which case it should be corrected on the appropriate data entry page and the risk calculation re-run.

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 standard barrier set-back should be manually reduced (edit it via the 'Collation & Reports' tab) to be the same as or marginally less than the offset of the hazard that was previously flagged as being in front of the safety barrier and the risk calculation re-run to ascertain the risk level and VRS requirements.

If no VRS is required for that particular hazard and there is no VRS requirement for other hazards nearby that would extend to the flagged hazard, then the hazard may remain, subject to the hazard meeting other DMRB requirements, such as sightline.

If the RRRAP indicates that the flagged hazard requires protection, then the programme will highlight the entry as detailed in section 2.10.4, and the actual barrier working width will be shown or as 0.01 m, (rather than 0.00, as programme would consider a zero here a problem).

Where there is a VRS requirement for other nearby hazards that would extend to or past the flagged hazard or the flagged hazard requires VRS protection as outlined above, then there are various options that may be possible depending on the circumstances:

- Move flagged hazard further from Psb (hazards should not lie in front of a VRS or within its working width)
- Move flagged hazard and make passively safe.
- Reduce VRS set-back within allowable limits (CD 127 refers)
- Reduce working width of VRS
- Combination of the above
- Remove flagged hazard altogether.

Please refer to CD 377 and the following which give further details and guidance.

2.10.6 Hazards where alternative VRS working width is available

When a new hazard is created, if a VRS is required, it is given a default working width of W2. Safety barriers with smaller working widths are generally more expensive than those with larger working widths. It is therefore important that the Designer checks and specifies the greatest working width class that can practicably be achieved in the circumstances. The Designer should take into account the following requirements in determining the working width class: set-back of the safety barrier; the location of the hazard and of other hazards adjacent to it; the minimum distances to top or toe of slope (CD 377 Figures 3.19, 3.28 and 3.29); the minimum length of VRS in advance and beyond returned by the RRRAP together with the additional length of safety barrier in advance to achieve full containment (CD 377 Figure 3.19 refers).

To help highlight which hazards have a potential alternative VRS working width, when risk is calculated for the hazard, if an alternative VRS working width class is possible at the hazard location, RRRAP will highlight the working width class cell in tables (see Figure 2-21). The Designer should check and specify the greatest VRS working width class that can practicably be achieved for each of these hazards.

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
	i	0600.0001	Nominally at Grade	0.0	100.0	2.5	Yes						N/A
	i	0600.0002	Falling at 50%	100.0	140.0	2.5	Yes						N/A
	i	0600.0003	Falling at 50%	140.0	160.0	2.6	No	Acceptable	45		W2	N2	N/A
	i	0600.0004	Falling at 50%	160.0	200.0	2.5	No	Acceptable	44		W2	N2	N/A
	i	1200.0001	Sign on post(s)	170.0	170.2	2.0	No	Acceptable	27		W2	N2	N/A
	i	1200.0002	Sign on post(s)	170.0	170.2	3.0	No	Acceptable	27		W2	N2	N/A
	i	1200.0003	Sign on post(s)	170.0	170.2	3.0	No	Acceptable	27		W2	N2	N/A
	i	0600.0005	Nominally at Grade	200.0	11500.0	2.5	Yes						N/A

Alternative WW/VRS available i.e W5

Figure 2-21 Hazard with VRS working width highlighted

Where a VRS working width class has been highlighted as having an alternative and the Designer wishes to accept the current VRS working width class, on the 'Collation' page click the 'Accept Working Widths' button. The 'Accept Working Width' page lists all the Hazards where an alternative VRS working width is available.

i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	VRS working width class	Alternative class	Accept?
i	0600.0003	Falling at 50%	140.0	160.0	2.5	W2	W3	☐
i	0600.0004	Falling at 50%	160.0	200.0	2.5	W2	W3	☑
i	1200.0001	Sign on post(s)	170.0	170.2	2.0	W2	W4	☑
i	1200.0002	Sign on post(s)	170.0	170.2	3.0	W2	W6	☐
i	1200.0003	Sign on post(s)	170.0	170.2	3.0	W2	W5	☐

Figure 2-22 Accept Working Widths

If you wish to indicate the current VRS working width class is acceptable rather than using any alternative, click the 'check'-box to accept the current VRS working width class. To save any changes to this page, click the 'Save' button.

If you accept the current VRS working width class, the highlight on the VRS working width class column in the tables will change from yellow to blue to indicate the current VRS working width has been accepted.

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	ℹ	0600.0001	Nominally at Grade	0.0	100.0	2.5	Yes						N/A
☐	ℹ	0600.0002	Falling at 50%	100.0	140.0	2.5	Yes						N/A
☐	ℹ	0600.0003	Falling at 50%	140.0	160.0	2.5	No	Acceptable	39		W2	N2	N/A
☐	ℹ	0600.0004	Falling at 50%	160.0	200.0	2.5	No	Acceptable	39		W2	N2	N/A
☑🔍	ℹ	1200.0001	Sign on post(s)	170.0	170.2	2.0	No	Acceptable	27		W2	N2	N/A
☐	ℹ	1200.0002	Sign on post(s)	170.0	170.2	3.0	No	Acceptable	27		W2	N2	N/A
☐	ℹ	1200.0003	Sign on post(s)	170.0	170.2	3.0	No	Acceptable	21		W2	N2	N/A
☐	ℹ	0600.0005	Nominally at Grade	200.0	11500.0	2.5	Yes						N/A

Figure 2-23 Hazard with VRS working width accepted highlighted

Note – if you subsequently change any of the following fields associated with a Hazard, then the alternative VRS working width class and any acceptance will be cleared (and removed from the table cells). The Designer will need to re-run the risk calculation to observe any changes and, if necessary, re-accept the current working width class:

- Offset of Hazard from Psb
- VRS Working Width Class
- VRS Working Width (m)
- VRS Set-back (m)

Also, the alternative VRS working width class and any acceptance will be cleared if you change the nature of an existing 1700 Structure / Parapet hazard.

As part of the review of working width class and 'Min Length VRS in advance' it is important to check that there are no hazards (including those that do not in themselves require VRS), that lie within the working width of the length of VRS or any transition or terminal in advance (or beyond) and that the values for each are appropriate. Having reviewed these, when the Designer is satisfied the working width class (either the original or the alternative one) and the 'Min Length VRS in advance' (and beyond) are appropriate, the 'accept working width class' and 'accept VRS length' boxes should be completed.

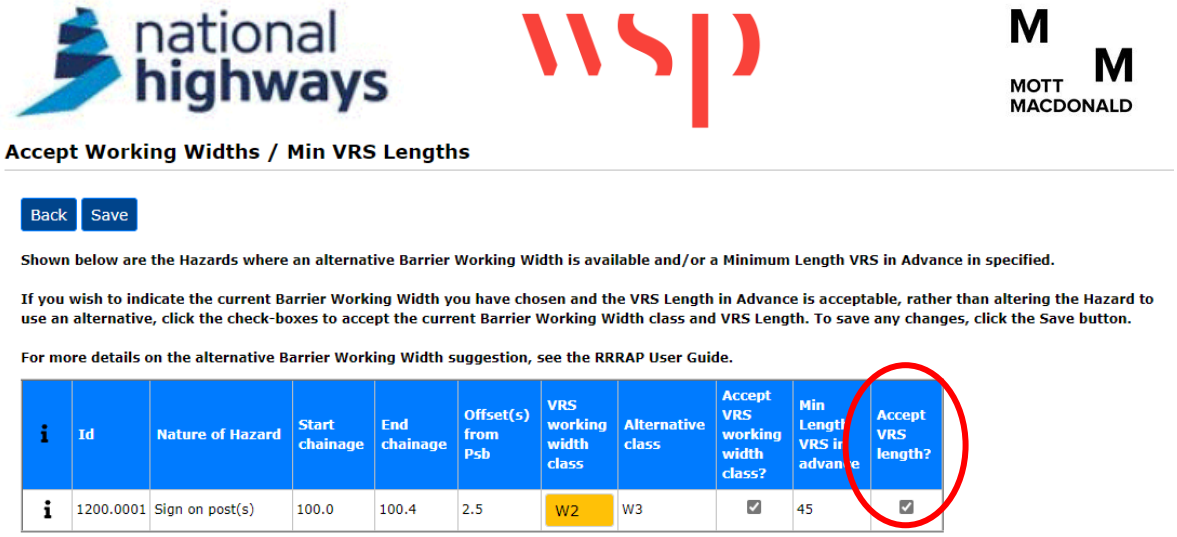


Figure 2-24 Accept Working Widths and Min VRS Lengths

2.10.7 Connection Problems

If there are any connection issues from your computer to the RRRAP server while using the site, a connection error message will be displayed (an example of one is shown in Figure 2-25.)

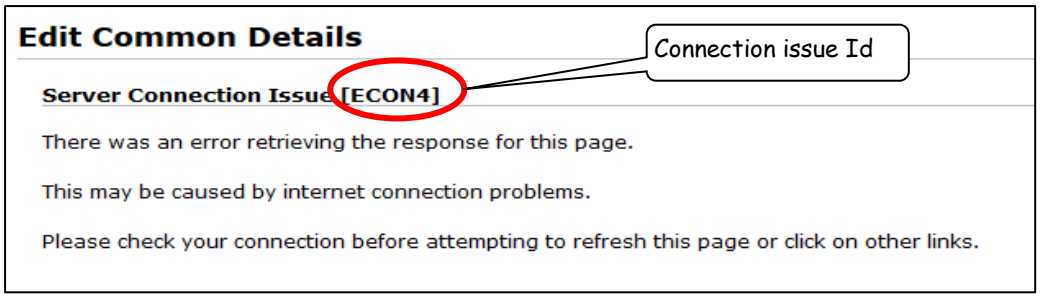


Figure 2-25 Connection Issue

Before raising any issues with the RRRAP Support, please make sure the problem is not with your internet connection.

- Can you access other external internet sites?
- Have you made sure any corporate firewall or internet filter your organisation uses has been updated to allow access and use of the RRRAP website. Failure to do this may cause connection errors and stop parts of the site working correctly.

If the problem persists, please contact the RRRAP Support. The email address is listed on the RRRAP home page. When reporting the issue, please include the following information:

- Connection issue Id (see figure 2-25 above)
- Time problem occurred
- A clear description of what actions you were performing at the time
- The name of any RRRAP record that was open when the problem occurred

2.10.8 Web Application Error

If there is a problem with the RRRAP web application, you may see a screen similar to that shown below.

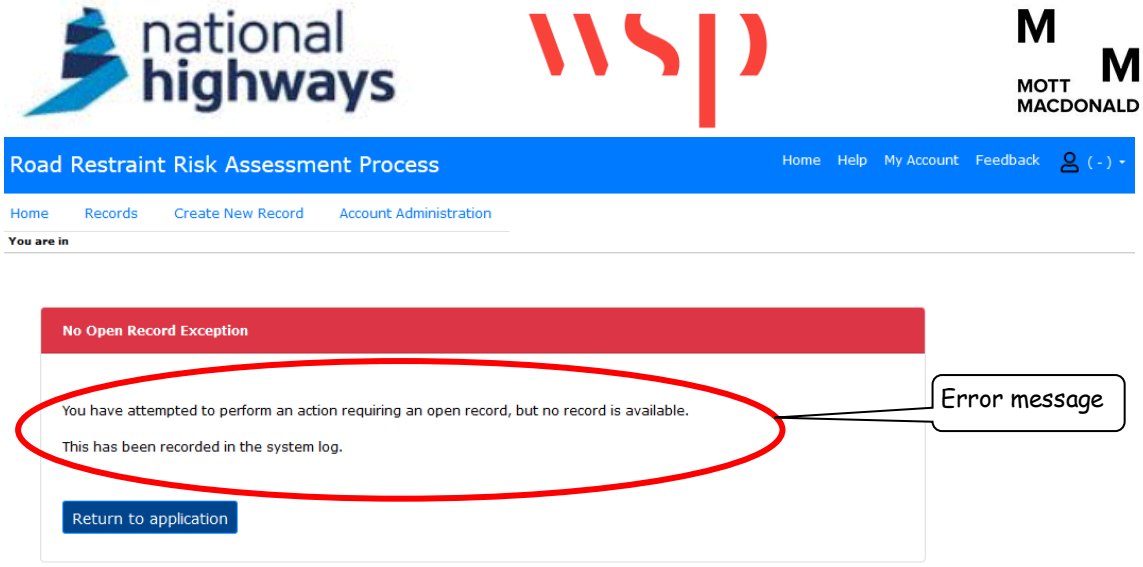


Figure 2-26 Web Application Error

If this occurs, please make a copy of the specific error message text.

Send any problems like this to the RRRAP Support. The email address is listed on the RRRAP home page. When reporting an issue, please include the following information:

- The details described above from the error page
- Time problem occurred
- A clear description of what actions you were performing at the time
- The name of any RRRAP record that was open when the problem occurred

2.11 Relaxations and Departures from Standard

If a Relaxation or a Departure from Standard is required, edit the hazard via the 'Collation & Reports' tab and then update the 'Relaxation / Departure required?' field. By default, this field has the value 'None'. The drop-down for this field can be changed to 'Relaxation' or 'Departure'.

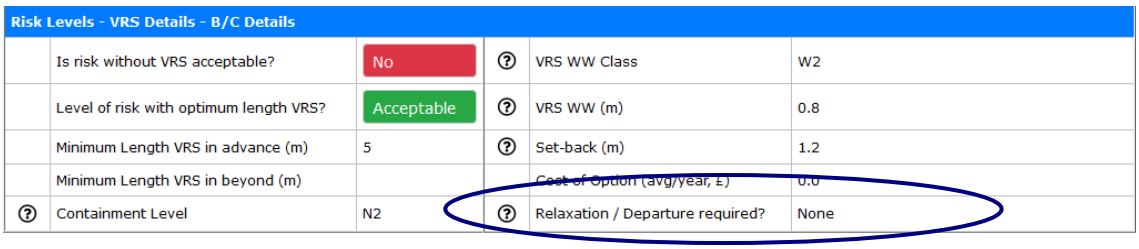


Figure 2-27 Relaxation / Departure required

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

The completed RRRAP record should contain sufficient detail to allow the Overseeing Organisation to form an opinion as to the acceptability of a Departure or Relaxation and demonstrate that the preferred option has been compared against options that would meet full Standards. The Hazard 'Comment' field can be used to record the justification for the Departure or Relaxation.

A full RRRAP report should form part of the application for a Departure from Standard.

3 Records

3.1 Overview

The 'Records' tab is the access point for locating, opening, copying, deleting, and importing RRRAP records.

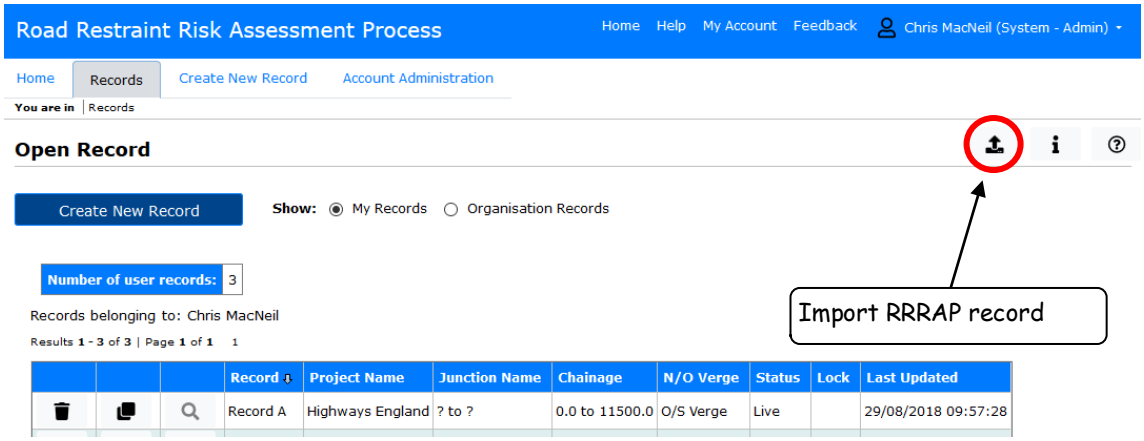


Figure 3-1 'Records' tab

When you first visit this tab, it will list the records that are registered against your user account (generally those records that you have created). If you have a lot of records, then the list may stretch over multiple pages. You can either click the 'page number' links at the top/bottom of the table to access different pages of the list, or you can click on the column headers of the table (only those that highlight when you move the mouse into the header), and this will re-order the list of records accordingly.

To open a record, click on a row in the table. The record will be opened and the 'Record Status' tab will be displayed. If a record is already open when you try to open another record, you will be asked if you wish to stay with your currently open record or if you wish to close it and open the selected record.

A RRRAP record ZIP archive that has been previously exported from the RRRAP web application (see section 4.4) can be imported into the RRRAP web application by clicking the 'Import RRRAP Record' icon at the top right of the page (shown in Figure 3-1). For more details see section 3.9.

3.2 Organisation records

As a user, your account in the RRRAP is associated with an Organisation and an area within that organisation. As well as being able to open and edit your own records, you can open and edit records of other users that belong to the same organisation as you do.

To view the records belonging to other users in your Organisation, click the show "Organisation Records" radio button. This will update the page to show all the records for users that belong to your Organisation. You can filter this list further by selecting an Organisation area from the additional dropdown.

3.3 Record Locks and Read-Only Records

If you open a RRRAP record, you will automatically lock the record for editing (assuming no other user already has the record open). Lock information shown on the 'Records' tab includes:

 Record is locked for editing by you

 (greyed out lock icon) Record is locked for editing by another user - moving the mouse over the icon will display the name of the user with the record lock.

If a record is locked by another user and you then open that record, it will be opened in a read only mode. You will be able to view all the details of the record and generate reports, but will not be allowed to create, edit or delete any data associated with the record whilst it is locked.

You can also open a record in read-only mode directly without placing an edit lock on the record by clicking the  icon in the 'Records' table (instead of clicking elsewhere on the row in the table).

3.4 Take Ownership

When viewing records that belong to users within your Organisation, an additional column is displayed that allows you to take ownership of a record. This can be useful if a colleague is off sick or going on holiday and you are taking over responsibility for a record. By taking ownership of the record, the record will now appear when viewing the list of your records.

To take ownership of a record click  . A dialog will be displayed asking if you are sure you wish to take ownership of the record. Clicking 'Ok' will complete the process.

You cannot take ownership of a record that you are already the owner of, or a record that is currently locked for edit by a different user.

3.5 Copy Record

To copy a RRRAP record, click the  icon in the appropriate row of the records list. A dialog will be displayed to check that you really want to copy this particular record. If you click the 'Ok' button, a page similar to creating a new record is displayed. The details are populated with the details of the record being copied. These should be changed as is required for the new record.

Note: The 'Record Name' and the 'Project Name' in combination have to be unique within your Organisation, e.g. you can use the same 'Project Name' for multiple RRRAP records so long as the 'Record Name' is different in each record.

The 'copy record' process duplicates the following information in a RRRAP record:

- Common Details
- Option Costs
- Hazards Overview (category selection and completion)
- All individual hazards (not including any calculated risk values)

To ensure that this new record is processed correctly, the record copy process ***does not duplicate the following***:

- Sign off information.
- Results of on page calculations for non-editable fields.
- Results of risk calculations.
- Generated detailed results.
- Restraint summary details (Specification Appendix 4/1).
- Temporary Hazards.

3.6 Delete Record

Each Organisation has a finite amount of space on the RRRAP database, so old / completed RRRAP records will have to be deleted off the system by the Organisation from time to time. This will release record 'slots' for re-use.

Before deleting a RRRAP record you should have exported a copy of the RRRAP record data and printed off a full RRRAP report. An exported RRRAP record can be re-imported back into the RRRAP web application (see section 3.9).

To delete a RRRAP record, click the  icon in the appropriate row of the records list. A dialog will be displayed to check that you really want to delete this particular record.

Once the record is deleted all its associated data will be lost and cannot be retrieved.

You cannot delete a record if you do not have ownership of the record, or another user currently has the record locked for editing.

3.7 Create New Record

You can create a new RRRAP record by either clicking the 'Create New Record' button on the 'Records' tab or, if no record is currently open, click directly on the 'Create New Record' tab that is available.

When creating a new RRRAP record there are four fields:

- 'Record Name' – name of RRRAP record - think equivalent to the name of a file on your computer (maximum 60 characters, including spaces)
- 'Is this record related to National Highways funded work?' - Select either 'Yes' or 'No' depending on if the work is for a National Highways funded project.
- 'Project Name' – name of the real-world project the record is related to (maximum 60 characters, including spaces)
- 'Description' – an optional text description of the record (maximum 255 characters, including spaces)

All but the 'Description' field are mandatory and must be completed before saving.

An important point to note is that the 'Record Name' and the 'Project Name' in combination have to be unique within your organisation, e.g. you can use the same 'Project Name' for multiple RRRAP records so long as the 'Record Name' is different in each record.

3.7.1 Create Record Notes

If when creating a new RRRAP record your Organisation has no free record slots, then an appropriate error message will be displayed. In the first instance, you should identify old and / or complete RRRAP records that can be deleted, otherwise contact your Organisation's RRRAP representative.

If you create a new record while you have one already open, once you click the 'Create' button (after entering the new record name, project name, etc.), you will be prompted if you wish to close your currently open record and open your new record. If you click the button to open the record, then your new record will be opened and the record you had open will be closed. If you decide to keep your existing record open, the new record is not opened, but can be accessed via the 'Records' tab.

3.8 Working copies of records

A new feature introduced in v3.3 of the RRRAP is the ability to create working copies of a record. This feature is intended for situations where Designers want to explore different options as part of the design process.

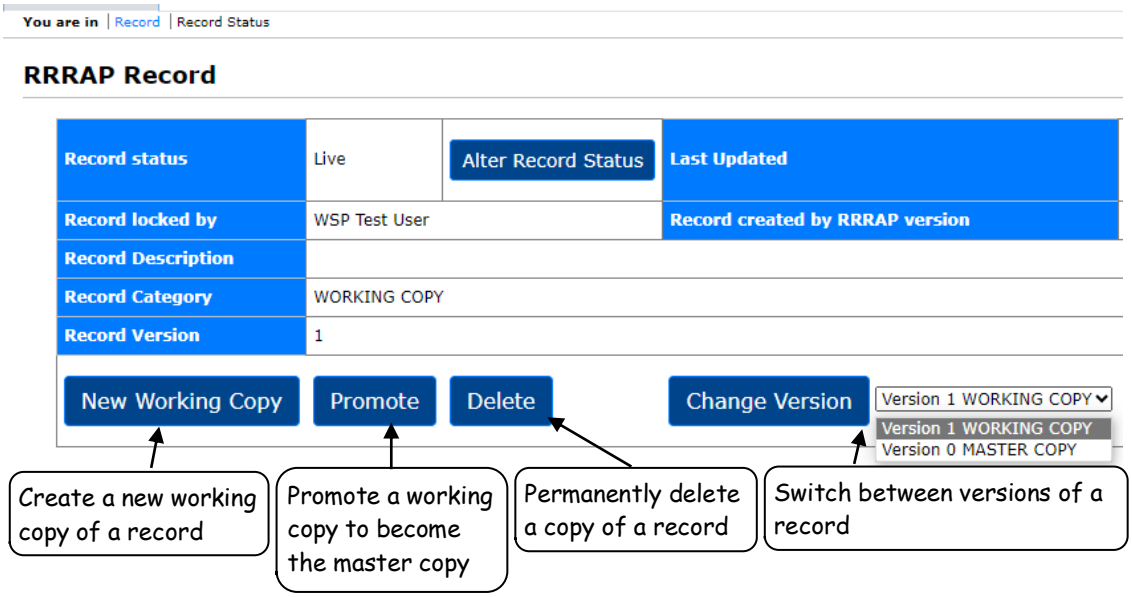


Figure 3-2 Working copy of records

A new copy of the record may be creating by clicking on the 'New Working Copy' button. Once a new working copy has been created users can switch between the master copy and the working copy by selecting the required version using the 'Change Version' button.

A working copy of a record can be promoted to the master copy by changing to the required version of the record and clicking the 'Promote' button.

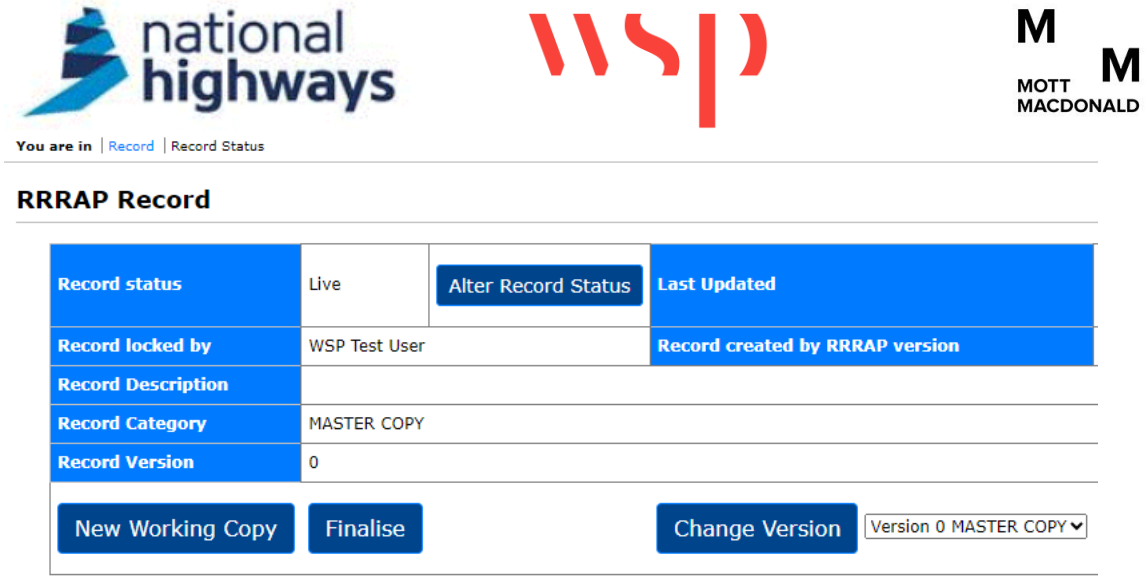


Figure 3-3 Finalise a RRRAP record

Clicking on the 'Finalise' button shown in the figure above will finalise the current master copy and permanently delete all working copies of the record. Working copies that have been deleted are deleted permanently and cannot be recovered.

Where users wish to retain copies of records that they have used to explore different design solutions then they should use the 'Copy Record' function from the 'Records' page as shown in the figure below.

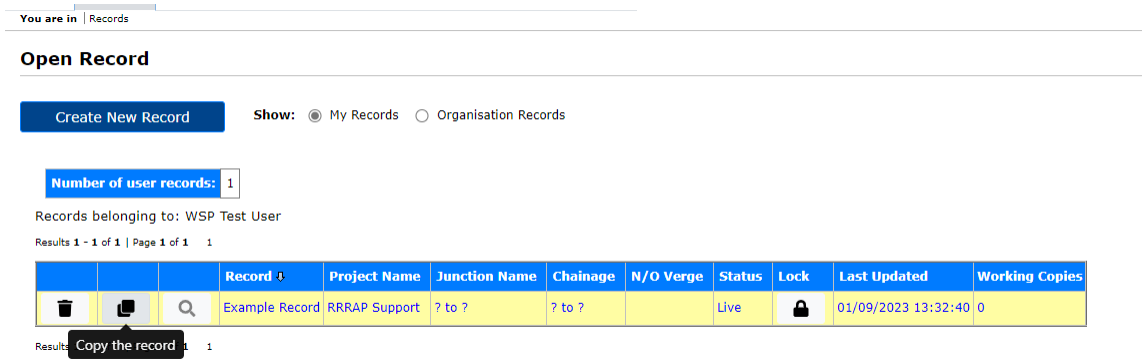


Figure 3-4 Copy a RRRAP record

For more information on copying a record, please refer to section 3.5 of this document.

3.9 Import RRRAP Record

The following steps describe how to import a RRRAP record ZIP archive that has been previously exported from the RRRAP web application. For instructions on exporting a RRRAP record ZIP archive, see section 4.4.

Currently, an exported RRRAP record will contain:

- All 'Common Details'
- The data entered for each of the hazard category types (not including any calculated risk values)

To import a RRRAP record ZIP file follow these steps:

1. Via the 'Records' tab, click the 'import RRRAP record' button  (located at the top right).
2. The first of two 'record import' pages is displayed. Enter the details for a new RRRAP record. A new RRRAP record must be created to import the RRRAP record data into. For more information on these fields see section 3.7 'Create New Record'.
3. Once all details of the new record have been entered, click the 'Next' button.
4. The second record import page is displayed. Using the 'browse' button on this page, specify the ZIP file to import from your local file system.
5. Click the 'upload' button.
6. On upload, there are several possible outcomes:
    - There is a fatal error with the zip (too big, missing individual CSV files, etc). This will stop the import from completing. Error messages will be displayed to try and help identify issues.
    - There are no fatal errors with the zip. A new RRRAP record is created, and issues with individual CSV files (if there are any) are listed.
7. Click the 'Open New Record' button to open the new record with the imported content.

During RRRAP record import, CSV files within the ZIP are imported one at a time and are considered in isolation. If one CSV file fails to import due to a fatal error, this error will be reported in the results of the import process but will not stop the attempted import of the other CSV files in the RRRAP record ZIP archive.

Warnings reported as part of the import process may indicate fields that require attention. Where appropriate, take action to fix these issues before attempting to perform the risk calculation.

4 Record Status

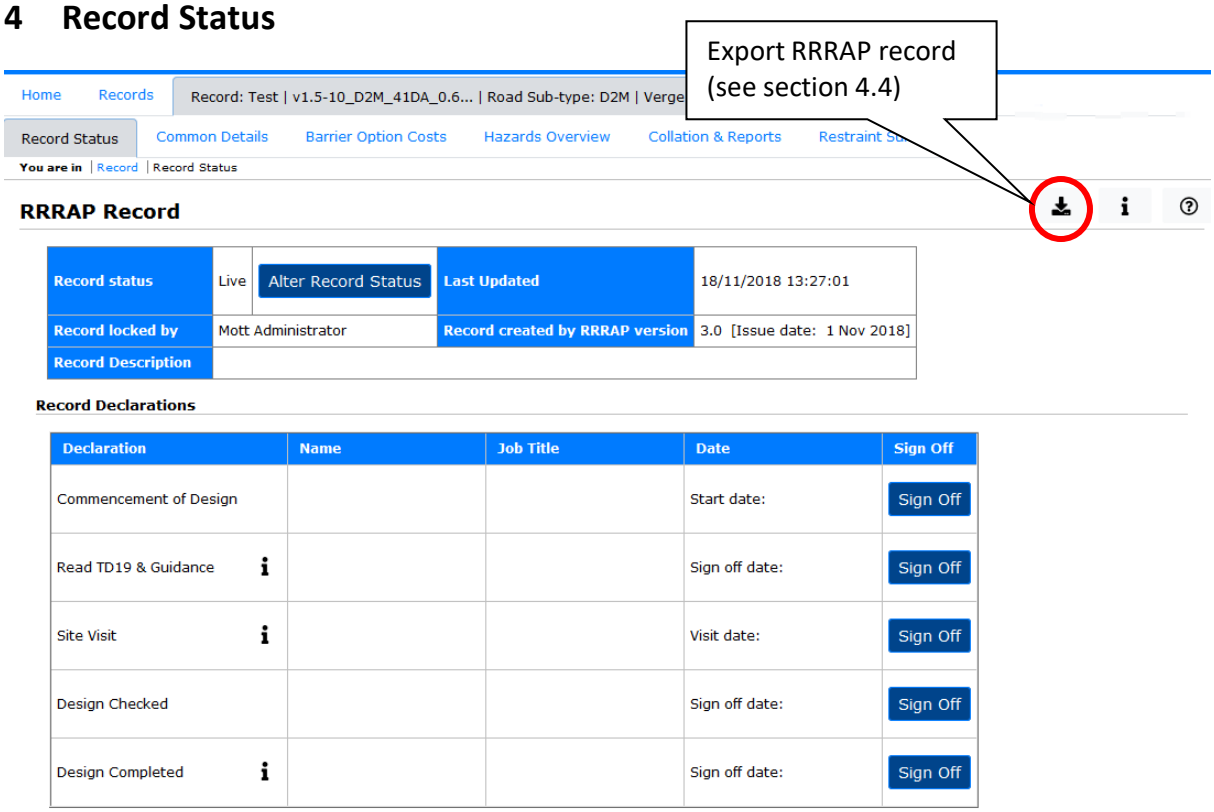


Figure 4-1 'Record Status' tab

The top part of this page presents a brief summary overview of the RRRAP record.

- Record status – the current status of the RRRAP record
- Last updated – when details of the record were last updated (see section 4.1)
- Record locked by – the name of the user who currently has the record locked for editing
- Record created by RRRAP version – The version of the RRRAP used to create the record and the date that version of the RRRAP was made available
- Record description – an optional description of the record to provide more detail

The bottom part of the page presents a set of declarations that should be signed off at different points during the lifetime of the record (see section 4.2).

The record status can be altered by clicking the 'Alter Record Status' button (see section 4.3).

The RRRAP record can be exported by clicking the 'Export RRRAP Record' icon at the top right of the page (see section 4.4).

4.1 Record Last Updated

The last updated date/time value will be updated when most data entry / manipulation events occur.

The following features of the RRRAP will NOT affect the last updated time:

- Opening or closing a RRRAP record
- Altering the record status

- Exporting a RRRAP record
- Generating a report

4.2 RRRAP Record – Declarations

There are several declarations that should be signed off by an appropriate user for particular aspects of the RRRAP record; e.g. commencement of design; indicating that CD 377 and supporting guidance has been read by the Designer; that a site visit has taken place; etc. The Designer could be the Design Manager responsible for the team carrying out site surveys and the design and the RRRAP process.

The application imposes no restriction on which users sign off these declarations and when the sign off should take place. Only those users with the appropriate authority should sign-off parts of the RRRAP in line with their own company's procedures.

Some of the declarations require a date to be entered (e.g. commencement of design, when site visit occurred). Either click the 'Calendar' image next to the entry field to display a calendar to pick a date or enter a date manually in the format 'dd/mm/yyyy'. For the declarations that do not require a date, the date will be taken from the current time when the 'Sign off' button is clicked.

4.3 Record Status Page

Each RRRAP record has an assigned status. The following table describes the meaning of each status.

Status Level	Description
Live	Record created and ready for data entry
On hold	Design currently on hold
Abandoned	Scheme/Design abandoned or indefinitely postponed
Prelimin. design	Preliminary/Feasibility Design
Detailed design	Data entry phase for detailed design
Complete	Design complete pending check and approval
Checked	Design is complete and checked
Approved	Design is complete, checked and approved
Archive	Inputs and outputs downloaded and saved
Closed	Design closed

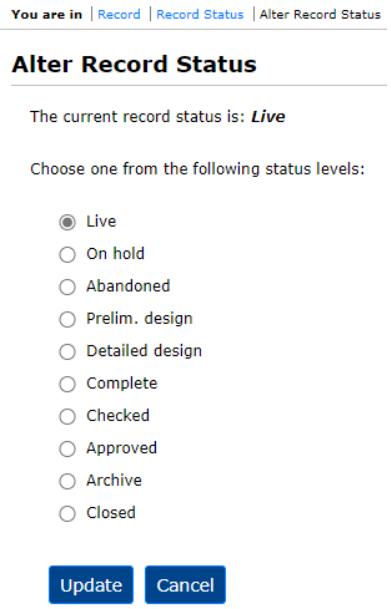


Figure 4-2 'Record Status'

Users should use the status alongside their own company's procedures to manage and monitor the progress of each RRRAP record.

4.4 RRRAP Record Export

The following steps describe how to export the raw hazard data that has been entered into the record as a RRRAP record ZIP archive. For instructions on importing a RRRAP record ZIP archive, see section 3.9.

Important Note - Exporting back-up copies of records

Records accidently deleted from RRRAP cannot be recovered. It is therefore important that users use the export facility to back-up their records at appropriate intervals during the design process.

The raw data exported includes:

- All common details
- The data entered for each of the hazard category types (not including any calculated risk values)

The record export does not export:

- Sign off details.
- Option costs.
- Hazard overview details (i.e. if a hazard category type is expected or has its data entry completed).
- Temporary hazards.
- Restraint summary details for inclusion in Appendix 4/1.

The above information is captured in the 'Full Report' (see section 11.3) and 'Restraint Summary Report' (see section 12.1) which can also be archived off the system.

The export consists of a ZIP file containing CSV files. Within the ZIP file, the common details will be contained in a folder called 'Common Details' and all the hazards will be in a folder called 'Hazards'. Each hazard category will have an individual CSV file.

To export a RRRAP record ZIP file follow these steps:

1. Via the 'Record Status' tab, click the export 'RRRAP record' button (located at the top right).
2. To export a RRRAP record a filename (for the generated ZIP file) has to be provided. By default the name of the export file is the record name (x) plus the name of the project (y) and the date, i.e. x_y_dd_mm_yyyy.zip
3. Click 'Export Record' to generate the export file.
4. Once the export file has been generated, a dialog will be displayed by your browser. At this point you can save the file to an appropriate location on your computer.

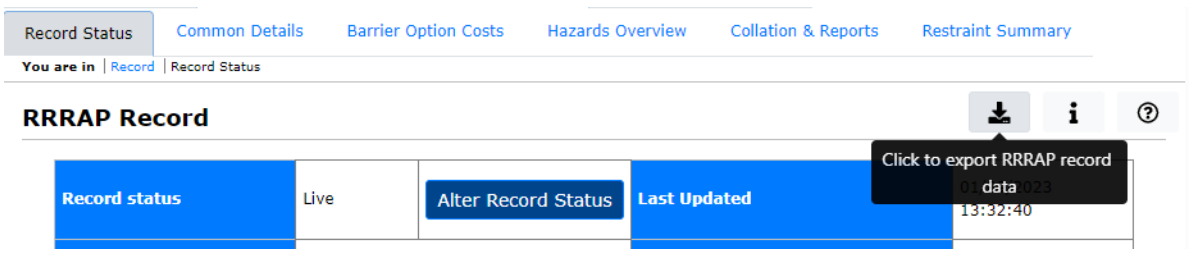


Figure 4-3 Exporting a RRRAP record

5 Data Entry – 'Common Details'

This tab records key details of the project for which the assessment of Road Restraint System requirements is being undertaken. The page is split into four sub-sections:

- Basic Details
- Reason for Design
- Section Details & Traffic Information
- Scheme Duration & Barrier Costs

To enter 'Common Details', click the 'Edit' button.

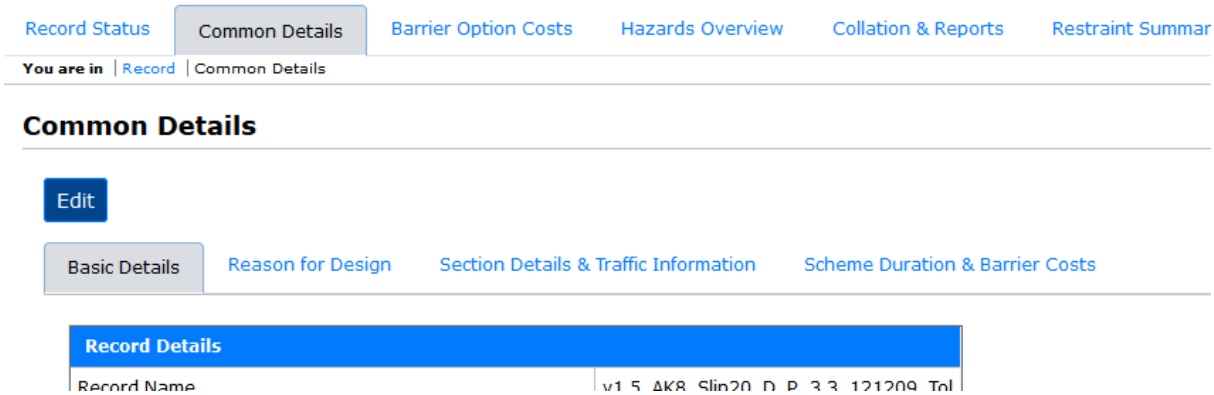


Figure 5-1 'Common Details' tab

Important Note – Saving 'Common Details'

To save values entered for 'Common Details' click the 'Save' button. Please note that 'Common Details' cannot be saved until **all required mandatory fields** have been completed across all 'Common Details' sub-tabs. Any sub-tab that has incomplete mandatory fields will be highlighted with the ❗ indicator – see figure 5-2.

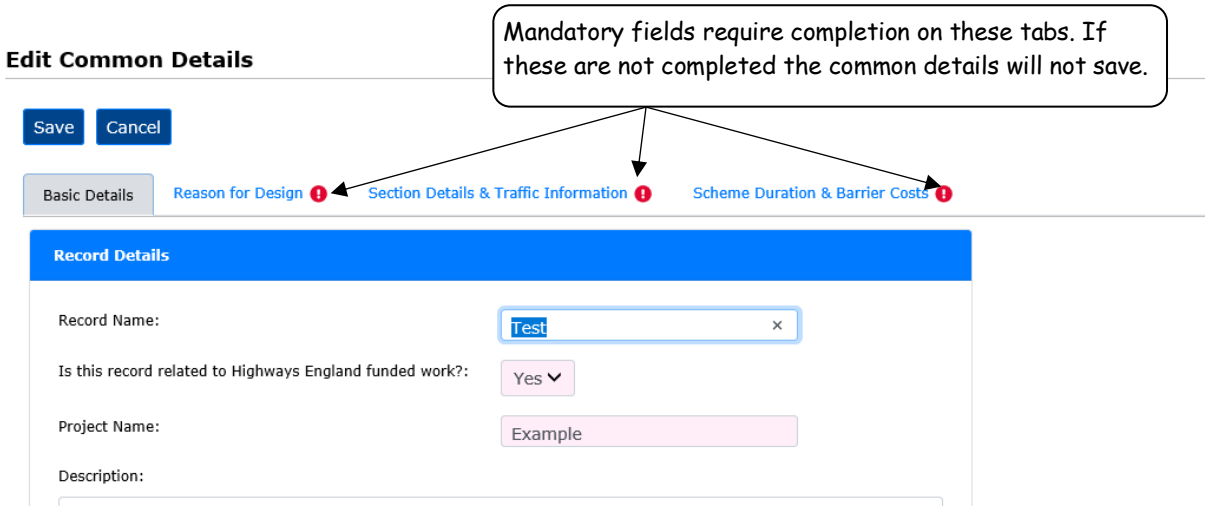


Figure 5-2 Incomplete mandatory fields on the 'Common Details' tab

It is also important to note that, whilst the mandatory fields are the minimum that must be completed before the 'Common Details' can be saved, and only completing the mandatory fields can be useful if, for instance, a quick trial is being carried out, it is essential that data is entered in all the other fields so that a complete auditable record is maintained for the final design.

5.1 Basic Details

This section is used to record overall details of the Project. It records details such as: Project ID; Designer Reference and location; etc.

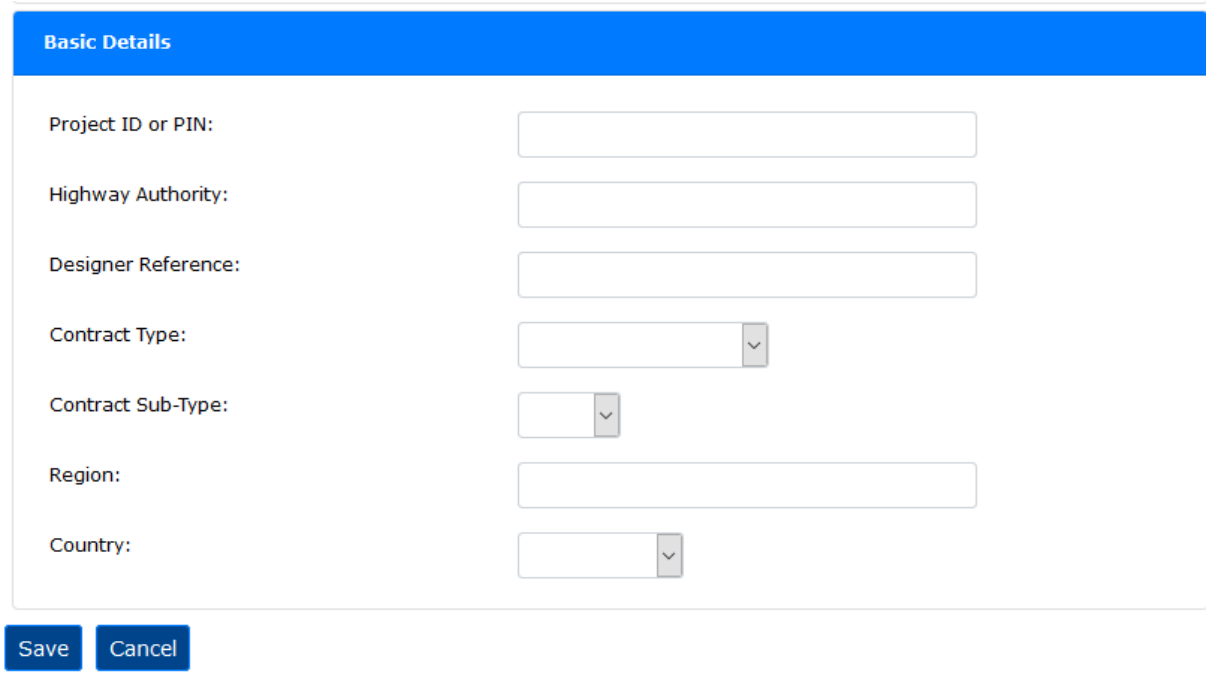


Figure 5-3 Common Details – Basic Details

Also included in the 'Basic Details' tab is the 'Record Details', i.e. Record name, Project name, Record Description, etc. These values can be edited while editing the other 'Common Details' values.

5.2 Reason for Design

This section is used to record details of why the Project and works are being done, e.g. upgrade or improvement to an existing carriageway or replacement of existing Restraint System; etc.

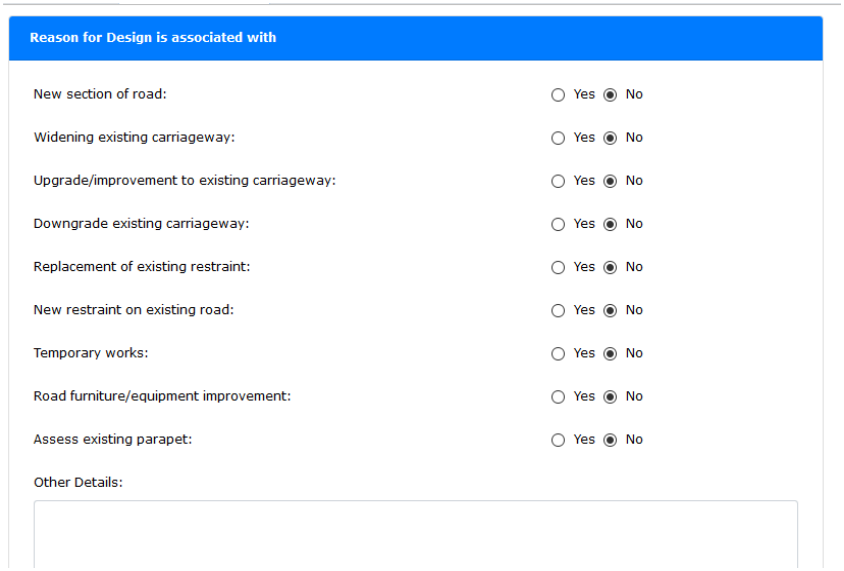


Figure 5-4 Common Details – Reason for Design

If you answer 'Yes' to 'Assess existing parapets', you will be prompted to fill in an additional set of 'Yes' / 'No' questions.

If none of the supplied reasons for the design are appropriate, then use the 'Other Details' text area at the bottom of the page to enter the reason for the design.

Important Note – Temporary Works

If you select 'Yes' for 'Temporary Works', an additional Temporary Works tab will be displayed (once the Common Details are saved). Note that temporary hazards are dealt with differently to other hazards. Please refer to section 13 of this document for more information on temporary works.

5.3 Section Details

This section is used to record details of the particular Section of the road that is under consideration: e.g. type of road; the road's 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; etc.

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 vehicle run-off and accident characteristics of the Slip and Mainline will be different.

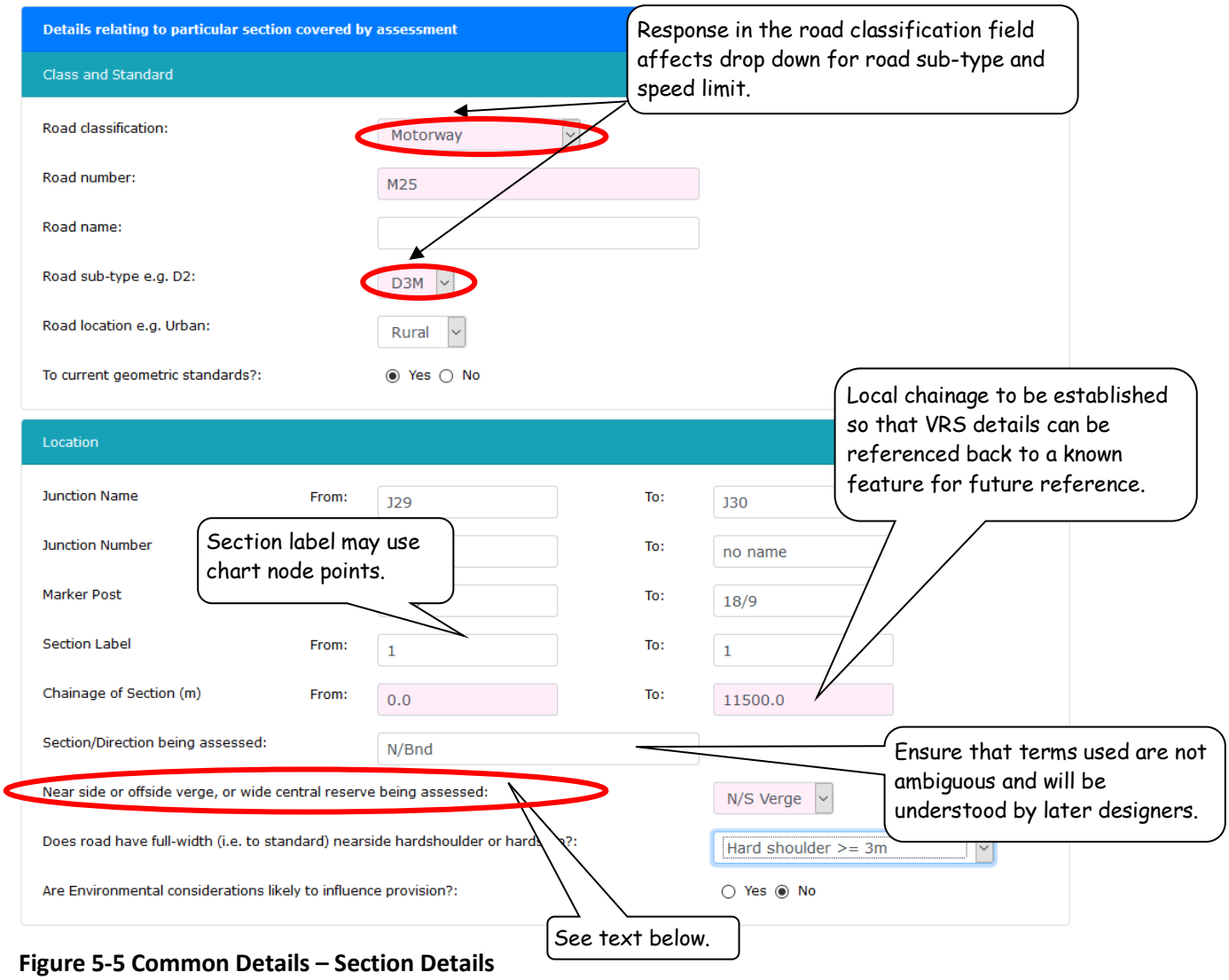


Figure 5-5 Common Details – Section Details

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

The RRRAP is normally used for assessing the near side verge (n/s verge) of a single or dual carriageway. It can be used for assessing the offside (o/s verge) of a slip or link road, which are essentially one-way roads or the o/s verge of a single carriageway. It can also be used for assessing whether hazards that are present in a wide central reserve (i.e. one that is more than 10 m wide) warrant protection 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.

5.4 Section Details - Chainage

The RRRAP can cater for Sections that are both increasing or decreasing in chainage order.

If say a section of road is being assessed with increasing chainage in the northbound direction from, say, ch 0 m to ch 1200 m then, for hazards in the northbound verge, the chainage will run from ch 0 to 1200, whilst for hazards in the southbound verge, the chainage will run from ch 1200 to ch 0. Each direction would require a separate RRRAP record.

In order that the RRRAP is meaningful and identifiable to maintenance and highway authorities' years after a design has been completed, it is essential that the local chainage that has been adopted for a design is referenced back to some known features e.g. node points or chart points or to a permanent structure such as a bridge. This should be captured via design drawings.

As a minimum, the length of section of carriageway being assessed should include data for at least 100m in advance of the first hazard and 50m following the final hazard being assessed.

5.5 Section Details – Hard shoulder width

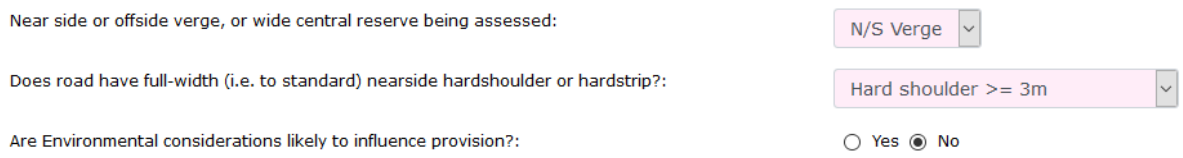


Figure 5-6 Section Details – Hard shoulder width

More details on defining hard shoulder widths can be found in section 8.2.

5.5.1 Motorways

For a Motorway, a standard nearside (n/s) full width hard shoulder is 3.3 m.

Where the hard shoulder is locally less than 3.0 m, it would normally be hatched and signed as having no hard shoulder in accordance with CD 127. If the n/s hard shoulder is generally full width, but locally is less than 3.0 m in width over lengths of less than 100 m, for the purposes of the RRRAP, indicate that the hard shoulder is >= 3 m in width.

Where the n/s hard shoulder is less than 3.0 m wide over a length greater or equal to 100 m then indicate that the road has a hard shoulder between 0.6 m and 3.0 m. Enter the actual hard shoulder widths in 'Width of adjacent Hardshoulder' / 'Hardstrip (A)' field in the 'Verge Widths' hazards section.

For the offside (o/s), the 'Width of adjacent Hardshoulder' / 'Hardstrip (A) & (B)' fields should both be zero for the central reserve situation.

5.5.2 Smart Motorways

For All Lane Running (ALR) Sections, follow the help and guidance given in section 8.2. For Hard Shoulder Running (HSR) sections, again follow the help and guidance in section 8.2, running two separate RRRAP records: one with standard running, i.e. with hardshoulder in place and permanent speed limit; and the second with HSR and the proposed speed limit for this scenario. The outputs from the two scenarios can be compared and the VRS requirement for each hazard for the worst case selected.

For the offside (o/s), i.e. the central reserve, the 'Width of adjacent Hardshoulder' / 'Hardstrip (A) & (B)' fields should both be zero.

5.5.3 All Purpose Roads

For a Single or Dual All Purpose Road, the standard n/s hardstrip width is 1.0 m. The drop downs are 'Hard strip >= 0.6 m' and 'Hard strip < 0.6 m'. If the hardstrip is generally full width, but locally is less than 0.6 m in width over lengths of less than 100 m, for the purposes of the RRRAP, indicate that the 'Hard strip >= 0.6 m'.

Where the hardstrip is less than 0.6 m wide over a length greater or equal to 100 m then indicate that the 'Hardstrip < 0.6 m'.

For the offside (o/s): the 'Width of adjacent Hardshoulder' / 'Hardstrip (A)' field = h/s width, typically 0.7 m or 1.0 m; the 'Width of adjacent Hardshoulder' / 'Hardstrip (B)' field = zero.

5.5.4 Slip and Link Roads

For a Slip Road or a Link Road where the standard n/s hard shoulder is 3.3 m, follow the guidance for a Motorway. For a Slip Road or Link Road where the standard hard shoulder is 2.8 m or standard hardstrip is 1.0 m in width, then indicate that the road has a 'hard strip/shoulder 0.6 m to 3.0m'.

For the offside (o/s): the 'Width of adjacent Hardshoulder' / 'Hardstrip (A)' field= h/s width, typically 0.7 m or 1.0 m; the 'Width of adjacent Hardshoulder' / 'Hardstrip (B)' field = zero.

5.5.5 All cases

The RRRAP defaults to a 0.6 m VRS set-back where full width n/s hard shoulder (>=3.0 m) or hardstrip (>=0.6 m) has been indicated, otherwise it defaults to 1.2 m set-back. The Risk calculations are pre-formed on the basis of the indicated hard shoulder width and the default set-back.

Should the local highway geometry not be sufficient for the default set-back values, it is possible, having run the RRRAP Risk Calculation, to overwrite the set-back values manually by editing hazards via the 'Collation & Reports' tab and to then recalculate the risk levels. If doing this, it is recommended that you generate 'Detailed Results' for the hazard(s) under investigation and either a 'Snapshot' or 'Full' report. This acts both as a record of previous values and to facilitate comparison.

In some circumstances, it is possible that only Tolerable results will be returned, and it will not be possible to get an Acceptable level of risk. This is due to the way in which the equations and thresholds within the RRRAP operate. Where it is not possible to obtain an Acceptable level of risk, a Departure from Standard must be applied for, accompanied by a RRRAP report and a summary of what options the Designer has looked at (see section 2.11).

5.6 Section Details - 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 the RRRAP indicates protection is required for a localised one off hazard on a low risk site within an 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 'Comment' field relating to the hazard. The response entered is purely used for audit purposes and the calculation is not affected in any way.

5.7 Traffic Information and Scheme Duration

The lower part of the page, 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 goods vehicles (LGVs), i.e. those over 3.5 tonnes, and, to a lesser extent, of medium goods 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.

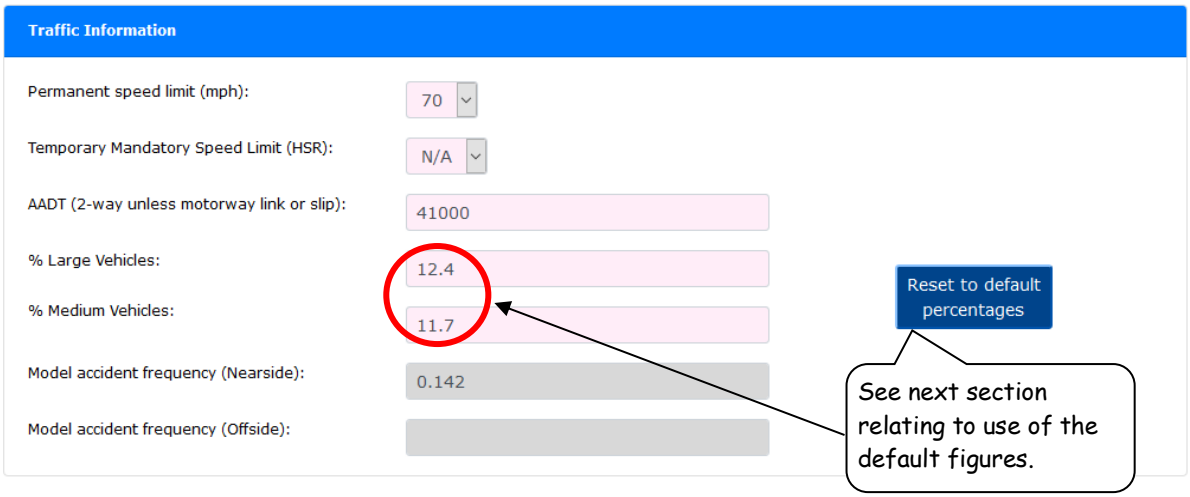


Figure 5-7 Common Details – Traffic Information

The page calculates default values for accident frequency and details are reported in the non-editable (grey) fields. Accident frequency is accidents per year per kilometre (1 fatal = 10 serious = 100 slight injuries). The default value takes into account the type of road and its AADT flow.

5.7.1 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. For Motorway Link and Slip Roads, the 1-way AADT should be entered as they are in effect one-way roads.

5.8 Scheme Duration & Barrier Costs

This section records the details of the scheme duration and whether default or non-default cost values are used for VRS.

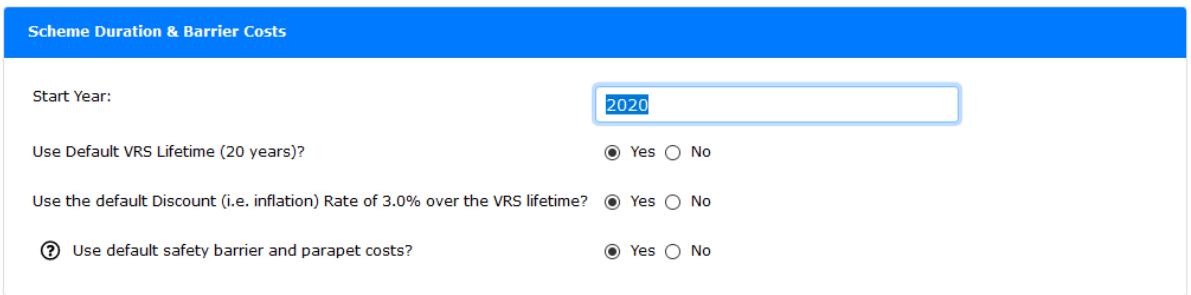


Figure 5-8 Common Details – Scheme Duration & Barrier Costs

The start year is for expected tender or start of works rather than design date.

The default VRS lifetime is normally 20 years. If this value is not suitable (e.g. DBFO schemes may be 30 years), answering 'No' to this question will display an additional field (see Figure 5-9) to enter a VRS lifetime (which must be a minimum of 20 years).

The default Discount (i.e. inflation) Rate of 3.0% is used over the VRS lifetime. If a different value is required, answer 'No' to this question and an additional field will be displayed (see Figure 5-9) where the non-standard value can be added.

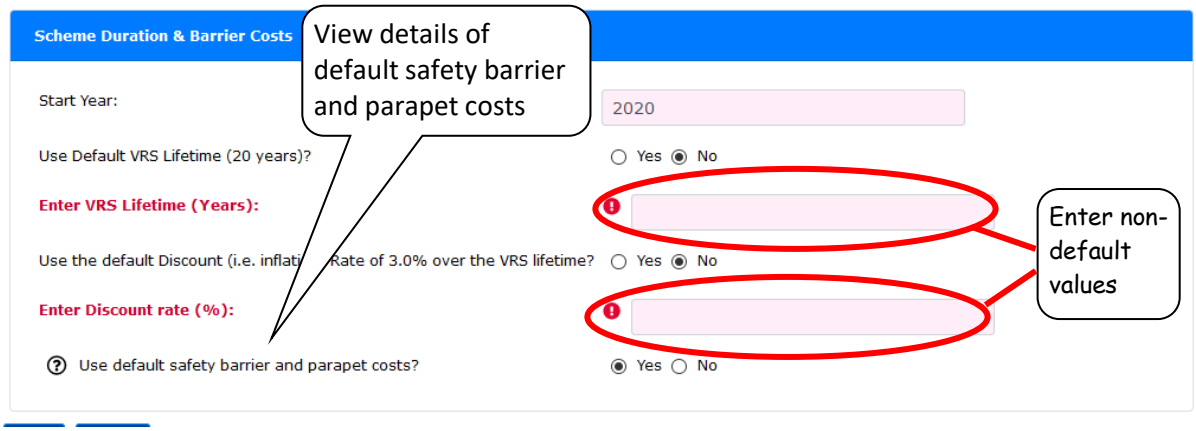


Figure 5-9 Scheme Duration & Barrier Costs – Non-default lifetime and discount rate

Unless otherwise specified, the RRRAP will use a set of default safety barrier and parapet costs (these can be seen by clicking on the nearby 'online help' button). More detail on default costs can be found in section 6.1 and in the online help.

If for a whole project the default values are not considered to be appropriate, e.g. on a DBFO where very competitive rates can be obtained for VRS, enter 'No' for field 'Use default safety barrier and parapet costs?'. A further set of data entry fields are displayed to enter non-default costs.

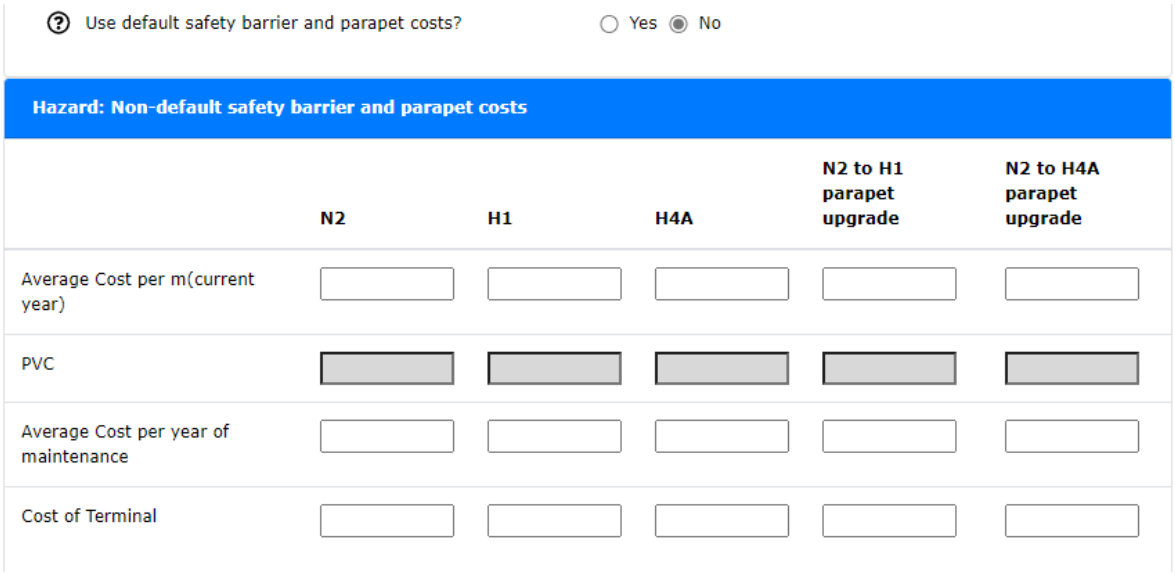


Figure 5-10 Common Details – Non-default safety barrier and parapet costs

If you choose to enter non-default costs, the only value pre-populated is PVC.
This is based on the formula: PVC = (1-(1+D)^(-1*(N)))/D

Where:

- D is the discount rate (either the default value or as defined by the user)
- N is the life of the restraint system (either the default value or as defined by the user)

Note, if you are using non-default costs, all the fields for non-default costs must be completed before the risk calculation will run.

5.9 Common Details Import from CSV (previously exported from Web Version of RRRAP)

The following steps apply to CSV (comma separated value) files that have been generated by exporting a RRRAP record from the web version of RRRAP (see section 4.4).

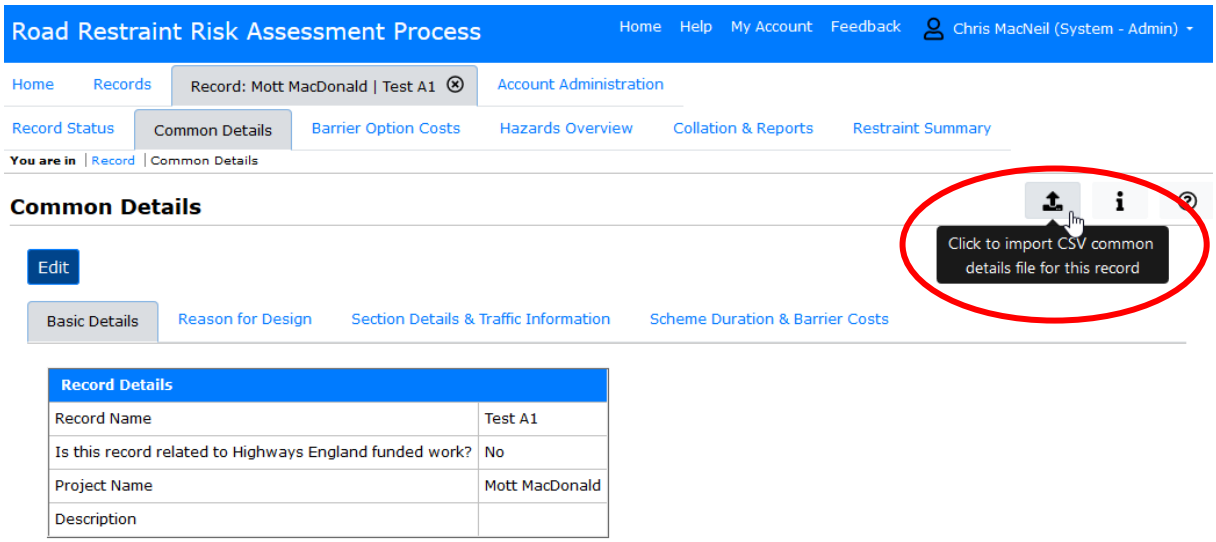


Figure 5-11 Importing a common details CSV file

To import 'Common Details' from a CSV file follow these steps:

1. Through the 'Records' tab open a RRRAP record.
2. Via the 'Common Details' tab, click the 'import common details' button (located at the top right).
3. Using the 'browse' button on this page, specify the CSV file to import from your local file system.
4. Click the 'upload' button.
5. If any errors are reported, these will have stopped the import from completing and no 'Common Details' will be imported. The CSV file will have to be manually altered before trying again.
6. If only warnings are reported, then the import will have completed, but the 'Common Details' page may have fields that require attention. Take appropriate action to fix these problems.
7. Click the 'Back to Common Details Overview page' button to go back and view the imported Common Details.

6 Barrier Option Costs

Where the cost of provision for an individual bridge parapet or a length of safety barrier is going to be significantly different to the default values (e.g. where significant strengthening of a bridge is needed to take the parapet or where an H1 or H4a safety barrier will require special footings due to poor ground conditions or its location on an embankment), then enter details for the revised cost in this tab for each separate installation.

Click the 'Add Option Cost' button to create a new Option Cost.

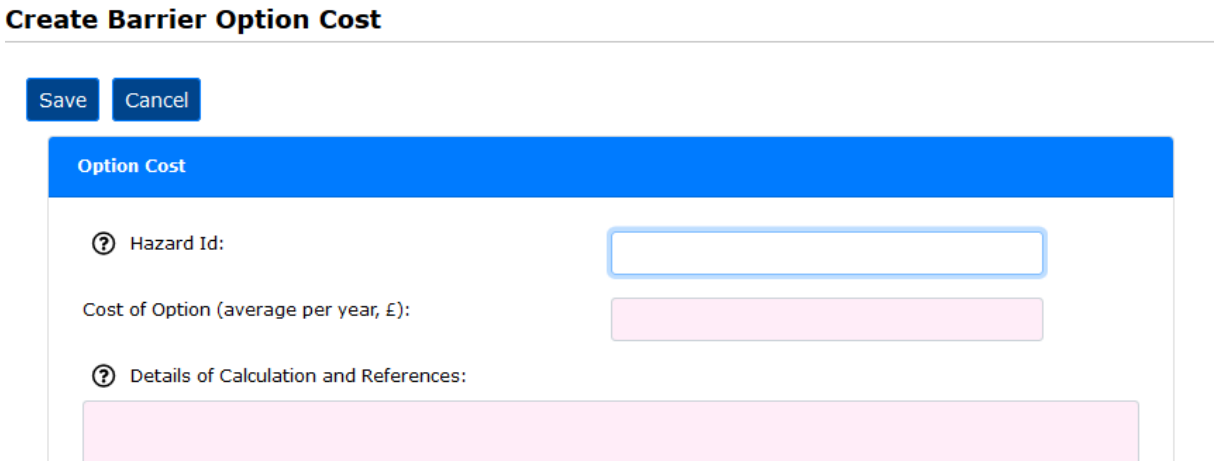


Figure 6-1 Create Barrier Option Cost page

The page displayed will allow you to record the details relating to the cost:

- Hazard Id – a cross reference to the affected Hazard (maximum 30 characters)
- Cost of option – average cost per year in pounds
- Details of calculation and references – provide details on the new cost (maximum 1000 characters)

The revised cost should also be set in the 'Cost of Option' field for the affected hazard (edit the hazard via the 'Collation & Reports' tab to access this field). This will ensure that the correct benefit cost ratio is determined when calculating risk. The benefit cost ratio can be viewed in the 'Detailed Results' report.

6.1 Default Costs

The default costs are:

	N2	H1	H4A	N2 to H2 parapet upgrade	N2 to H4A parapet upgrade
Average Cost Per M (Current Year)	54.69	101.66	370.00	1000.00	2000.00
PVC	14.88	14.88	25.73	0.00	0.00
Average cost per year of maintenance	4.19	4.19	0	0	0
Cost of Terminal	510.17	510.17	481.72	0.00	0.00

These are maintained within the RRRAP and may change depending on the version of the RRRAP the web record was associated with when it was created.

The default values are generated from the following calculations:

	N2	H1	H4A	N2 to H2 parapet upgrade	N2 to H4A parapet upgrade
Average Cost Per M (Current Year)	See cost / m in Source Data section	See cost / m in Source Data section	See cost / m in Source Data section	Stated as 1000	Stated as 2000
PVC	(1-(1+D)^(-1*(N)))/D	(1-(1+D)^(-1*(N)))/D	(1-(1+D)^(-1*(N)))/D	Stated as 0	Stated as 0
Average cost per year of maintenance	See Maint / yr / min in Source Data section	See Maint / yr / min in Source Data section	See Maint / yr / min in Source Data section	Stated as 0	Stated as 0
Cost of Terminal	See Terminal in Source Data section	See Terminal in Source Data section	See Terminal in Source Data section	Stated as 0	Stated as 0

D is the discount rate (default 0.03)
N is the life of the restraint system (see Lifetime in 'Source Data' section below)

Notes on derivation

Benefit Cost Ratio = PVB / PVC

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

The lifetime cost of installing a road restraint system is:

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

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).

Source Data

Costs taken from Spon 2006; maintenance values from MouchelParkman (M25); traffic management costs (not currently used) for installation taken from 25 costs supplied by MouchelParkman to TRL.

	Single sided	Cost of beam/m	Length	Cost/ post	Post spacing	No. of posts	Total	Cost/m	Maint/yr/m	Terminal	Life time	Traffic mgt costs per m during installation	Additional costs (e.g. resurfacing / drainage work	Total cost per m
N2	TCB	24.29	1000	41.6	3.2	312.5	37290	37.29	4.19	355.15	20	176.00		214.00
N2	OBB	37.36	1000	41.6	2.4	416.7	54693	54.69	4.19	510.17	20	176.00		231.71
H1	DROBB	84.33	1000	41.6	2.4	416.7	101663	101.66	4.19	510.17	20	176.00		278.68
H4A	Concrete	370	1000	0	0	0.0	370000	370.00	0	481.72	50	189.00		559.96

No. of posts = Length / Post spacing

Total = Cost of beam/m * Length + Cost per post * No. of posts

Cost / m = Total / Length

Total cost per m = (Total+2*Terminal)/1000+Traffic mgt costs per m during installation + Additional costs (e.g. re-surfacing / drainage work)

Notes:

- Traffic management costs for installation not currently included.
- Repairs costs subsumed in maintenance costs.
- Removal costs not included.
- TCB – Tensioned corrugated beam VRS
- OBB – Open box beam VRS
- DROBB – double rail open box beam VRS

7 Data Entry - Hazards Overview

This tab, shown in Figure 7-1, is used to identify if 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.

To pre-define what hazard categories are going to be populated, click the 'Edit Category Configuration' button on the top left side of the page (see section 7.1).

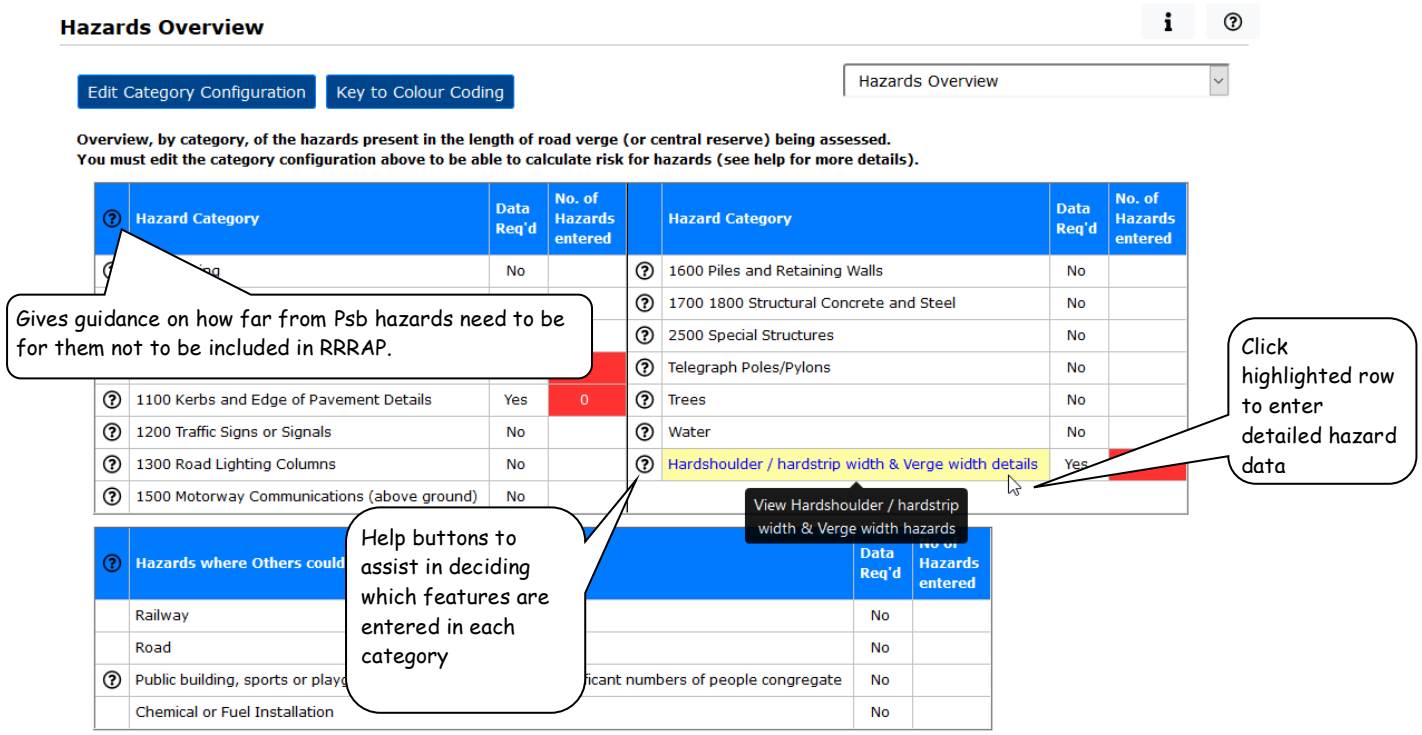


Figure 7-1 Hazards Overview

On the 'Hazards Overview' page, two additional columns are shown for each hazard:

- Data Required: This indicates whether hazard data is expected to be entered for this hazard category
- No. of Hazards entered: This displays the current number of hazards entered for a hazard category

The 'No. of Hazards entered' column is also colour coded:

Red	No hazards have so far been entered for a category that is expecting hazards to be entered
Yellow	Entering of hazard data for this category is in progress
Green	All hazards have been entered for this category
Purple	Hazards have been entered for this category, but none were expected
Clear	No hazards are expected to be entered for this category

Detailed hazard data is entered on the appropriate hazard pages which are accessed by clicking on the appropriate row in the 'Hazard Overview' table - or by selecting a hazard category from the drop-down list at the top right of the page. There is a button on each hazard page that returns to the 'Hazards Overview' page.

Data is always required and must always be entered for:

- 600 Earthworks
- 1100 Kerbs and Edge of Pavement Details
- Hard shoulder / hardstrip width & Verge Width details

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 the back of the verge making the hazard effectively nearer.

The 'Kerb and Edge of Pavement Details' currently do not alter the calculations but need to be recorded for audit purposes and record completeness. 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 hard shoulder width is substandard, 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 hard shoulder running for extended periods is contemplated.

If the start and end chainages for these three hazard categories do not match the start and end chainages for the Section under consideration, then an error message will be generated when trying to calculate risk, advising the user of the problem (see section 2.10.3).

7.1 Edit Category Configuration

To configure which hazard categories are going to be populated, click the ‘Edit Category Configuration’ button on the top left side of the ‘Hazards Overview’ tab.

For each hazard there are two columns shown, ‘Present?’ and ‘Completed?’.

	Hazard Category	Present?	Completed?	No. of Hazards entered
?	300 Fencing	○Yes ◉No	☐	
?	400 Parapets	○Yes ◉No	☐	
?	500 Drainage Features	○Yes ◉No	☐	
?	600 Earthworks	Yes	☐	0
?	1100 Kerbs and Edge of Pavement Details	Yes	☐	0
?	1200 Traffic Signs or Signals	○Yes ◉No	☐	
?	1300 Road Lighting Columns	○Yes ◉No	☐	
?	1500 Motorway Communications (above ground)	○Yes ◉No	☐	

Figure 7-2 Edit Category Configuration

The first, ‘Present?’ indicates whether hazard data is expected. Click ‘Yes’ if hazard data is to be entered or click ‘No’ if none is expected. Because hazard data is always required for ‘600

Earthworks', '1100 Kerbs and Edge of Pavement Details', and 'Hardshoulder / hardstrip width & Verge Width details' they are always set to 'Yes'.

The second column, 'Completed?' indicates that the person editing the record believes that all hazards of this type have been entered for the record. If all hazards have been entered, click the 'checkbox'. If, at a later date, the situation changes and more hazards are to be entered for a category, simply click on the 'checkbox' to remove the tick.

Once finished, click the 'Save' button to save the changed hazard Category Configuration.

Important Note – Marking Categories as Complete

Any hazard category that has been set as being present (indicated by a 'Yes' value) must be marked as complete before running the risk calculation, otherwise it will fail to run. Error messages will be displayed for each category set as being 'present' but not marked as 'complete'.

7.2 Hazard Categories

There are broadly two groups of hazards, those that are generally within the Highway Boundary based on MCHW categories, and those that are generally outside or may cross the highway (generally hazards where Others could be affected).

7.2.1 Within Highway Hazards

'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 the side under consideration, and 15m in all other situations.

7.2.2 Hazards where Others could be affected

'Are hazards where Others could be affected present that could potentially be reached by an errant vehicle or falling object that is hit?' Hazards where Others could be affected include adjacent road and rail situations. Hazards where Others could be affected within 100m from the carriageway should be considered and the guidance in this document in respect of the point of no recovery should be followed.

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.

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.

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

7.3 Hazard Data Entry Completed

Once all the 'Common Details' and hazard data has been entered, and hazard categories with data have been marked as 'Complete' (see section 7.1), click on the 'Collation & Reports' tab. This tab lists all the hazards that have been entered and can have risk evaluated. From here the risk calculation can be run and hazards evaluated for risk.

Note that Verge and Kerb hazards do not have risk evaluated so do not appear in the 'Collation & Reports' tab (although Verge details are used as part of the risk evaluation for all other hazards). Also not included is the last Earthwork hazard. It is used purely as an end marker to define the slope width and height at the end chainage point for the section being assessed.

7.4 Saving a Copy

It is recommended that you export a copy of the RRRAP record (see section 4.4) once all the hazard data has been input and at key stages in the design process. This will allow the designer to get back to the situation prior to making any changes when evaluating hazards. Exporting will back up only the 'Common Details' and the data entered for each of the hazard category types. You can also generate a full report as PDF or CSV file that contains all the data entered in a readable format.

An optional way to back-up your data is to create a copy of the record via the 'Records' tab (see section 3.5). This will create a copy of the record with 'Common Details', 'Option Costs', 'Hazards Overview', and all individual hazards (not including any calculated risk values). The restriction on this method is that it uses up a valuable record slot. It is recommended that this option only be used for short term backups.

7.5 Upper and lower limits to the number of hazards

There were several queries that arose during the trialling of the original RRRAP spreadsheet relating to whether it 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 CD 377. Unlike the earlier Excel versions of the RRRAP, there is no limit to the total number of each hazard that can be entered into RRRAP version 3 (and later versions).

7.6 Minimum length of road for data entry

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 full information local to only these hazards or over the entire length of a scheme being entered, as long as the earthworks and other mandatory data has been input and the flow and road types are consistent throughout the length.

Important Note – Minimum length of road

It is recommended that the minimum length of a section of road includes a 100 m length in advance of the first hazard being assessed and at least 50 m beyond the final hazard. This is to ensure the RRRAP can correctly calculate any lengths of VRS required in advance or beyond the hazard.

8 Data Entry - Detailed Data on each Hazard

8.1 General Notes

8.1.1 Unique ID reference number

The RRRAP automatically assigns each hazard an ID Number.

8.1.2 Aggressiveness

The RRRAP automatically assigns each hazard a default aggressiveness factor depending on the type of hazard. (Refer to section 2.9.4)

The default aggressiveness values can be viewed by clicking the 'Help' button next to the 'Aggressiveness' field.

The aggressiveness values for hazards, which will have an impact when calculating risk, may be changed manually (apart from those for Earthworks) to see, for example, the effect on the VRS requirement of changing the hazard to a less aggressive type of hazard. To manually change the aggressiveness value, first click the button next to the 'Aggressiveness' field. This will make the field editable. If you wish to revert back to the RRRAP assigned aggressiveness value, click the button next to the 'Aggressiveness' field.

8.1.3 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 millimetres.

8.1.4 Hazard Data Entry Pages

Once a hazard category has been selected from the 'Hazard Overview' tab (see section 7), an overview page is displayed for that hazard category, listing all hazards entered so far (an example is shown in Figure 8-1). If no hazards have yet been entered, no summary table is shown and the text 'There are currently no items of this type' is displayed.

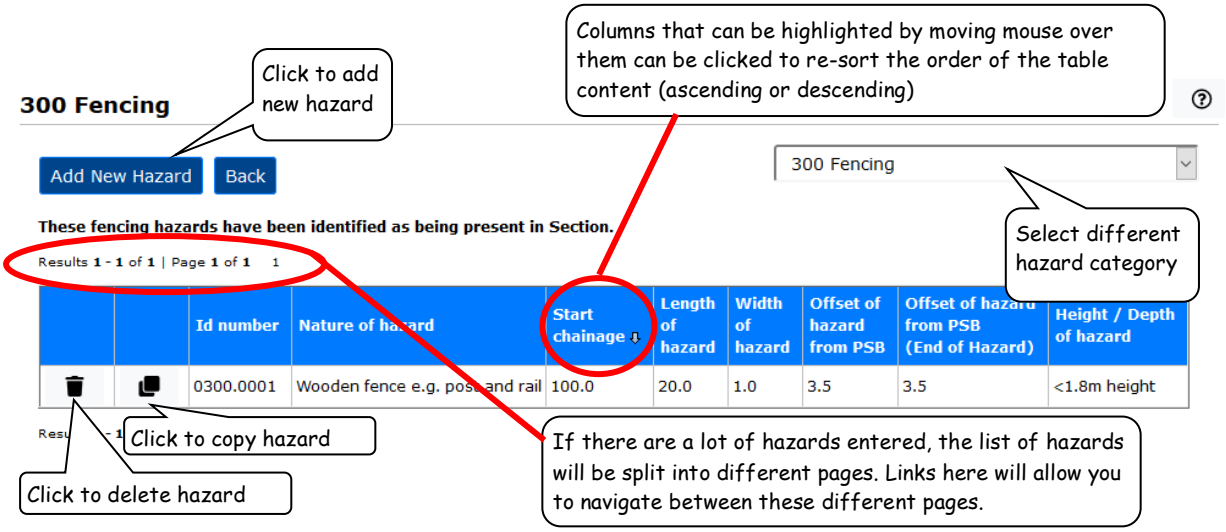


Figure 8-1 Fencing Hazard Data Entry Summary Page

The summary page allows you to:

- Create new hazards
- Edit location and hazard type parameters such as width, height, length, etc for existing hazards
- Delete hazards
- Copy a hazard (see section 8.1.5 for more details)

Once a hazard is deleted, the information is permanently lost from the record.

8.1.5 **Hazard Copy**

In the Hazard Data Entry Summary page (see Figure 8-1), if you click the 'copy hazard button' for an entry, a new hazard is created with all the selected hazard's values, except for start chainage and risk calculated values. This mechanism is useful where many of the values do not change across similar hazards. Create the first hazard, and then use that as a template to derive the remaining hazards. If this method is chosen, it must be ensured that when complete, all of the inputs accurately reflect the actual parameters and locations for each hazard.

8.1.6 **Saving Hazards**

When creating a new hazard or editing an existing hazard click the 'Save' button to make your changes permanent.

If you are creating a new hazard, a 'Save & Next' button is also available. Clicking this will save the hazard you have just defined and, once that has been completed, will display another blank data entry page so that you can enter details of another hazard.

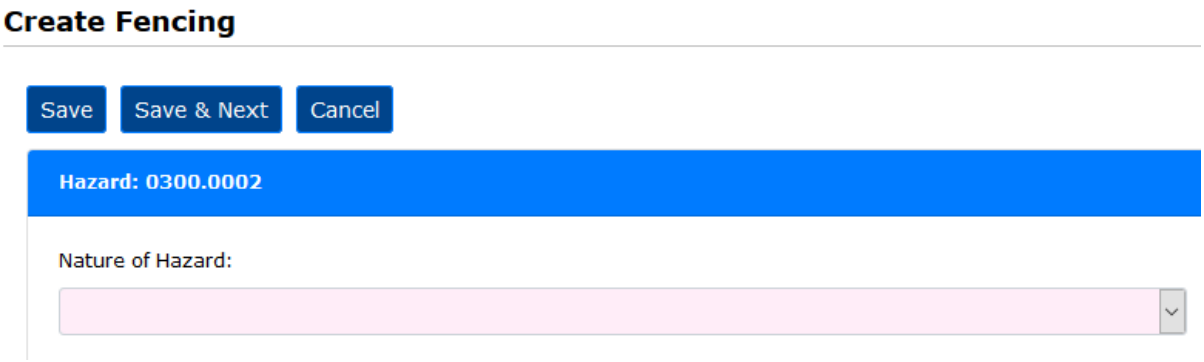


Figure 8-2 Using 'Save and Next' when entering hazard data

If you copy a hazard (as described in section 8.1.5), a 'Save & Next' button is also available. Clicking this will save the hazard you have just defined, and once that has been completed, will display another copy of the original selected hazard (with the chainage field blank) so that you can enter and check details of another similar hazard quickly.

8.1.7 **Drop down listings and Helps**

Many of the fields in the right side of the hazard data entry pages are the same, e.g. Local Alignment, Sleep, Speed, etc. They have the same options and help (shown in Figure 8-3).

Where they differ, (e.g. on the '600 Earthworks', '1100 Kerbs and Edge of Pavement Details', 'Railways', 'Roads', 'Buildings', and 'Chemical or fuel installation' data entry pages), details and guidance has been given within the appropriate section of this User Guide.

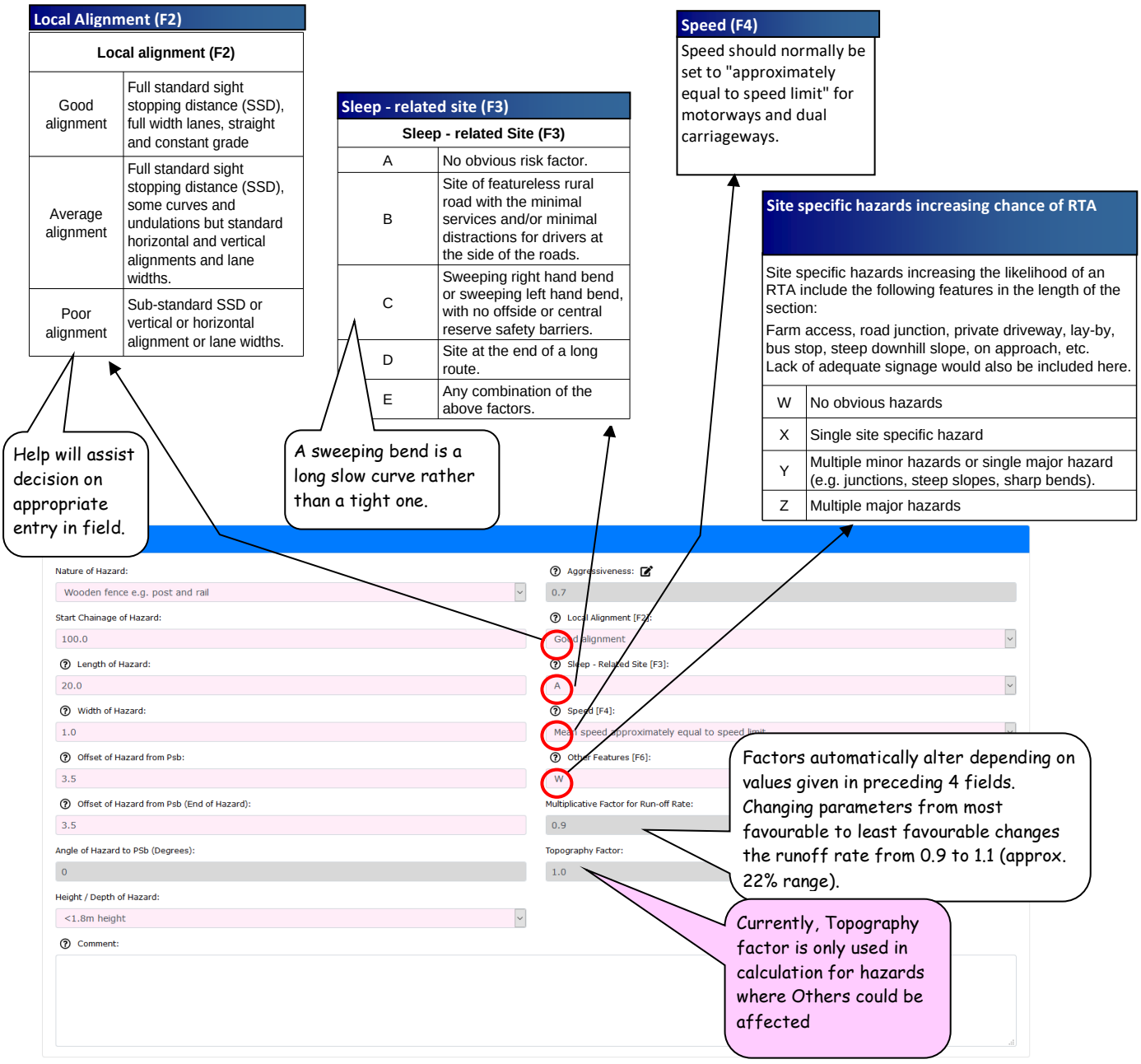


Figure 8-3 Common Hazard Fields

8.1.8 What to do if an existing hazard lies in front of the normal VRS location

Occasionally an existing hazard, e.g. a sign or perhaps, in rural areas, the start of an earthworks slope, will lie in front of the VRS position i.e. within the default VRS set-back of 0.6 m where there is a hard shoulder or hardstrip, or of 1.2 m where there is no hard shoulder or hardstrip.

In these cases, when the 'Calculate Risk' button is pressed, the risk calculation will stop evaluating this hazard (and move on to the next hazard). In the 'Risk Calculation Issues' page (displayed after all risk calculations have finished), a message will be displayed highlighting this problem for the affected hazards (see section 2.10.5 Hazard located in front of barrier). See also section 8.2.1 Substandard verges.

As hazards are not permitted to lie in front of a VRS, edit the affected hazard via the 'Collation & Reports' tab. To ascertain the risk level and VRS requirements for the hazard, either the set-back of the barrier should be manually altered (to the same value as the hazard offset, or to a lesser value); or the hazard offset increased so as to lie outside the VRS position. Risk should now be recalculated. If the hazard requires protection, then the programme will highlight the entry and the 'actual barrier working width' will be shown as either 0.01 m (rather than 0.00, as the programme would consider a zero here a problem) or as the actual value achievable based on the revised VRS location or on the revised hazard location.

The Designer can compare 'Detailed Results' with the barrier at different setbacks and or the hazard at different offsets. By generating 'Detailed Results', 'Snapshot' and 'Full reports' for different data sets, users can reference and compare results.

It is important to ensure that any permanent changes and the reasons for them are fully documented in the hazard 'Comment' field.

A Departure from Standard will be required if the VRS set-back is maintained at the reduced value (i.e. less than the standard minimum set-back) or a hazard is left within the safety barrier working width. See section 2.11 Relaxations and Departures from Standard.

8.1.9 Hazard Import from CSV (CSV exported from Web Version of the RRRAP)

The following steps apply to CSV (comma separated value) files that have been generated by exporting a RRRAP record ZIP from the web version of the RRRAP (see section 4.4). The entire RRRAP record can be imported back into the RRRAP (see section 3.9).

To import hazards for an individual hazard category (e.g. Fencing) from a single CSV file follow these steps:

1. Through the 'Records' tab, open a RRRAP record.
2. Via the 'Hazard Overview' tab, click the desired hazard category row in the table.
3. Click the 'import hazard' button  (located at the top right).
4. Using the 'browse' button on this page, specify the CSV file to import from your local file system.
5. Click the 'upload' button.
6. If any errors are reported, these will have stopped the import from completing and no hazards will be imported. The CSV file will have to be manually altered before trying again.
7. If only warnings are reported, then the import will have completed, but some hazards may have fields that require attention. If a hazard has had a problem importing, it will be

highlighted via a warning icon on each of the 'hazard category overview' pages (see section 2.10.2). Take appropriate action to fix these problems.

8. Click the 'Back to Hazard List page' button to go back and view the imported hazards.

CSV Note:

- When importing Structure/Parapet hazards, if there are parapets that protect Road or Railway hazards, these cross references will have to be re-established once parapet hazards are imported. On individual hazard imports, hazard Id cross references cannot be guaranteed to be to the same hazard, so are left blank.

When importing this way, the hazards will be added to the list of hazards already available for the chosen hazard category.

8.1.10 Hazard Import from CSV (CSV generated from the RRRAP v1.3 Excel Spreadsheet)

It is possible to import hazard information from previous Excel v1.3 RRRAP spreadsheets onto the web system. The steps described in this section must be completed to prepare the data for import into the RRRAP web application followed by the steps in section 8.1.9.

Important Note – RRRAP Excel Spreadsheets

This process only supports data extracted from RRRAP v1.3 Spreadsheets. Data cannot be extracted from older versions of the RRRAP Spreadsheet or imported into the RRRAP web application.

A CSV file has to be generated for each hazard category.

1. Open the RRRAP v1.3 Excel spreadsheet.
2. Navigate to the worksheet tab that contains the desired hazards.
3. Create a new empty spreadsheet (where the copied content will go).
4. Next, select the cells that contain the hazard data, starting with the ID Number column and including all other columns to the right, e.g. for 1300 Lighting Columns worksheet you would select columns A to N. The selection MUST also include as its first row the row that contains the column headings, e.g. ID Number, Nature of Hazard, Start chainage of hazard, Length of hazard, etc. For 1300 Lighting Columns worksheet, this is row 4.
5. Copy the selected cells. Move to the new empty spreadsheet. Via the 'Edit' menu select 'Paste Special'. Under the 'Paste' heading select 'Values' and click the 'Ok' button. The content is now pasted into this new file.
6. Under the 'File' menu, select 'Save As'. In the 'Save' dialog change the 'Save As type' to 'CSV (Comma delimited) (*.csv)'.
7. Excel then states that 'the selected file type does not support multiple sheets' - click 'Ok' button.
8. Excel then states that 'the csv file may contain incompatible features '– click the 'Yes' button.
9. The CSV file has now been saved. See section 8.1.9 for steps to import this CSV file.

CSV Notes:

- 'Roads'. At step 5, once the content has been pasted into the new empty spreadsheet, some values need to be fixed. For the values under the 'Actual Speed of Traffic on Adjacent Road (F12)' column, replace the special 'less than or equal to' character with the two characters '<=' and replace the special 'greater than or equal to' character with the two characters '>='.

If you try to save the CSV file without making this change, the CSV file contains the '?' character and, when imported, the drop-down value is not matched.

- When importing 'Structure/Parapet' hazards, if there are parapets that protect 'Road' or 'Railway' hazards, these cross references will have to be re-established once parapet hazards are imported (on individual hazard import, hazard Id references cannot be guaranteed to refer to the same hazard, so are left blank).
- 'Hardshoulder / hardstrip width' & 'Verge width' hazards. The 'Width of adjacent Hardshoulder / Hardstrip' column found in version 1.3 of the RRRAP spreadsheet has now been split into two separate columns - (A) and (B). Due to this, the 'Width of adjacent Hardshoulder / Hardstrip' value will not be imported. The Designer will need to manually populate the 'Hardshoulder / Hardstrip (A) and (B)' fields taking into account the previous single value and the new help guidance for determining 'Hardshoulder / Hardstrip' values.
- For 'Earthwork' hazards the 'nature of hazard' column values must be changed once imported via the 'Hazard Edit' page to 'falling' or 'rising' as appropriate.
  For 'Railway' hazards, the angle of Psb has to be manually entered via the individual 'Railway Hazard's edit' page after importing.

8.2 Hard shoulder and Verge widths

Data must be entered for this hazard category in order that the RRRAP will run.

The first and last chainage entries must match the Start and End chainages for the section.

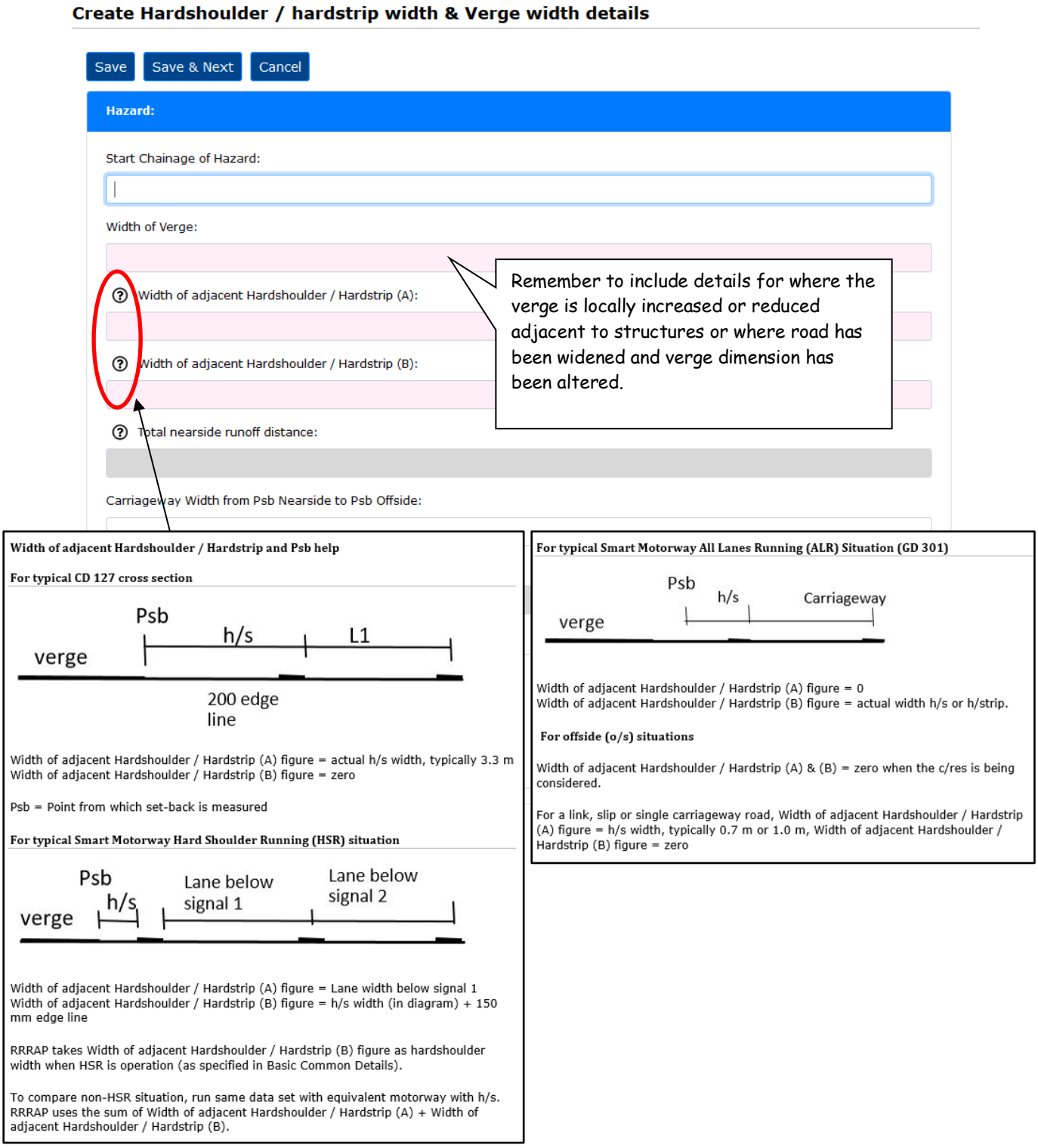


Figure 8-4 Enter Hard shoulder / hardstrip width and Verge width details

It is important to ensure that hardshoulder and verge widths are entered for the whole length of the Section under consideration, even if for the o/s they are zero entries in the 'Width of adjacent Hardshoulder / Hardstrip' fields. There is no need to identify every single change in verge width. It is normally sufficient to record the nominal verge width for the road (CD 127 gives the standard dimensions) but, at locations where the verge width is significantly less than the nominal width, for instance at pinch points, or where it is widened, for instance at the approaches to bridge parapets, it is important that the actual width is recorded to ensure that any safety barrier can be properly located in accordance with CD 377.

Note that the RRRAP assumes that the verge is nominally level and that the area beyond the verge until the top or toe of the earthworks slope (whichever is nearer) is reached is also broadly level. A 1 in 20 (or 5%) fall is considered broadly level in this context. The programme calculates the risk posed by the earthworks slopes and the effective offset of hazards that are on or beyond the earthworks slope based on the information in the 'Earthworks' page, rather than on information in the 'Verge and Hardshoulder Widths' page.

8.2.1 **Substandard verges**

Substandard verges typically occur in rural areas on old highway routes, or possibly on widened carriageways where additional land-take is problematical, and may result in the earthworks slope commencing in front of or very close to the standard safety barrier location. See section 8.1.8 above, and also Figures 3.28 and 3.29 in CD 377. The Designer may need to consider means of assuring stability and strength of the VRS support e.g. strip or piled footings for the VRS, earthworks strengthening or retaining structures to ensure the required stability of the VRS and carriageway.

8.3 300 Fencing and 500 Drainage Features

Note that each of these is broadly similar in content and layout. The drainage features hazard entry is intended for narrow bodies of water up to a nominal width of 3m. Larger bodies of water should be input under the 'other hazards – water' section.

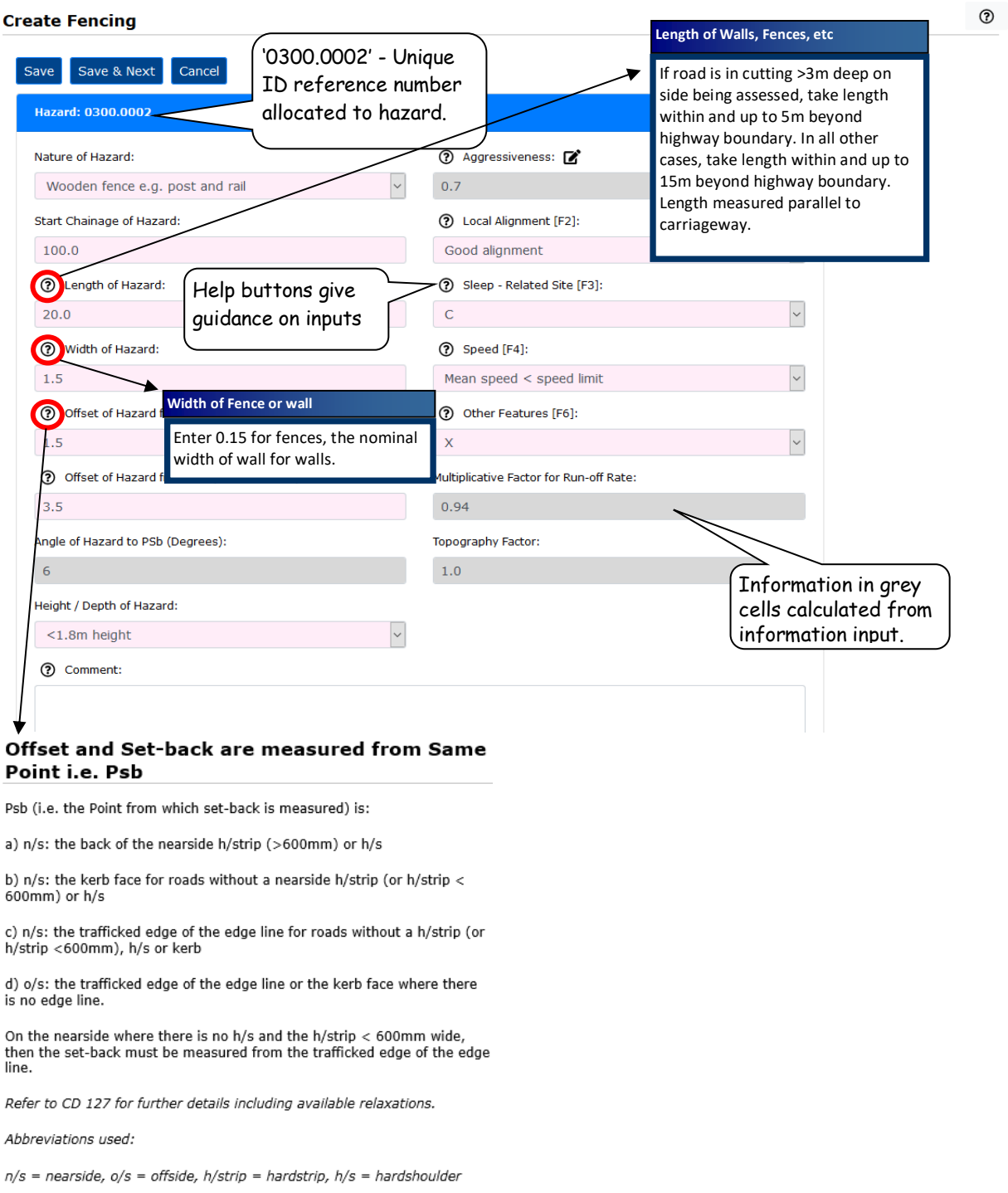
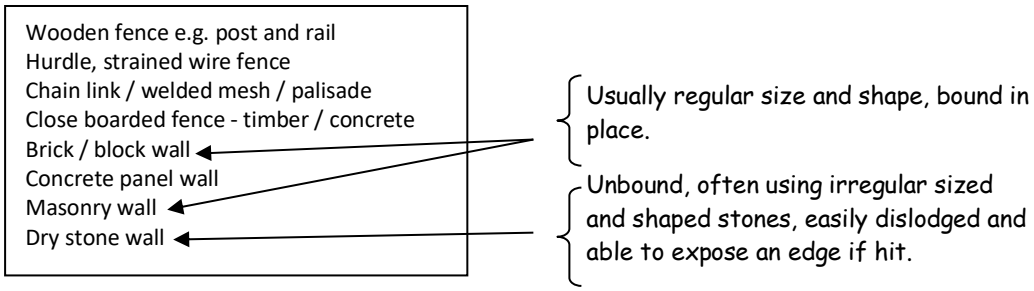


Figure 8-5 Fencing and Drainage data entry

Drop down menu for Nature of Hazard



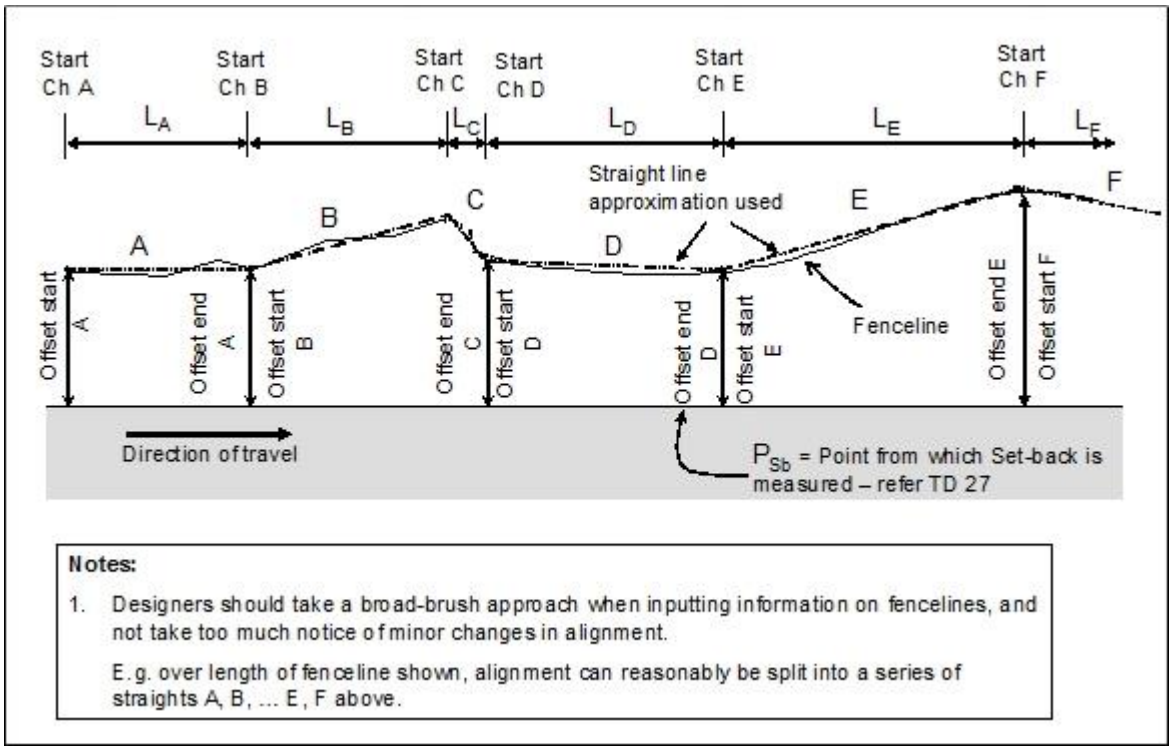


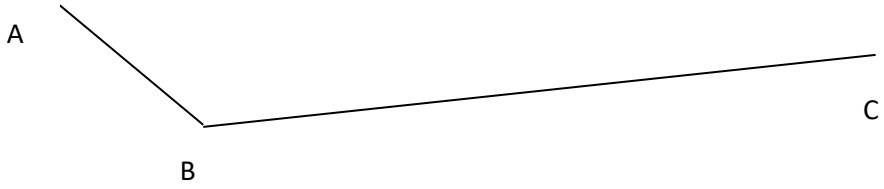
Figure 8-6 Fencing Hazards – Splitting into sections

The RRRAP programme (shown in Figure 8-5) looks at the offset and hazard width at Start chainage A and calculates the VRS need for the hazard over Length A (between Start chainage A and B). For a linear hazard such as a fenceline, the programme will then look at the offset and hazard width of Start chainage B and calculate if VRS is needed to protect at Start chainage B over Length B (between Start chainage B and C), 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.

See also Figure 2-12 and Figure 2-13 and guidance sections 8.3 and 8.4.

8.3.1 Checking VRS requirement when fenceline / hazard offset changes significantly

See also Figure 2-12 and Figure 2-13. 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) 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 in a similar way by checking intermediate positions and offsets. It is hoped that a future version of the RRRAP will automatically perform this calculation.



8.3.2 Drainage item at angle to the carriageway

If there is a drainage item such as a drainage lagoon that is at an angle to the carriageway, e.g. as shown in Figure 8-7, 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.

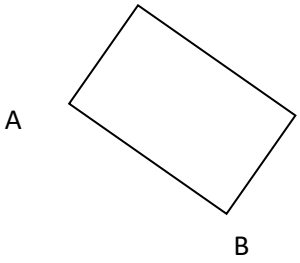


Figure 8-7 Drainage item that is at an angle to the carriageway

8.3.3 Data entry for culverts

These are typically for narrow bodies of water up to say 3 m overall width. Culverts should be entered in the drainage section; larger bodies of water, e.g. a river, lake, lagoon, etc. should be entered into the Water data entry page.

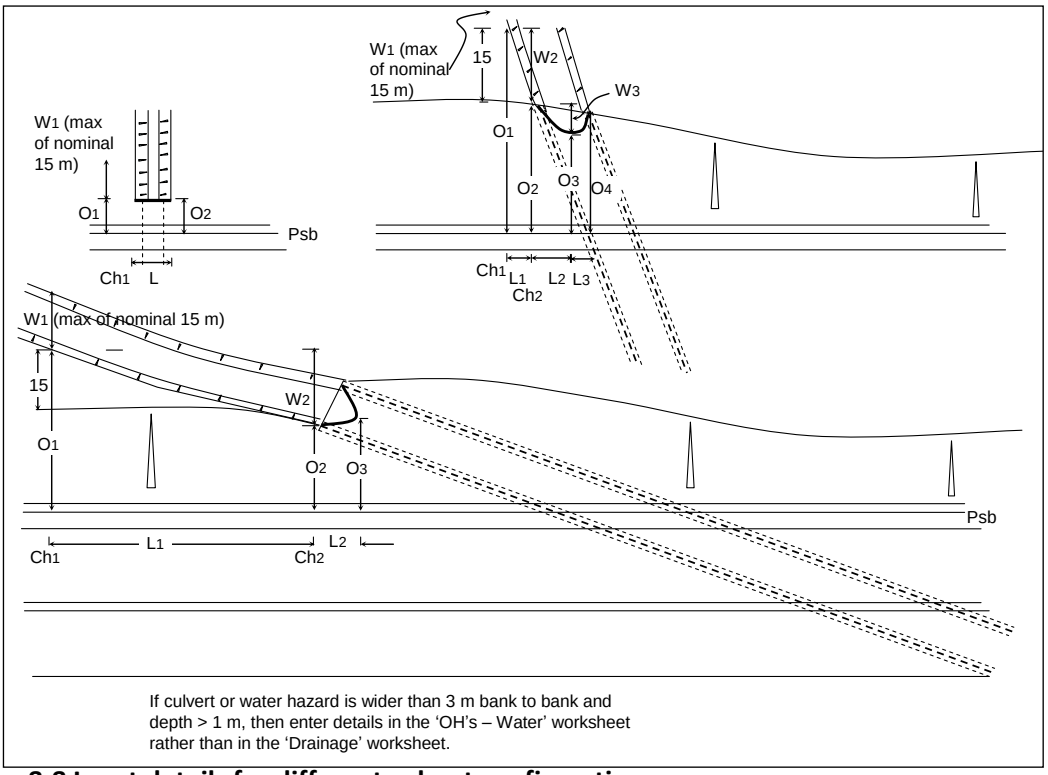


Figure 8-8 Input details for different culvert configurations

Putting the culvert details in the 'Parapets' page 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 the back of the standard verge.

Note that for all the culvert situations, a pedestrian parapet / barrier may be required to stop people falling over a vertical drop regardless of whether a vehicle restraint is required.

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

You should enter these into the 'Water' hazards page.

8.4 600 Earthworks

Earthworks must be entered for the entire length of carriageway being assessed. If the section of carriageway being considered starts at chainage 0 and ends at chainage 500 then there must be at least two entries in the earthworks section, one at ch. 0 and one at ch. 500. An entry should also be made in the earthworks section of the RRRAP at regular intervals and at each point that there is a significant change in the profile or height of the earthworks along the route.

The offset of the earthworks hazard from Psb is the offset to the top of the slope for an embankment and offset to the base of the slope in a cutting, i.e. to the start of the slope. This may not be the same as the back of verge position recorded in the 'Verge width' page. The RRRAP assumes that the width between the back of verge position and start of the slope is nominally level as described in section 8.2 above. If this is not the case, see Figure 8-14 for how to enter the details for multiple slopes.

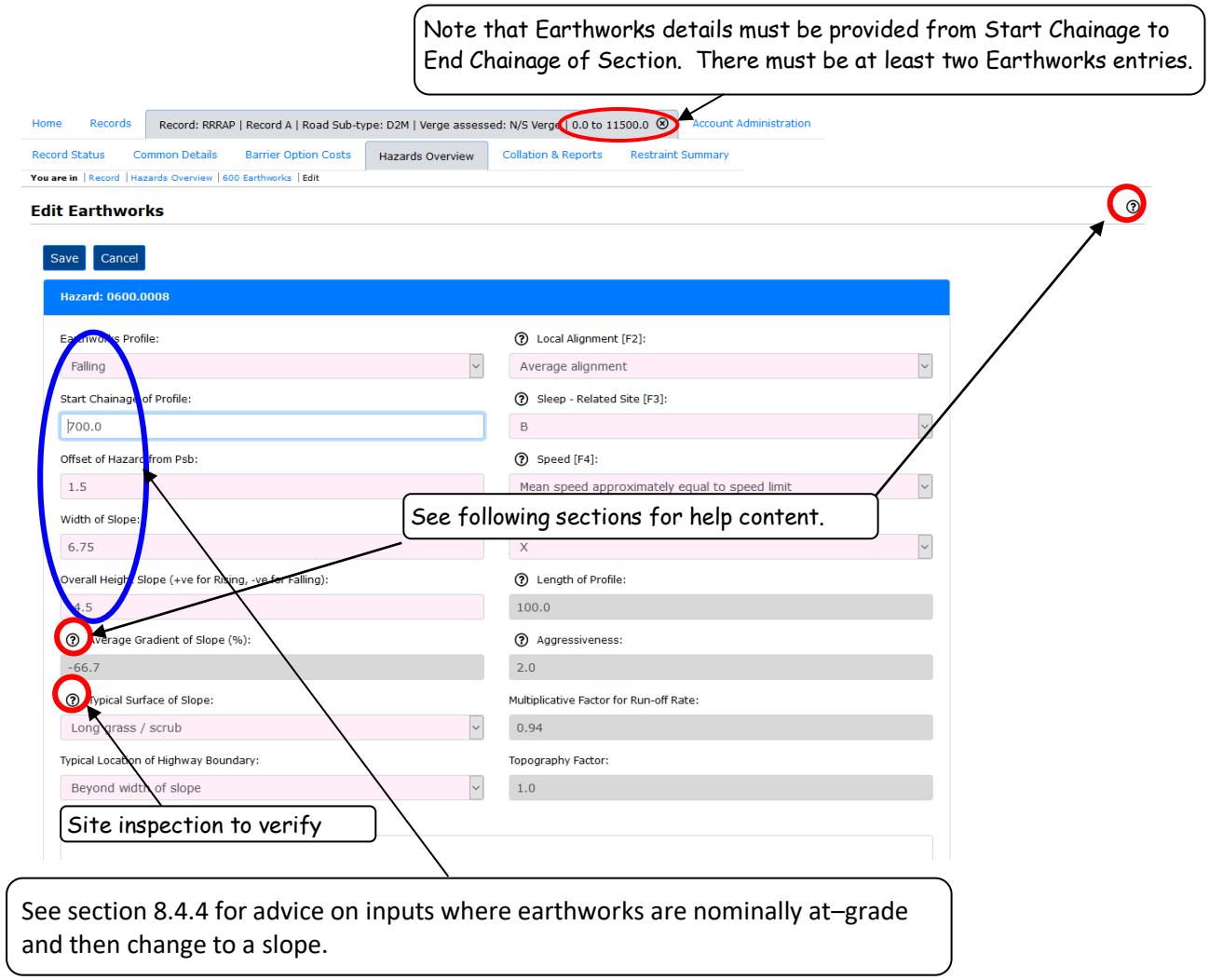


Figure 8-9 Earthwork data entry

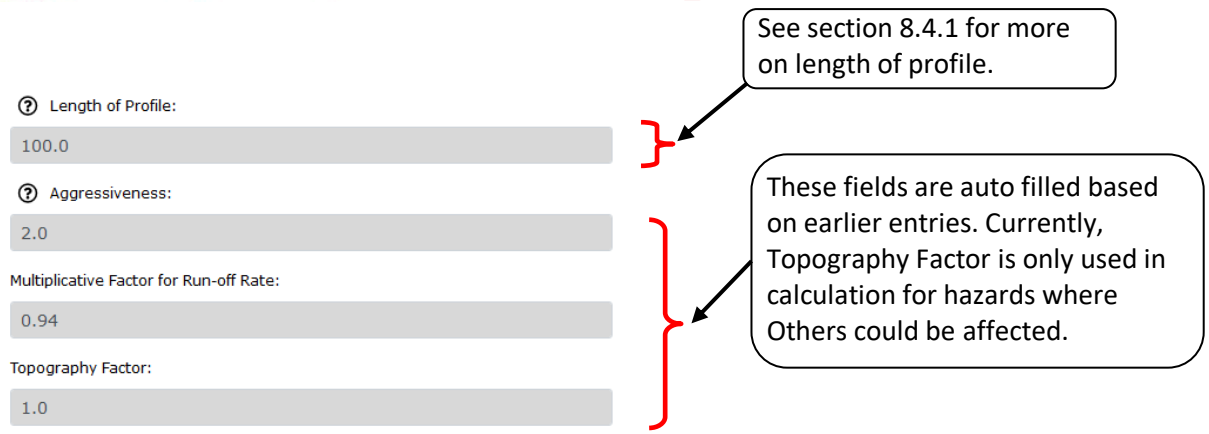


Figure 8-10 Earthwork data entry – non-editable fields

Important Note – Earthwork Chainage

No earthworks entries should be given the same chainage.

Drop down menu for Nature of Hazard

Falling
Nominally at Grade
Rising
Exposed rock face cutting

The RRRAP calculates the gradient as a % based earthworks inputs of width and height rather than e.g. 'falling 1:2 or steeper'. Note if Nominally at Grade, a nominal width of slope 0.1 m and height 0.0 m must be entered.

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

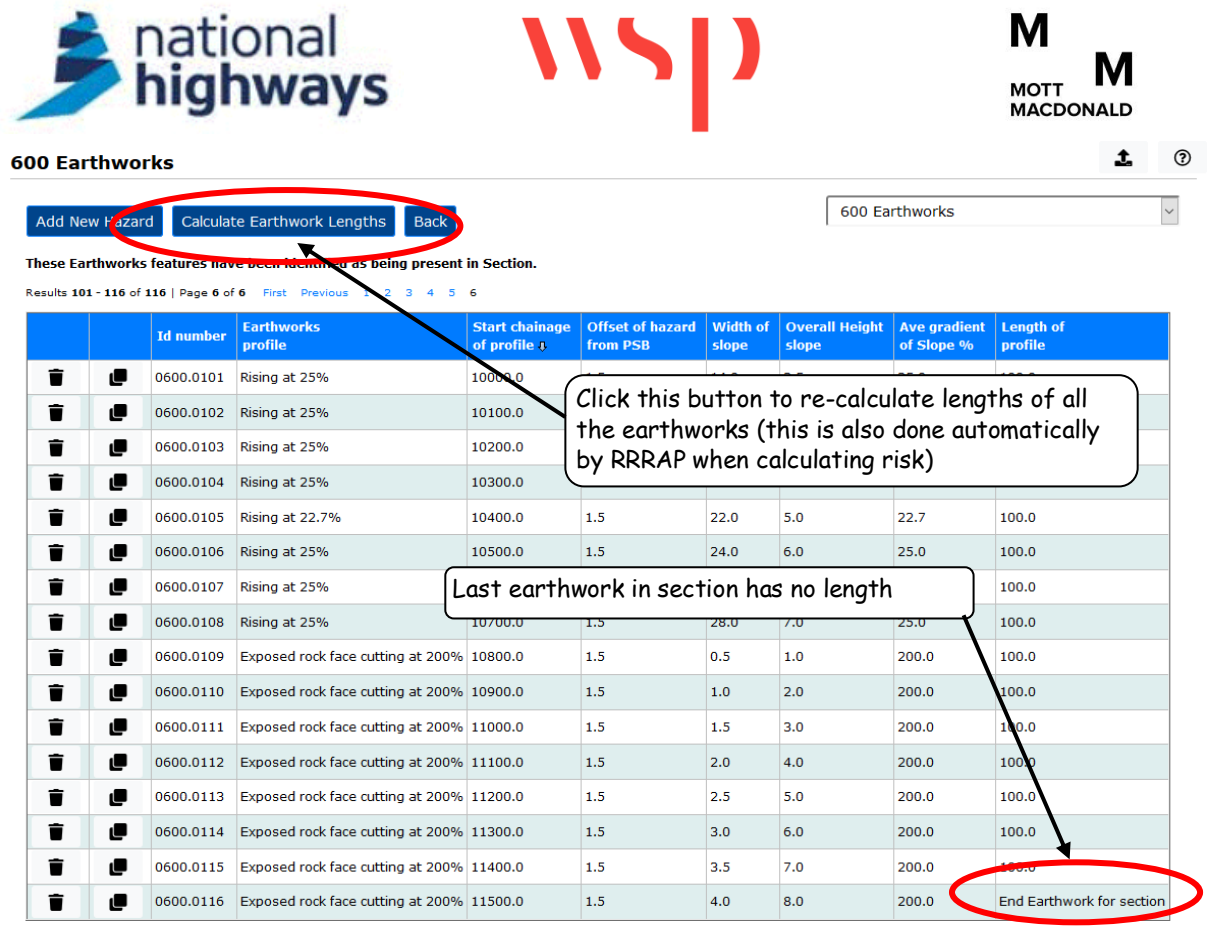
If the road is nominally at-grade, then use "Beyond width of slope".

8.4.1 Length of profile

This is the length of the earthwork in relation to its start chainage and the start chainage of the next earthwork entry. The length of the earthwork is a non-editable field (see Figure 8-10 'length of profile') and is not user populated when entering the earthwork details.
It can be populated:

- By clicking the 'Calculate Earthwork Lengths' button on the 600 Earthworks page. To access, navigate to the 'Hazards Overview' page then click 'Earthworks'.
- Automatically, by running the risk calculation on the 'Collation and Reports' tab

The last earthwork entry in the section being assessed will not have a length. Instead, the text 'End Earthwork for section' will be displayed. Risk is not calculated for this last earthwork.



		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0101	Rising at 25%	10000.0					
		0600.0102	Rising at 25%	10100.0					
		0600.0103	Rising at 25%	10200.0					
		0600.0104	Rising at 25%	10300.0					
		0600.0105	Rising at 22.7%	10400.0	1.5	22.0	5.0	22.7	100.0
		0600.0106	Rising at 25%	10500.0	1.5	24.0	6.0	25.0	100.0
		0600.0107	Rising at 25%						100.0
		0600.0108	Rising at 25%	10700.0	1.5	28.0	7.0	25.0	100.0
		0600.0109	Exposed rock face cutting at 200%	10800.0	1.5	0.5	1.0	200.0	100.0
		0600.0110	Exposed rock face cutting at 200%	10900.0	1.5	1.0	2.0	200.0	100.0
		0600.0111	Exposed rock face cutting at 200%	11000.0	1.5	1.5	3.0	200.0	100.0
		0600.0112	Exposed rock face cutting at 200%	11100.0	1.5	2.0	4.0	200.0	100.0
		0600.0113	Exposed rock face cutting at 200%	11200.0	1.5	2.5	5.0	200.0	100.0
		0600.0114	Exposed rock face cutting at 200%	11300.0	1.5	3.0	6.0	200.0	100.0
		0600.0115	Exposed rock face cutting at 200%	11400.0	1.5	3.5	7.0	200.0	
		0600.0116	Exposed rock face cutting at 200%	11500.0	1.5	4.0	8.0	200.0	End Earthwork for section

Figure 8-11 Length of Earthwork

8.4.2 Earthworks - Splitting into sections, Slope Gradient and Critical Height

Earthworks – Splitting into sections and nomenclature

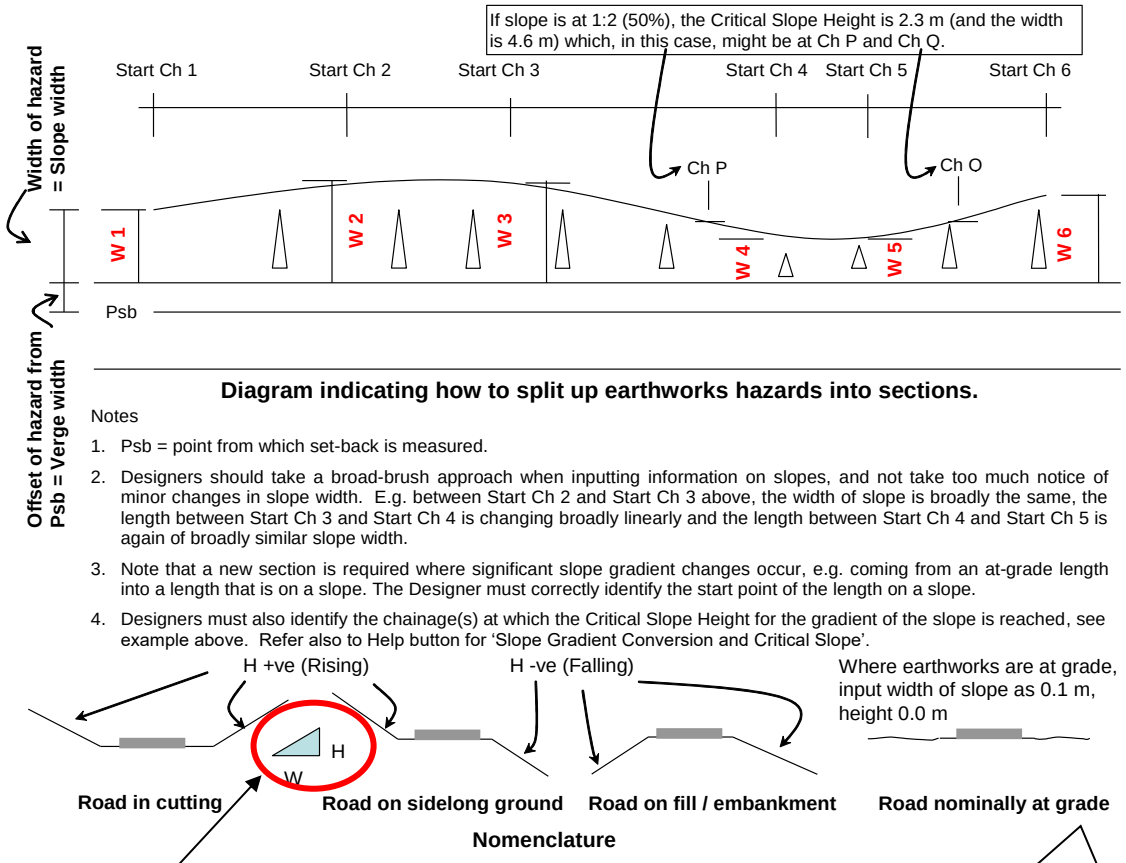


Diagram indicating how to split up earthworks hazards into sections.

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'.

Figure 8-12 Earthworks - Splitting into sections and nomenclature

The nomenclature is important. The RRRAP calculates the gradient based on earthworks inputs of width and height.

Slope Gradient & Critical Slope Height		
Slope conversion		**Critical slope height (m)**
H:W	**%**	
Falling steeper than1:1		1.0 m or higher
1:1	100	1.05
1:1.25	80	1.3
1:1.5	66.67	1.65
1:1.67	60	1.9
1:2	50	2.45
1:2.5	40	3.45
1:2.75	36.4	4.1
1:3	33.3	4.9
1:3.5	28.6	7.35
Falling 1:4 (25 %) and shallower		None
Rising 1:1 (100 %)		1.0 m or higher
Rising shallower than 1:1		None

Critical slope height (CSH) applies to embankments, false cuttings and falling sidelong ground only.

When the critical slope height is reached or exceeded for the gradient the RRRAP will assign a higher aggressiveness to the slope.

The slope heights of falling slopes should be entered in RRRAP as a negative value (e.g -1.0 m).

It is important to identify **all** points at which the critical height for the particular gradient is reached, see section 8.4.3.

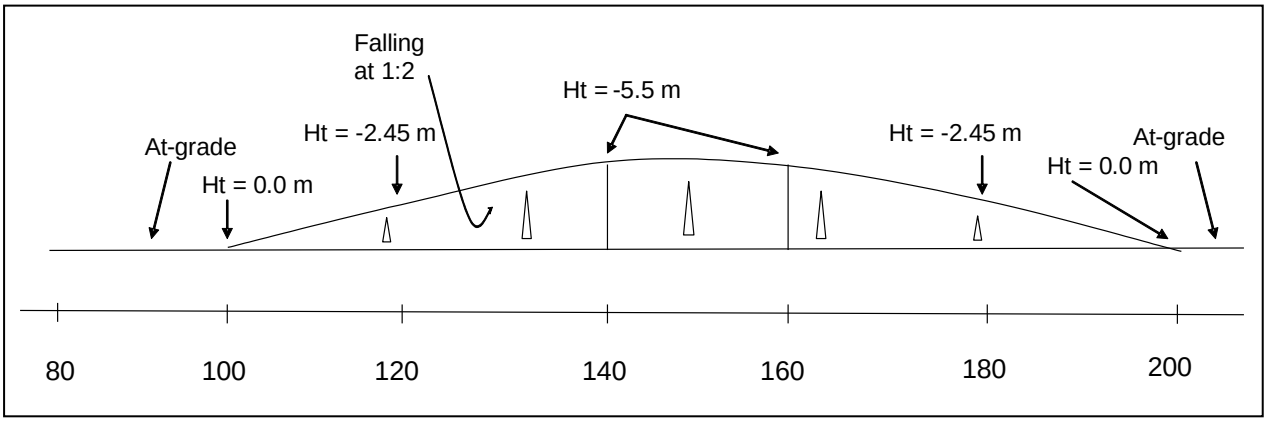
Figure 8-13 Earthworks – Falling Slope Gradient and Critical Slope Height

Critical slope height does not apply to cutting slopes which are handled differently in the RRRAP, and a higher aggressiveness is only assigned to slopes of 1 in 1 or steeper which are greater than 1m in height as per CD 377 3.20.2.

8.4.3 **Critical height of slope**

Important Note – Critical slope height

The chainages at which the critical height of a falling slope for that slope gradient should be identified (see figure 8-13). At the critical slope height for the slope gradient the RRRAP will assign the higher aggressiveness factor for the slope. If the point at which the critical slope height is attained is not entered into the RRRAP, potentially the start and end points for VRS will not be correct.
This is demonstrated by the example below.



Suppose you input the information as follows (i.e. without noting critical height locations).

600 Earthworks

Add New Hazard | Calculate Earthwork Lengths | Back

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

Results **1** - **7** of **7** | Page **1** of **1** 1

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0001	Nominally at Grade	0.0	2.5	0.1	0.0	0.0	95.0
		0600.0002	Nominally at Grade	95.0	2.5	0.1	0.0	0.0	5.0
		0600.0003	Falling at 50%	100.0	2.5	0.1	-0.05	-50.0	40.0
		0600.0004	Falling at 50%	140.0	2.5	11.0	-5.5	-50.0	20.0
		0600.0005	Falling at 50%	160.0	2.5	11.0	-5.5	-50.0	40.0
		0600.0006	Nominally at Grade	200.0	2.5	0.1	0.0	0.0	50.0
		0600.0007	Nominally at Grade	250.0	2.5	0.1	0.0	0.0	End Earthwork for section

Results **1** - **7** of **7** | Page **1** of **1** 1

The RRRAP might output:

Collation & Reports

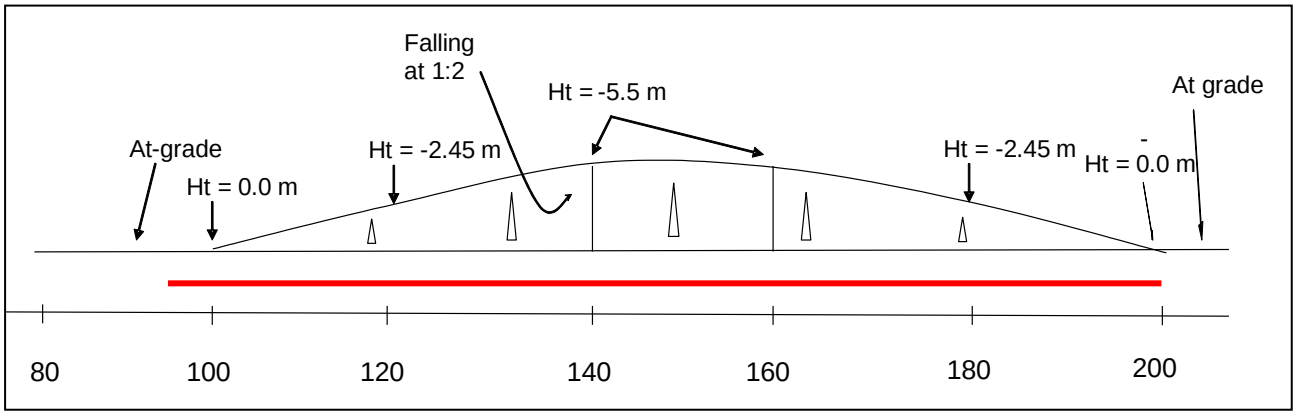
Calculate Risk | Snapshot Report | VRS Summary | Accept Working Widths

Results 1 - 6 of 6 | Page 1 of 1 1

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	0.0	95.0	2.5	Yes						N/A
☐	i	0600.0002	Nominally at Grade	95.0	100.0	2.5	Yes						N/A
☐	i	0600.0003	Falling at 50%	100.0	140.0	2.5	Yes						N/A
☐	i	0600.0004	Falling at 50%	140.0	160.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0005	Falling at 50%	160.0	200.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0006	Nominally at Grade	200.0	250.0	2.5	Yes						N/A

Results 1 - 6 of 6 | Page 1 of 1 1

Resulting VRS provision, which is incorrect as it commences and ends too late, is shown below. Only the results from the RRRAP have been plotted.



If the information is input correctly as follows (i.e. including critical height locations).

600 Earthworks

Add New Hazard | Calculate Earthwork Lengths | Back

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

Results 1 - 9 of 9 | Page 1 of 1 1

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
🗑	⧉	0600.0001	Nominally at Grade	0.0	2.5	0.1	0.0	0.0	95.0
🗑	⧉	0600.0002	Nominally at Grade	95.0	2.5	0.1	0.0	0.0	5.0
🗑	⧉	0600.0003	Falling at 50%	100.0	2.5	0.1	-0.05	-50.0	20.0
🗑	⧉	0600.0008	Falling at 50%	120.0	2.5	4.9	-2.45	-50.0	20.0
🗑	⧉	0600.0004	Falling at 50%	140.0	2.5	11.0	-5.5	-50.0	20.0
🗑	⧉	0600.0005	Falling at 50%	160.0	2.5	11.0	-5.5	-50.0	20.0
🗑	⧉	0600.0009	Falling at 50%	180.0	2.5	4.9	-2.45	-50.0	20.0
🗑	⧉	0600.0006	Nominally at Grade	200.0	2.5	0.1	0.0	0.0	50.0
🗑	⧉	0600.0007	Nominally at Grade	250.0	2.5	0.1	0.0	0.0	End Earthwork for section

Results 1 - 9 of 9 | Page 1 of 1 1

The RRRAP might output:

Collation & Reports

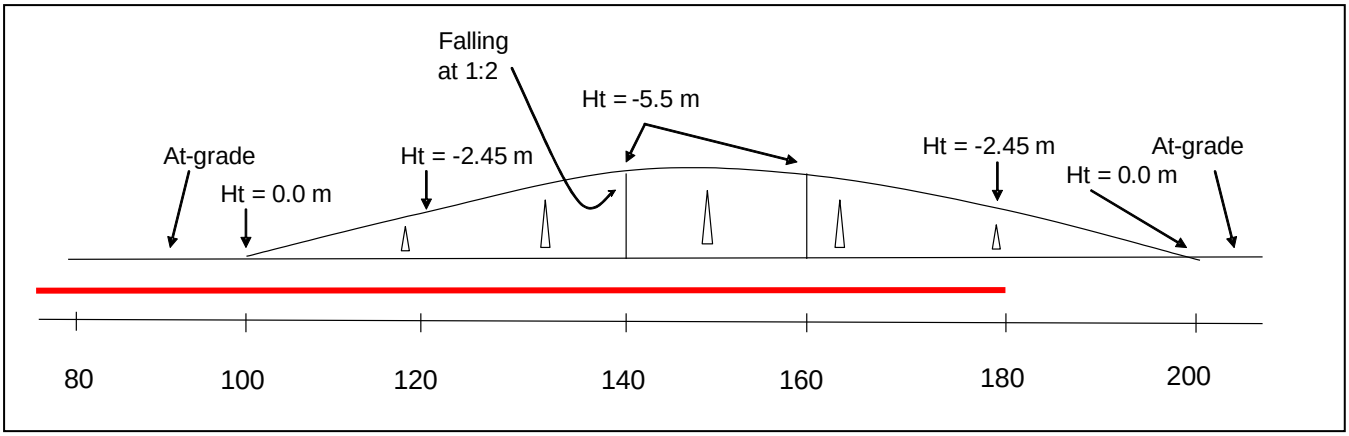
Calculate Risk | Snapshot Report | VRS Summary | Accept Working Widths

Results 1 - 8 of 8 | Page 1 of 1 1

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	0.0	95.0	2.5	Yes						N/A
☐	i	0600.0002	Nominally at Grade	95.0	100.0	2.5	Yes						N/A
☐	i	0600.0003	Falling at 50%	100.0	120.0	2.5	Yes						N/A
☐	i	0600.0008	Falling at 50%	120.0	140.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0004	Falling at 50%	140.0	160.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0005	Falling at 50%	160.0	180.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0009	Falling at 50%	180.0	200.0	2.5	No	Acceptable	45		W2	N2	N/A
☐	i	0600.0006	Nominally at Grade	200.0	250.0	2.5	Yes						N/A

Results 1 - 8 of 8 | Page 1 of 1 1

Resulting correct VRS provision is as follows – note that this will prevent an errant vehicle running down the slope where it is equal to or higher than the critical height of 2.45 m. Only the results from the RRRAP have been plotted.



8.4.4 Dealing with lengths where the earthworks 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 (a zero value is not permitted). The RRRAP assumes that the ground beyond any slope or at-grade section is broadly level. In the example in Figure 8-12, the earthworks go 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. 0.05 m in this case to correlate with the width of 0.1 m and gradient of 1 in 2.

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 1 m should be entered.

8.4.5 Earthworks profile having multiple slope gradients

Figure 8-14 indicates the method of inputting earthworks information where there are multiple slopes.

In Figure 8-14 (a) where the gradient of the lower slope is both shallower than 1:4 and shallower than the upper slope, then it should be disregarded. For the critical slope height of multiple slopes enter the point at which the overall slope height meets the CSH for the steepest slope and enter the width of slope for that CSH as per width in the table in figure 8-13.

Figure 8-14 (b) and (c) show a situation 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.

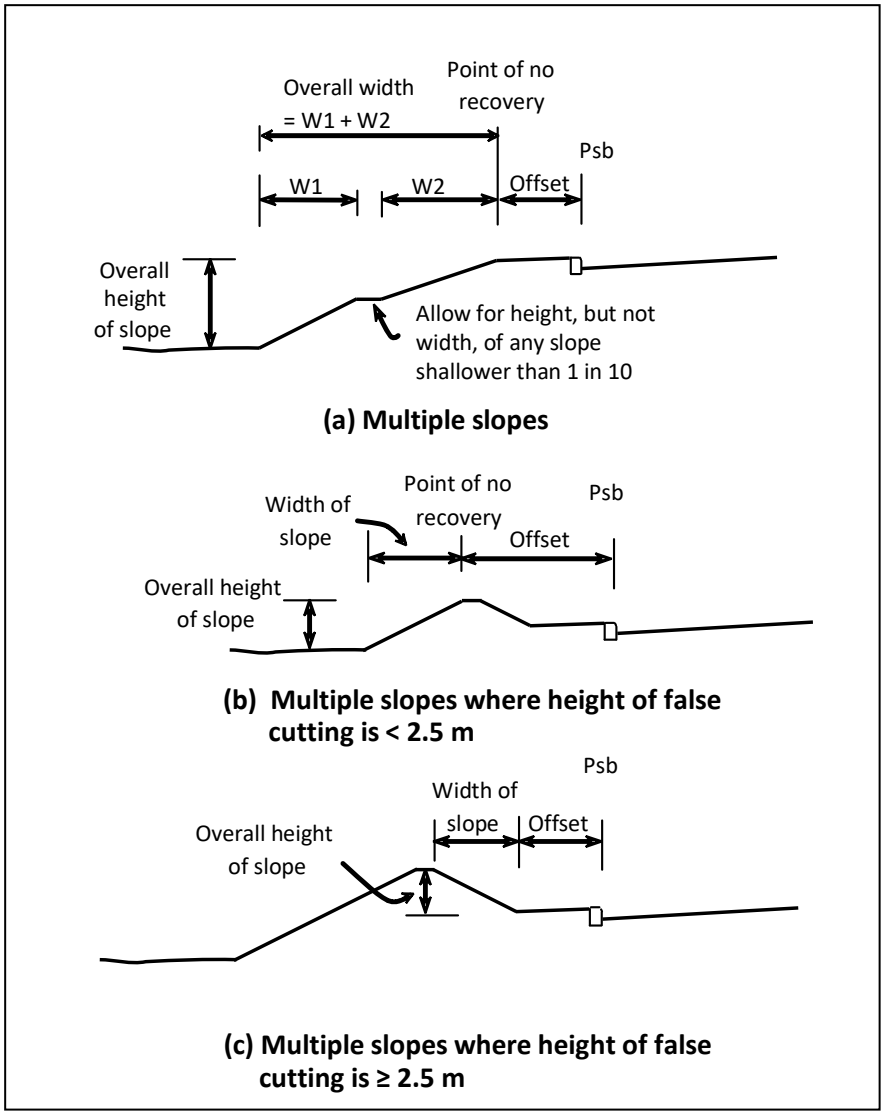


Figure 8-14 Multiple Slopes

It is considered unlikely that an errant vehicle would be able to traverse an uphill slope of more than about 2.5 m height, but may be able to reach the crest of a slope that is less high and, if there is an embankment slope beyond the crest, then to run down or roll down that slope and hit a hazard that is on that slope or possibly even beyond it (e.g. a railway). The chance of the errant vehicle reaching the top depends on factors such as speed, type of vehicle, gradient, etc and whether there are any hazards on the slope, such as trees, that might inhibit or prevent the vehicle reaching the crest.

The programme assumes that the area between Psb and the start of the earthworks slope is broadly level, and that the area beyond the earthworks slope is broadly level. For a hazard that is part way up a cutting slope, the programme assumes it has an effective offset that is further from the Psb than its actual position and for a hazard on an embankment, that it is effectively closer.

The earthworks module of the RRRAP is not sophisticated enough to be able to handle the effects of an initial upward slope followed by a downward slope, so where the height of the false cutting varies between say 2 and 3 m, the input data following Figure 8-14 (b) and (c) is at best a compromise. A way round the problem is to run the RRRAP twice, once with the earthworks input for the cutting slope (i.e. Rising) along the whole length, i.e. assuming that the embankment slope beyond does not exist, and the second time with the earthworks Rising up to the chainage where the height rise starts to drop below 2.5 m, and Falling up to the chainage where the height of false cutting again reaches 2.5 m. The critical height for the Falling section being based on the overall height of slope and width of slope shown in Figure 8-14 (b) and the 'Slope Gradient' and Critical Slope Height'. The verge width would be constant throughout both runs. The first run would under-report VRS requirements, and the second over-report them. The appropriate VRS provision would be based on the outputs and engineering judgement. The Designer should generate and keep as evidence a copy of the hazard details at each run (and any generated detailed results) by generating a full report (see section 11.3). An explanation of the conclusions reached should be entered into the hazard 'Comment' field as a record of the decision process.

8.4.6 **Strengthened Slopes**

Inputting information where the slope has been strengthened to steepen it may either be entered in the 600 Earthworks page or in the 2500 Special Structures page. 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 page, see also Section 8.11.

8.4.7 **Retaining walls supporting an embankment or sidelong ground**

Retaining walls below the level of the carriageway being assessed that support an embankment or sidelong ground should be input in the earthworks hazard entry section as a 'falling' hazard with a nominal slope width of 0.1 m. The height of the earthwork input should reflect the height of the drop from the top of the wall to the bottom. See also Figure 8-14 (a).

In the case of a crib wall that is retaining a carriageway, the RRRAP does not consider the additional risk in respect of accidental wheel loading that might lead to the crib wall failure; it is only assessing the risk to vehicle occupants posed by the drop formed by the crib wall. In such circumstances reference should be made to CD 622 'Managing Geotechnical Risk'. The designer should indicate their reasoning in respect of any decision made on VRS provision at such locations in the hazard 'Comment' field.

8.4.8 Viaduct – Parapet and Earthworks Input

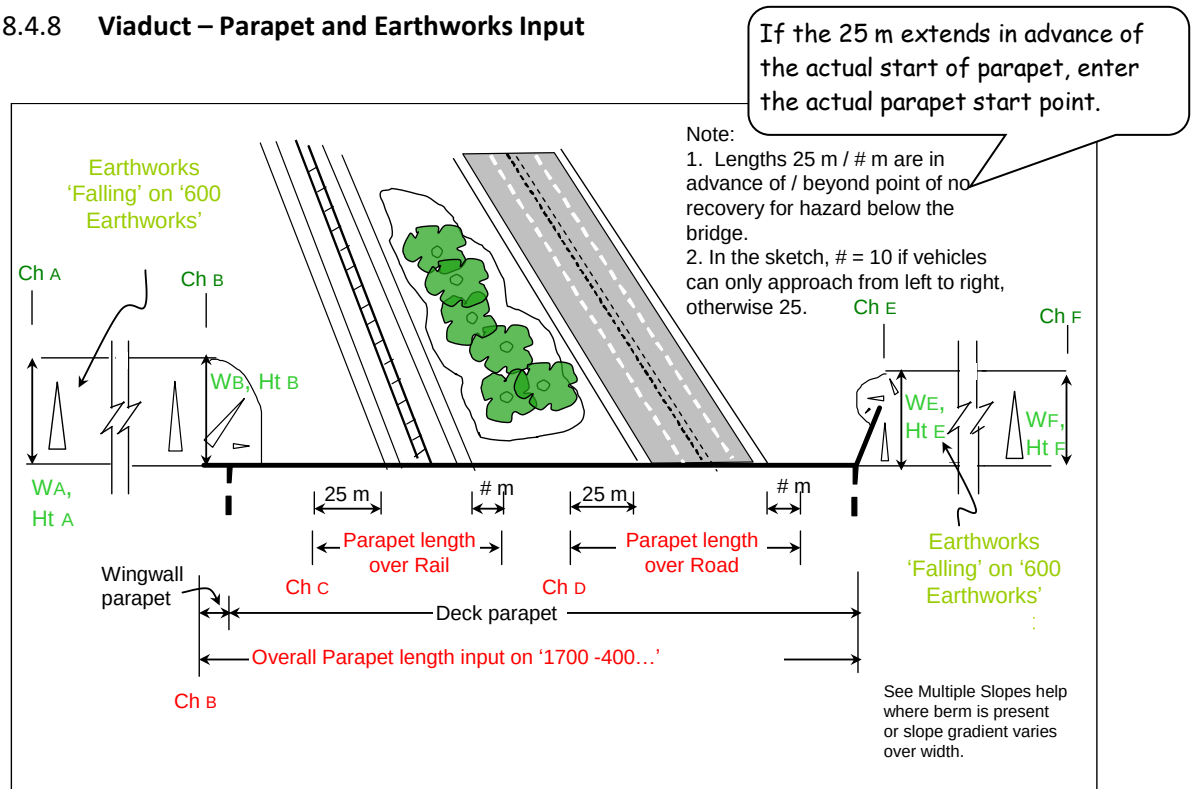


Figure 8-15 Viaduct – Parapet and Earthworks Input

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

8.4.9 Splayed Wingwall – Parapet and Earthworks Input

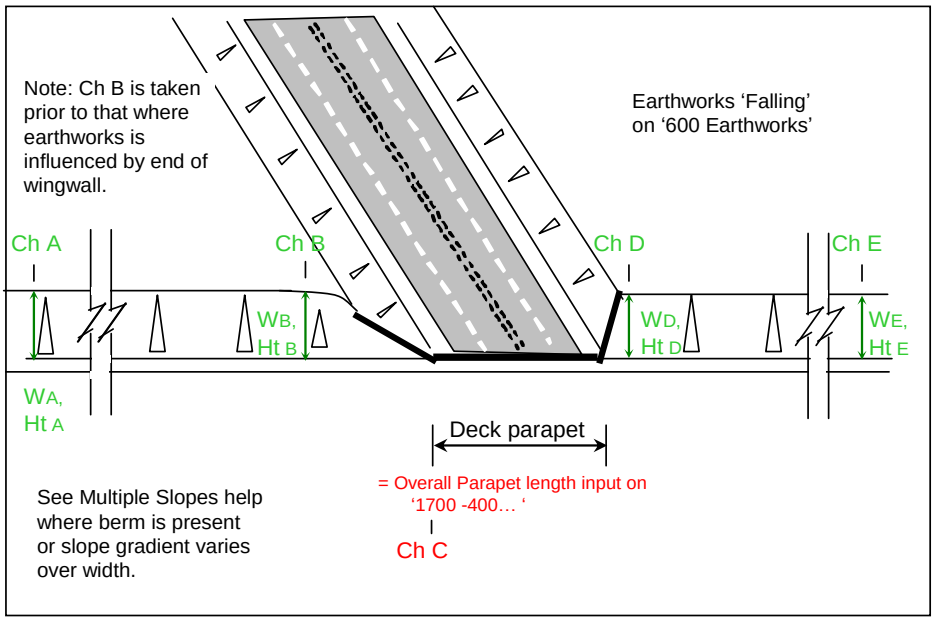


Figure 8-16 Splayed Wingwall – Parapet and Earthworks Input

Parapet details are entered in the '1700 – 400 Structures – Parapets' page as indicated. See also the OH's Road page and Help pages for how to input details relating to road.

8.4.10 Parallel Wingwall – Parapet and Earthworks Input

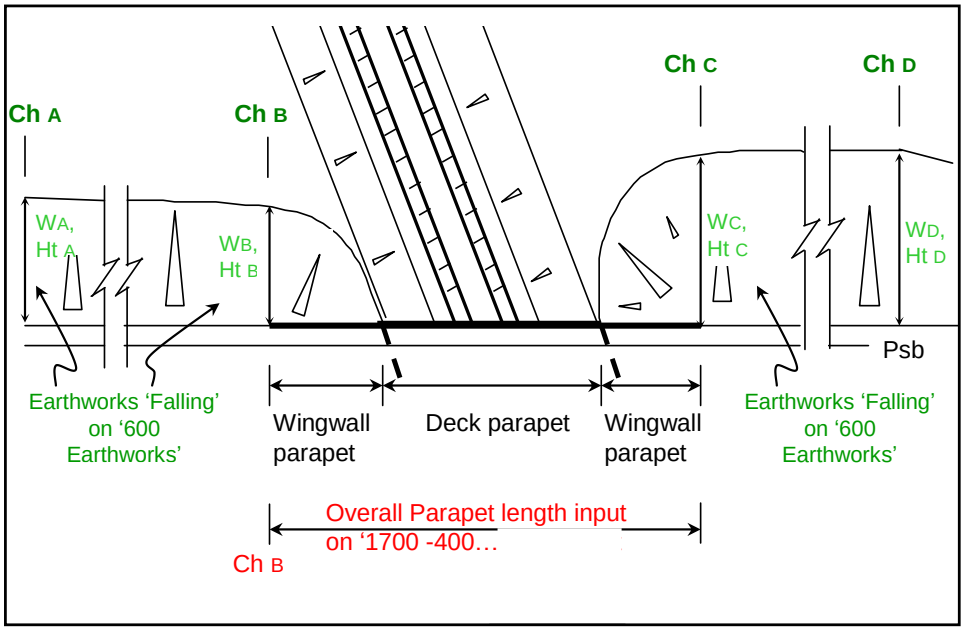


Figure 8-17 Parallel Wingwall – Parapet and Earthworks Input

Parapet details are entered in the '1700 – 400 Structures – Parapets' page as indicated. See also the OH's Railway page and Help pages for how to input details relating to railway.

8.4.11 Parallel Wingwall – Parapet and At-Grade Earthworks Input

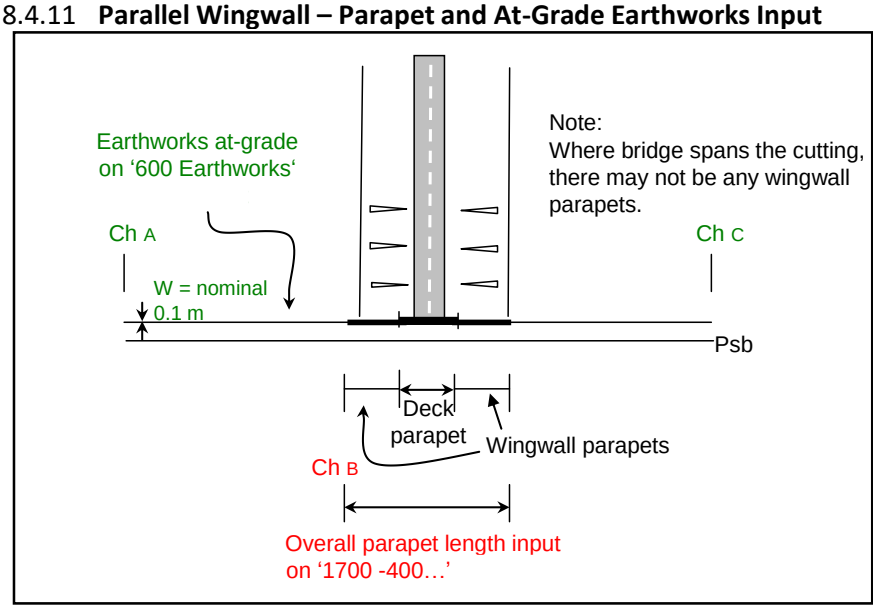


Figure 8-18 Parallel Wingwall – Parapet and At-Grade Earthworks Input

Parapet details are entered in the '1700 – 400 Structures – Parapet's page as indicated. See also the OH's Road page and Help pages for how to input details relating to a road.

8.5 1100 Kerbs

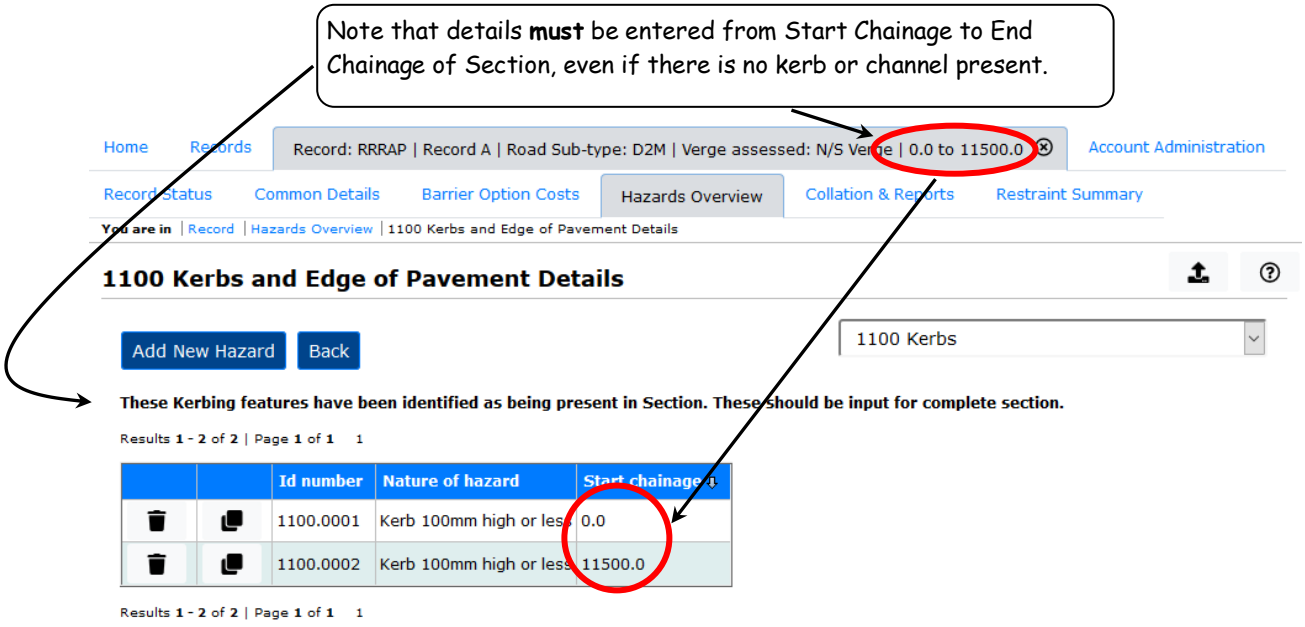


Figure 8-19 Kerbs and Edge of Pavement Details

Drop down menu for Nature of Hazard

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

The edge type does not influence the risk calculation.

8.6 1200 Traffic Signs and Signals

See section 8.6.2 below for further information on Passively Safe and Small Posts.

See sections 8.6.1 to 8.6.3 for further information relating to Gantries.

Offset and Set-back are measured from Same Point i.e. Psb

Psb (i.e. the Point from which set-back is measured) is:

a) n/s: the back of the nearside h/strip (>600mm) or h/s

b) n/s: the kerb face for roads without a nearside h/strip (or h/strip < 600mm) or h/s

c) n/s: the trafficked edge of the edge line for roads without a h/strip (or h/strip <600mm), h/s or kerb

d) o/s: the trafficked edge of the edge line or the kerb face where there is no edge line.

On the nearside where there is no h/s and the h/strip < 600mm wide, then the set-back must be measured from the trafficked edge of the edge line.

Refer to CD 127 for further details including available relaxations.

Abbreviations used:

n/s = nearside, o/s = offside, h/strip = hardstrip, h/s = hardshoulder

Edit Traffic Signs or Signals

Save Cancel

Hazard: 1200.0001

Nature of Hazard: Sign on gantry

Start Chainage of Hazard: 5.0

Length of Hazard: 0.2

Width of Hazard: 2.5

Offset of Hazard from Psb: 2.0

Cluster of Hazards: Individual hazard

Height / Depth of Hazard: >3m

Mounting Height: >1.5m mounting ht

Designed for Collision Loading? :

Comment:

3.6

Aggressiveness: 2.0

Local Alignment [F2]: Poor alignment

Sleep - Related Site [F3]: E

Speed [F4]: Mean speed approximately equal to s

Other Features [F6]: Z

Multiplicative Factor for Run-off Rate: 1.06

Topography Factor: 1.0

What to do if Cluster of Hazards?

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 returns the highest aggressiveness of the possible descriptions for the hazards in the cluster.

Note that it is a cluster of hazards in 'Cluster of hazards' field.

Collision Loading

For collision loading requirements of Portal and Cantilever Sign and/or Signal Gantries see CD 365.

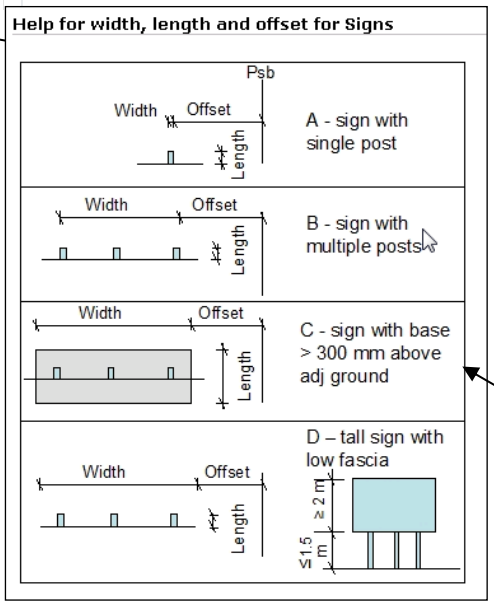
Gantry will either be passively safe or non-passively safe with VRS requirements being either TAA or CD 377 determined.

See also RRRAP Guidance Manual.

Normal and passively safe signs are not designed for collision loading.

This collision loading entry will influence the containment level returned for the safety barrier. The designer must check that appropriate containment level is chosen. See section 8.6.3

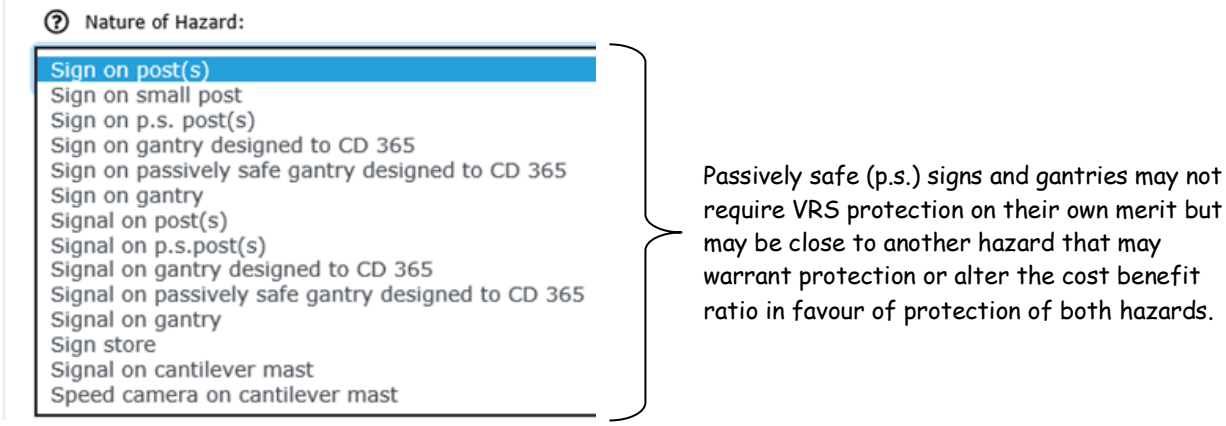
Help for width, length and offset for Signs



In example C the base of sign may be hit rather than / as well as the sign itself

Figure 8-20 Traffic Signs and Signals data entry

Drop down menu for Nature of Hazard



8.6.1 **Gantries**

Note: This also applies to Gantries in 1500 Comms

Details of any risk ranking assessment carried out in accordance with the National Annex to BS EN 1991-7 to determine the sensitivity of the structure to collision required by CD 365 should be cross referred to in the User Comments and included within the HS File.

8.6.2 **Use of Passively Safe Supports for Signs or Gantries**

Note: This also applies to Passively Safe Supports for Gantries in 1500 Comms worksheet.

It may be beneficial in many situations to consider using passively safe supports for a sign or a passively safe 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 at relatively low cost. It should be noted however that passively safe supports 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. The Designer should check that the criteria and failure mechanism of the passively safe support structure is suitable for the proposed location and what is being supported. 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.

Refer to CD 365 for further information relating to the design of these structures. The provision of any vehicle restraint system for a passively safe gantry must be agreed with the Technical Approval Authority.

When a drop down for a passively safe support structure is chosen, the item must meet the requirements of one of the three BS EN 12767 categories i.e. High Energy absorbing (HE), Low Energy absorbing (LE), or Non-Energy absorbing (NE). Note that Class O is not acceptable as a passively safe support (the Class has no performance requirements, and no test is required). Standard supports come within this Class.

Passively Safe (p.s.) Posts or Supports and 'Small' posts

A passively safe post or support is one which meets the requirements of BS EN 12767. A small post is one which is deemed to meet the requirements of BS EN 12767.

A single small post is one which does not exceed the equivalent section properties of a tubular steel post having an external dia. of 89 mm and a nominal wall thickness of 3.2 mm.

If two or more posts, perpendicular to the carriageway, are used for one sign, the Designer must check that the sign post spacing and post dimension criteria of the National Annex to BS EN 12767 will be complied with when selecting 'Sign on small post' or 'Sign on p.s. post(s)'.

Where these criteria, including the recommended sign plate mounting height, are not met, the post(s) will be standard posts, and use the caption 'Sign on post(s)'.

A passively safe gantry is one that meets the passively safe requirements of CD 365.

The adjacent definition of a small post that is deemed to be passively safe has been taken from the National Annexe of BS EN 12767.

Figure 8-21 Passively Safe and Small Posts help

8.6.3 Results for Gantries

An example of the output relating to gantries and gantry mounted signs in the collation pages will be as per the example below.

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	0.0	10000.0	1.4	Yes						N/A
☐	i	1500.0001	Gantry designed to CD 365	100.0	102.0	2.0	No	Must be agreed with TAA	13		W2	H4A	N/A
☐	i	1500.0002	Gantry	200.0	204.6	2.0	No	Refer to Guidance Manual				H4A	N/A
☐	i	1500.0003	MS3/MS4 designed to CD 365	300.0	302.0	2.0	No	Must be agreed with TAA	13		W2	H1	N/A
☐	i	1500.0004	MS3/MS4 sign	400.0	402.6	4.6	No	Refer to Guidance Manual				N2	N/A

Figure 8-22 Typical outputs for gantries and MS3/MS4 signs, and gantries

Where the offset from Psb of a gantry that does not meet the requirements of CD 365 in respect of collision loading exceeds 4.5 m, a containment level will be returned based on the offset of the hazard.

Note that the offset is measured from Psb to the traffic face of the gantry base when the base exceeds 300 mm above the adjacent road level, otherwise it is from Psb to the traffic face of the gantry support.

If the offset is less than 4.5m then a H1 or H4a containment will be returned. The Designer is required to check the loads that the gantry base and supports have been designed for. If it has been designed for residual loads or main and residual loads, H1 minimum containment VRS will be required and, if designed for no collision load, then H4a containment VRS is required, and the containment level in the 'Collation' page adjusted accordingly.

Note that if a new gantry is proposed, CD 365 at present does not currently allow for main load impact forces on gantry supports to be mitigated by the use of barrier.

There will be some instances where an existing gantry has a safety barrier that is contiguous with the gantry base and the safety barrier provision is being assessed in the RRRAP as part of a scheme to, for instance, upgrade the road, add new hazards in the vicinity of the gantry, or replace an end-of-life safety barrier. With gantries it is not possible to select the safety barrier to be contiguous with the gantry base, as this arrangement requires a Departure from Standard under CD 377. Gantries, along with other hazards, should be placed outside the normalised working width class of the safety barrier and as indicated in Figure 3-19 of CD 377.

To carry out the assessment in RRRAP, the set-back of the safety barrier should be changed from the default setting of 0.6 m where there is a hardshoulder or hardstrip, or 1.2 m where there is no hardstrip to match or nearly match that of the gantry base (it is suggested that a dimension a nominal 10 mm less than the gantry base offset is chosen to avoid a possible error message that the hazard is in front of the VRS). The RRRAP will indicate that the gantry base is within the working width of the safety barrier though, as it is proposed to be contiguous, this can be ignored.

Where a gantry (or passively safe gantry) has been designed to meet the requirements of CD 365 in respect of collision loading, the RRRAP returns a containment and a length of VRS before and after the hazard that give an acceptable level of risk to the vehicle occupants. However, details of the vehicle restraint system must be agreed with the Technical Approval Authority as part of the gantry design process.

When no minimum length of VRS is returned for an existing gantry or MS3/MS4 sign, the hazard should be run again as a gantry designed to CD 365 and the results compared to ascertain the length of need that returns an acceptable level of risk. The containment requirements should then be checked as described above.

8.6.4 **Standard Posts with widened base section for housing electrical equipment**

These will tend to have a higher moment of resistance than a ‘small post’ described above. The dimensions described in the ‘Help for width, length and offset for Signs’ should be taken to the widened section of the post.

8.7 1300 Lighting Columns

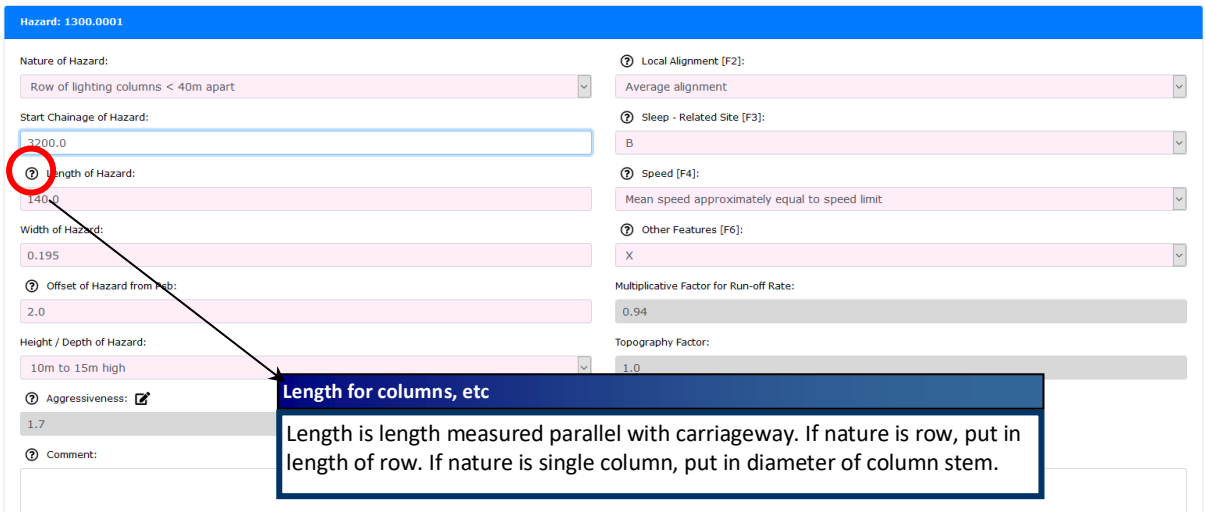


Figure 8-23 Road Lighting Columns data entry

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.

8.7.1 High Masts

A high mast lighting column is a lighting column that exceeds 18m in height.

8.7.2 Spacing of columns

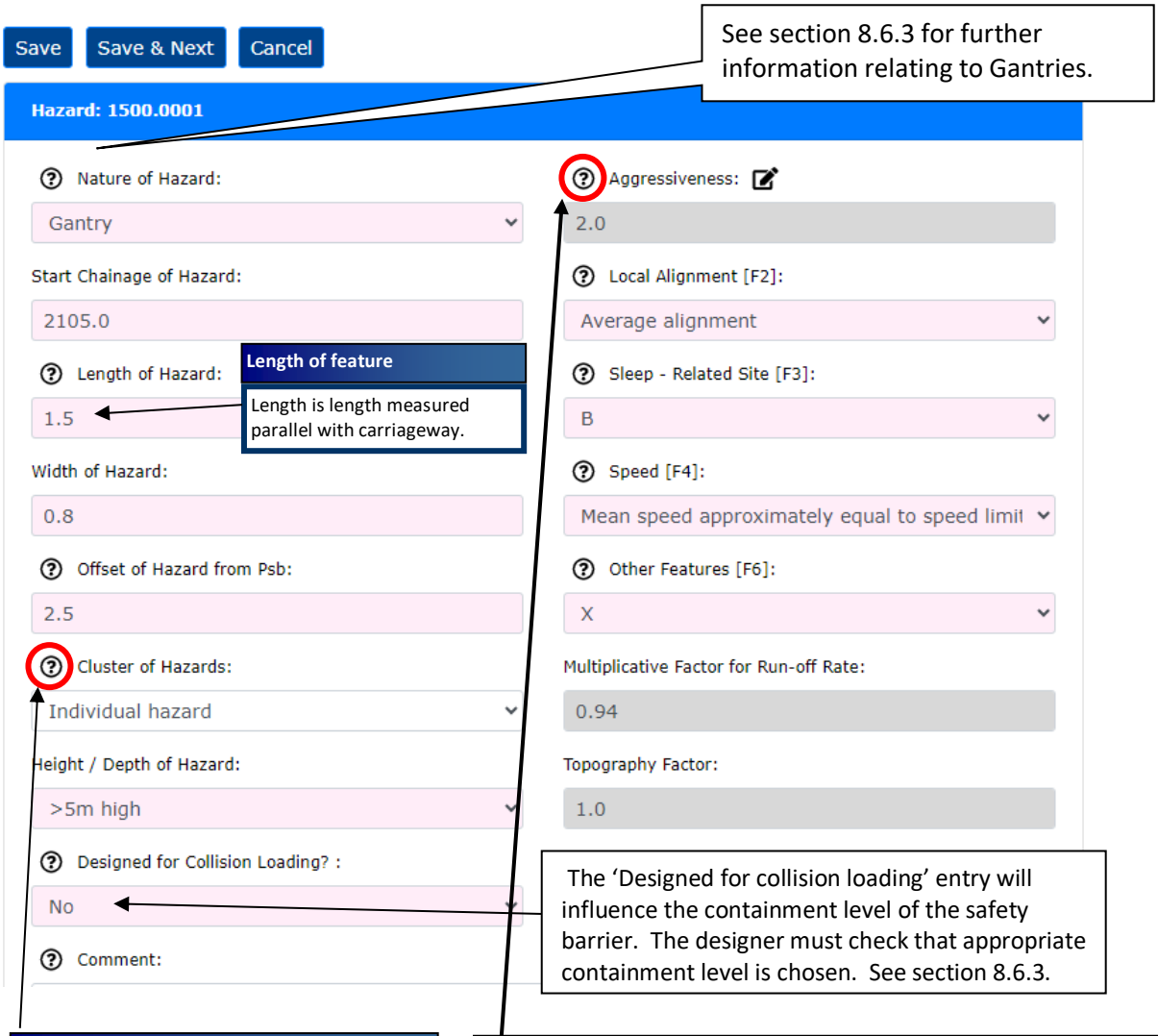
Note that at present, the RRRAP assesses the risk of the first column in a row. It assumes that, if there is a need to protect it, then each column in the row will similarly need to be protected. The spacing of the columns is not currently taken into account. In practice, a line of closely spaced columns 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. If there is a line of columns at broadly similar spacing of around 40 m or less, then enter as a row of columns, rather than enter each one separately.

8.7.3 Passively safe columns

There may be merit in considering the use of passively safe lighting columns that meet the requirements of BS EN 12767, 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. For more details see section 8.6.2.

8.8 1500 Motorway Communications

Create Motorway Communications (above ground)



What to do with clusters of objects

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.

Aggressiveness of Comms Hazards

The aggressiveness factor for communications equipment such as cabinets has been based on the hazard having no effect on Others, and without consideration of maintenance workers.

Some equipment (or items in a cluster) may have a significant effect on, for instance, the safety of Others if it were to be out of action for a period or will require regular and or time-consuming maintenance.

In such cases, the Designer must consider these additional factors and decide whether the VRS provision resulting from the RRRAP is sufficient. The outcome of these considerations should be documented in the Comments field for the hazard.

The aggressiveness factor can be altered from its default value (see section 8.1.2) to 2.5 to reflect the higher risk or 0.6 where a passively safe cabinet is used. If in doubt, it is better to protect than not protect. If the aggressiveness is altered and risk has already been calculated for the hazard, then risk will have to be re-calculated on the 'Collation and Reports' page in order that the correct result is displayed. See also section 8.8.1.

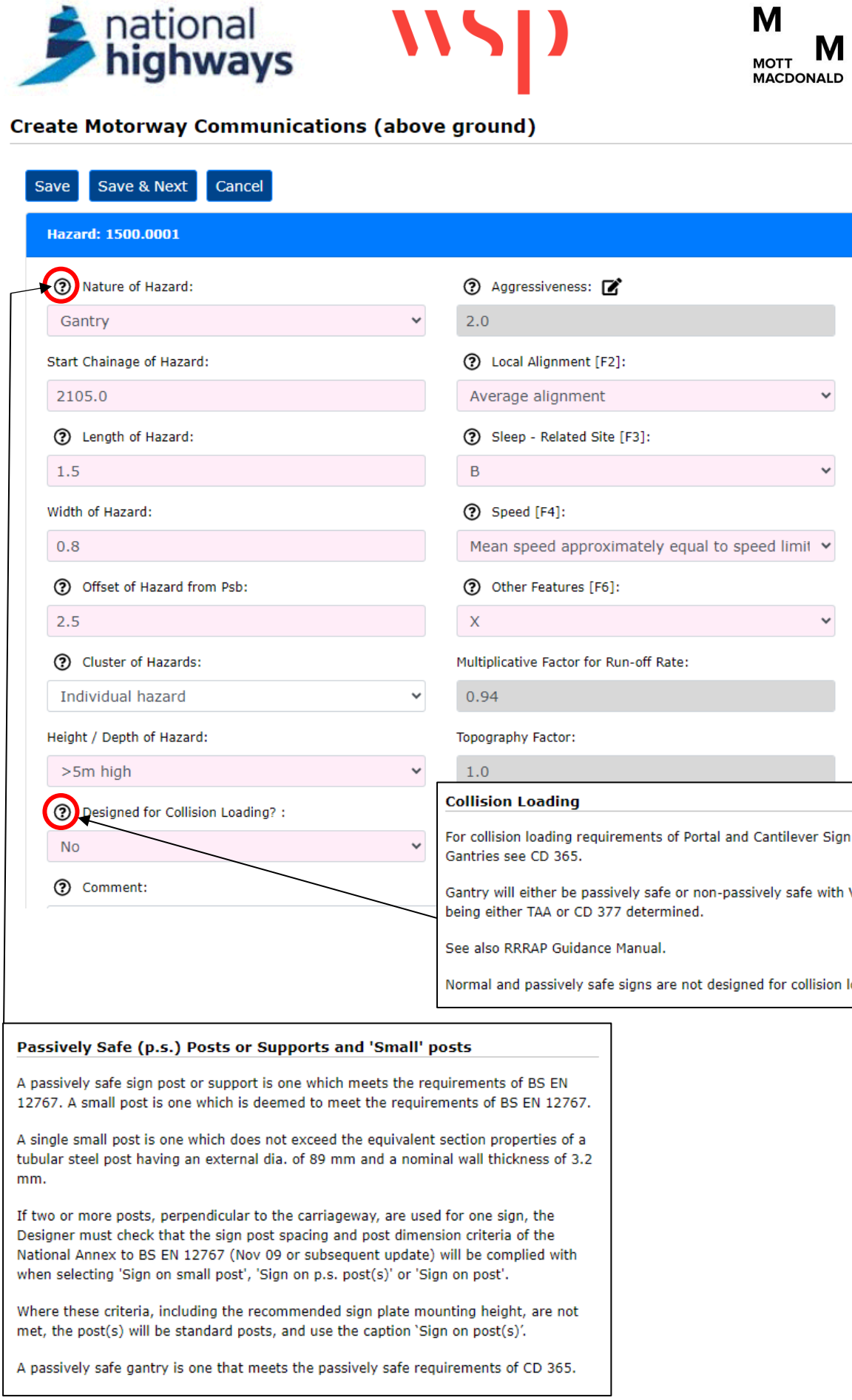
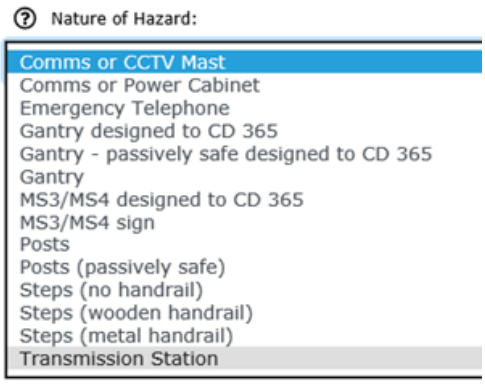


Figure 8-24 Motorway Communications (above ground) data entry

Drop down menu for Nature of Hazard



Notes:
In CD 365, 'Gantry' is a generic term for structure supporting signs, signals, variable message signs (VMS) and other equipment.
The term 'gantry' is used for a variety of structures, including single or multiple portals, single and double cantilevers and combinations of same.

8.8.1 Results for Comms Cabinets and Equipment

The RRRAP assigns an aggressiveness factor of 2.0 for standard electricity and communications (comms) cabinets. The results for these cabinets and their equipment will indicate the level of risk to vehicle occupants from an errant vehicle hitting the hazard and whether a safety barrier is required to reduce this risk.

Passively safe cabinet products, which have been developed, potentially offer a lower level of risk to the occupants of an errant vehicle than a standard cabinet as the impact level is reduced by the shearing action and the risk of electrocution is reduced or eliminated where break-away electrical connections are used. However, when testing to EN12767 was carried out by TRL it was found that a passively safe cabinet impacted by a car could travel more than 50 m. As with all breakaway systems, the final resting place of the cabinet may vary, and (dependant on direction and distance of travel) the possibility exists for the cabinet to pose a secondary risk to other street furniture, pedestrians, other road users or others.

The RRRAP typically assigns aggressiveness values of between 0.6 and 0.25 to passively safe supports, and it would be appropriate to assign such a lower aggressiveness to a passively safe electrical or comms cabinet. This can be done by the designer within RRRAP by editing the aggressiveness under the hazard input section and the effect on the need for VRS at various offsets from Psb analysed.

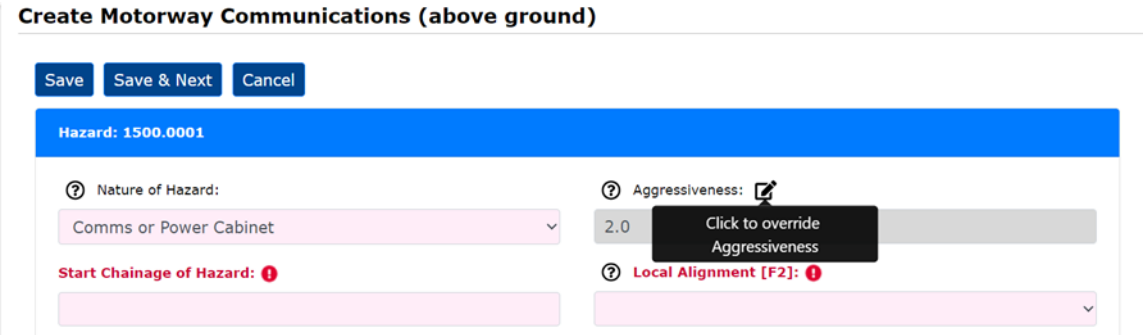


Figure 8-25 Editing the aggressiveness field for a passively safe cabinet

The siting of any cabinet or equipment (whether passively safe or not) needs to be carefully considered, firstly to minimise the chances of it being impacted, and secondly to minimise or preferably eliminate the risk of a secondary incident occurring if it is impacted.

A safety barrier may be provided where no risk is indicated, or the containment level increased if it is felt that there is a significant additional risk to (i) any road workers maintaining the Comms cabinet or equipment or (ii) due to its effects on the Network if the Comms cabinet or equipment were damaged or (iii) other equipment, pedestrians, other road users or Others if the cabinet is displaced. These increased risks are not calculated within the RRRAP and, if the provision is altered as a result, a note should be made in the 'Comment' field of the relevant hazard(s).

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

It is important that all the factors considered in the assessment for the need or otherwise of VRS and conclusions as to any provision, its extent and parameters are documented within the RRRAP.

8.8.2 **Results for Gantries**

See guidance paragraph 8.6.3 above.

8.8.3 **Steps**

Steps are generally regarded as relatively low risk. However, care needs to be taken with regard to some preformed metal step units to ensure that they are installed in such a way as to minimise the chances of an errant vehicle snagging and dragging the assembly. If carefully detailed, such installations can be a cost effective and low risk solution.

Care also is required when detailing the handrails alongside steps: to avoid the inclusion of relatively stiff braced assemblies that could become a potential hazard to the occupants of vehicles; and, if there is a safety barrier passing in front of the steps, that the handrails are not within its working width. A closed off end to the rails is potentially safer than a rail or rails extending beyond the last post, which if impacted could penetrate the cabin of an errant vehicle and cause injury.

Passively safe supports, e.g. for signs and lighting columns, do not require safety barrier protection to give an acceptable level of risk within the RRRAP. So, if frangible holding down bolts that will break on vehicle impact, but not fail in normal usage and or passively safe handrails can be sourced and installed, then it would be reasonable to manually assign the aggressiveness factor for 'Steps (metal handrail)' to be the same as for 'Steps (no handrail)'.

8.9 1600 Retaining Walls

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

In instances where a retaining wall is below the carriageway level and the wall is supporting an embankment or verge and cannot be hit by an errant vehicle, the level between the top and bottom of the wall and the drop present should input in the earthworks hazard input section.

Where the wall is supporting a cutting slope and the wall could be impacted by an errant vehicle, the details of the wall should be input in this section.

And under 2500 Special Structures the following are included: 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.

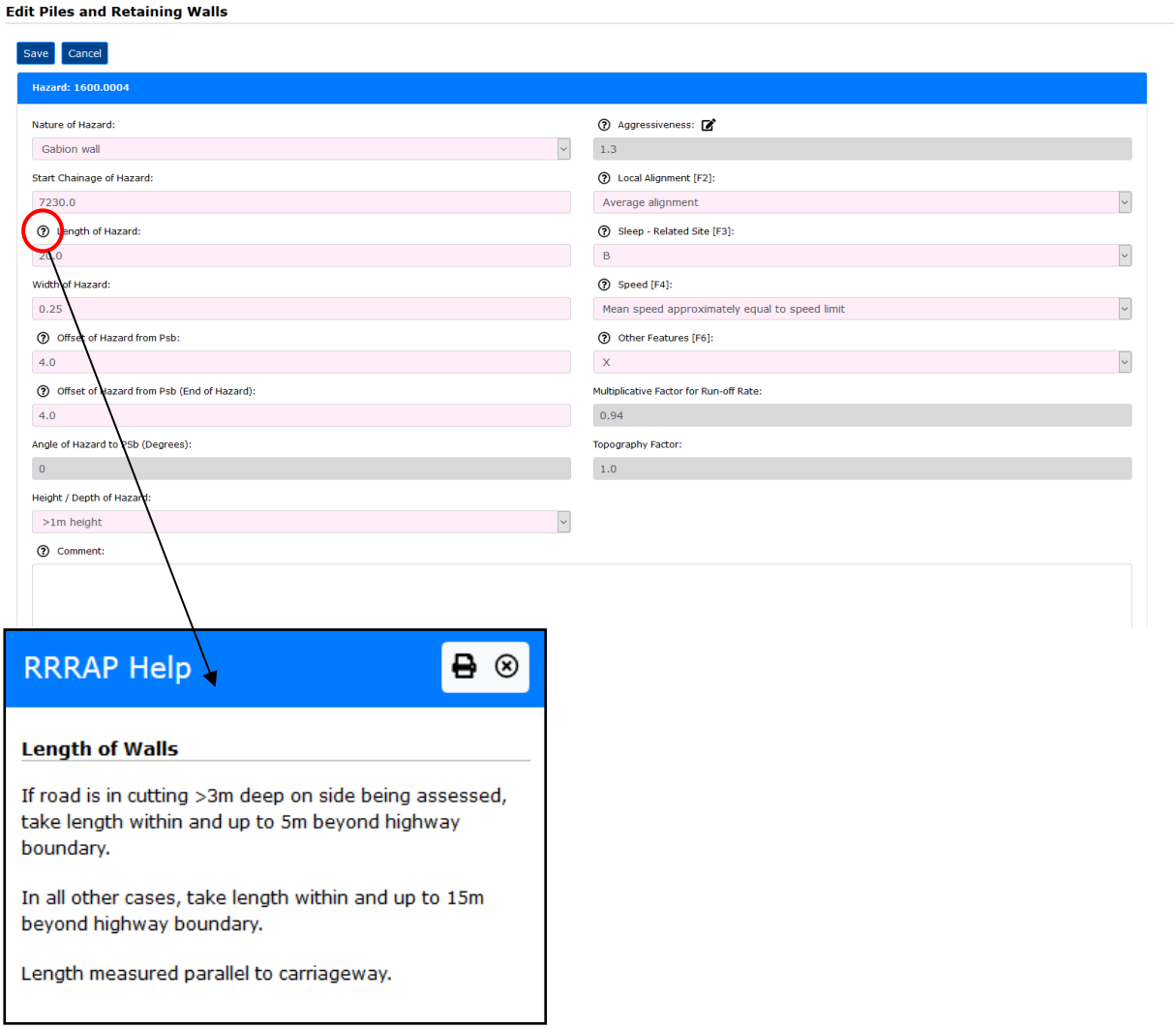


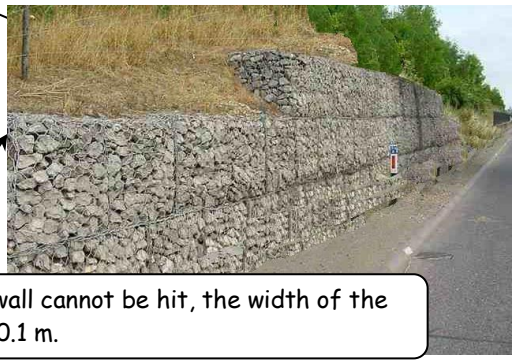
Figure 8-26 Retaining Walls data entry

Drop down menu for Nature of Hazard

Smooth faced wall
Profiled wall (shallow features)
Profiled wall (deep features)
Sheet Piled wall
Concrete Piled wall
Rough faced wall
Gabion wall
Crib wall retaining a c'way
Crib wall toe adj. to c'way

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.

Figure 8-27 Crib Wall



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

Figure 8-28 Gabion Wall

In the case of a crib wall that is retaining a cutting slope, the RRRAP does not take into account the risk 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 their reasoning in respect of any decision made on VRS provision in the 'Comment' field of the relevant hazard.

8.9.1 Smooth Face Walls

A smooth faced wall over 1.5 m in height may 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 end of the wall.

It should be noted that the Impact Severity Level (ISL) of a smooth faced wall that is vertical is generally similar to that of a vertical concrete safety barrier (ISL Class C). This is higher than the ISL for a smooth faced wall that is profiled in a similar way to a proprietary profiled concrete safety barrier of similar height, these typically being ISL level A or B. Note that CD 377 requires that safety barriers have an ISL level A or B and the use of a vehicle restraint with an ISL greater than Class B requires a Departure from Standard and must be with the agreement of the Overseeing Organisation and justified within the RRRAP.

Other forms of wall, that are not smooth faced, typically require a safety barrier in front of it (when a VRS is required due to the wall's offset and aggressiveness). The RRRAP outputs the length in advance of the start of the wall (or abutment) with the VRS continuing for the length of the hazard to a point beyond the end of the hazard.

8.10 1700 - 400 Structures and Parapets

This includes vehicle parapets and pedestrian restraint systems, bridge abutments and piers and other structures. Note that the RRRAP will output containment levels for vehicle 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 the RRRAP output against the requirements of CD 377 section 4 to ensure correct provision.

Note that for existing parapets designers should refer to CS 461 'Assessment and upgrading of in-service parapets' and follow the procedure outlined in the standard to determine the required containment of the parapet with the details and outcome of the assessment added into the 'Comment' field of individual hazards in RRRAP and included in the HS File.

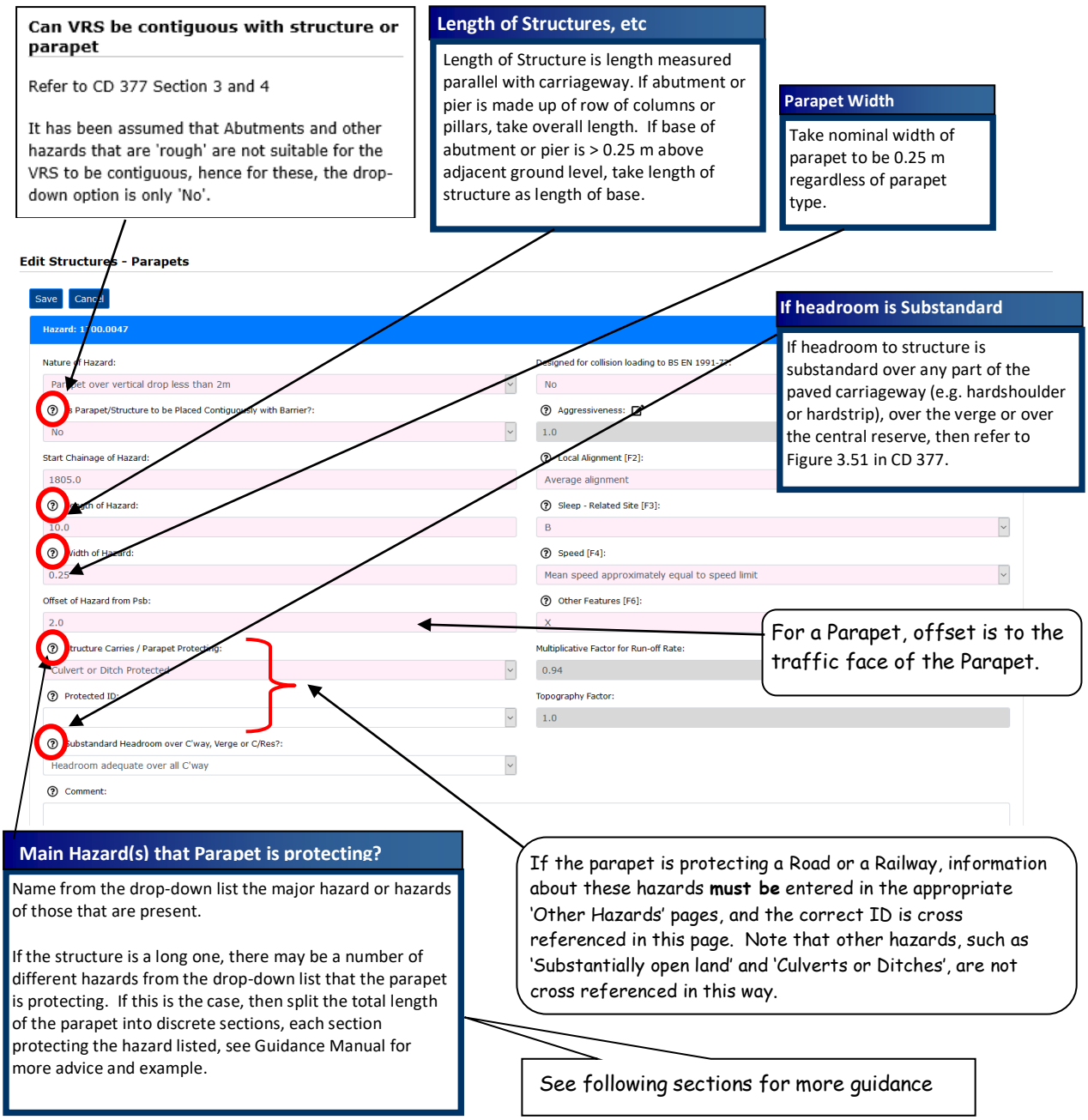
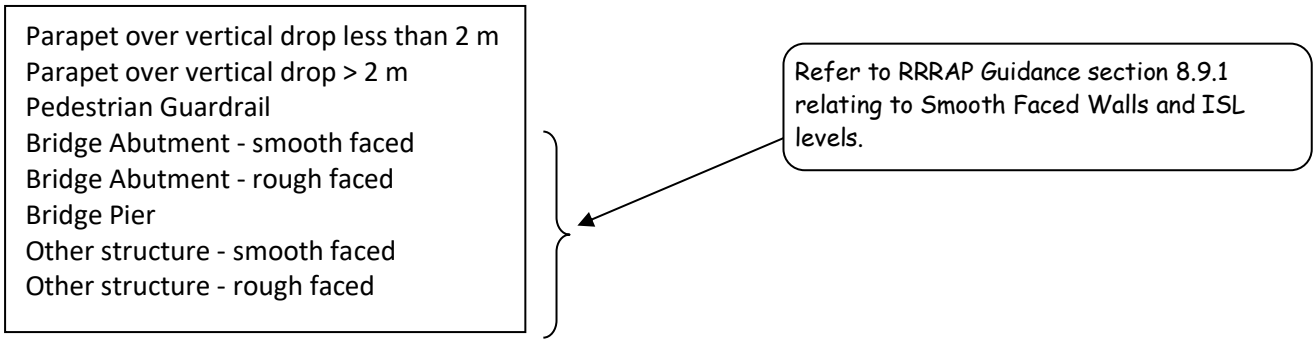
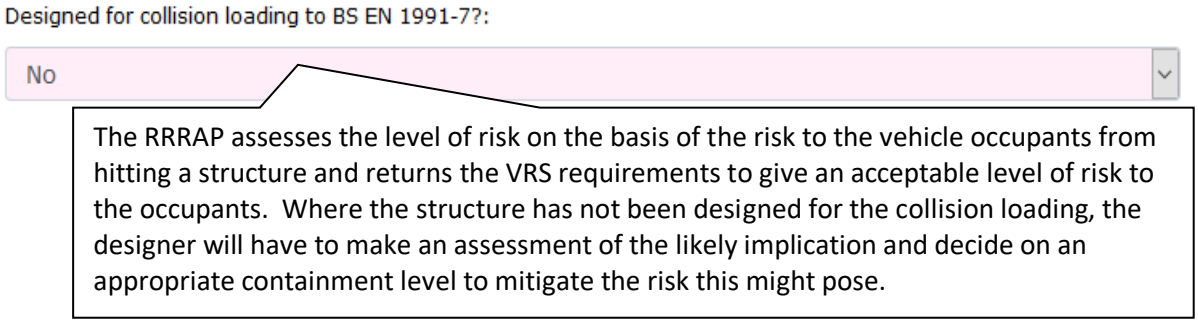


Figure 8-29 Structures and Parapets data entry

Drop down menu for Nature of Hazard





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

8.10.1 Minimum length of VRS to prevent direct impact with approach end of parapet

The RRRAP calculation for parapets assumes that a parapet is relatively close to Psb and, in general, parapets are at or close to the back of a standard verge. As such, the RRRAP will return the need for an N2, H2 or H4a containment parapet, depending on the nature of the hazard(s) that the parapet is protecting, even if, in practice, the parapet is a much greater distance from Psb.

It is essential that the drop behind the parapet is entered in the earthworks section so that the hazard of the vertical drop is correctly assessed by the RRRAP.

In instances where the parapet protecting the vertical drop is significantly further from Psb than the back of the standard verge (such as may occur with a culvert passing beneath the road), the earthworks slope in front of the parapet and drop behind the parapet should be entered in the Earthworks hazard data entry section.

Where a VRS is required in order to have an acceptable level of risk for the vertical drop behind the parapet and or the earthworks slope between back of verge and the vertical drop, a decision should be taken as to whether the vehicle restraint would be better deployed in the form of a safety barrier within the standard verge with pedestrian restraint to protect from a fall from height, or a vehicle parapet on the structure with a VRS preventing an errant vehicle reaching the hazard posed by the slope in advance of the parapet and also preventing impact with the end(s) of the parapet, in accordance with section 3.55 of CD 377.

Where a vehicle parapet is used, a separate pedestrian restraint and fall protection may also be required in accordance with sections 8.25 to 8.30 of CD 377 for instance on angled wingwalls. The fall protection should not compromise the performance of the parapet or pose an added hazard to any errant vehicle. See also section 8.10.6 of this Guide.

The background to decisions made in respect of VRS provision should be included in the hazard 'Comment' field.

8.10.2 **Selecting protected road or railway hazard ID**

When the Nature of hazard is a "Parapet" and the 'Structure carries / Parapet protecting' field is set as "Road Protected" or "Railway Protected", then the 'Protected ID' field is populated with either the list of Road or Railway hazard IDs that are available in the RRRAP record. Under these conditions the 'Protected ID' field is mandatory and a 'Hazard ID' must be selected from the list provided.

Note this field will only have the option to select the 'Hazard ID' in the drop-down menu when the adjacent road or rail hazard has been input on the relevant hazard data entry page. The Hazard ID correlates the parapet with the correct parameters of the hazard that the parapet is protecting.

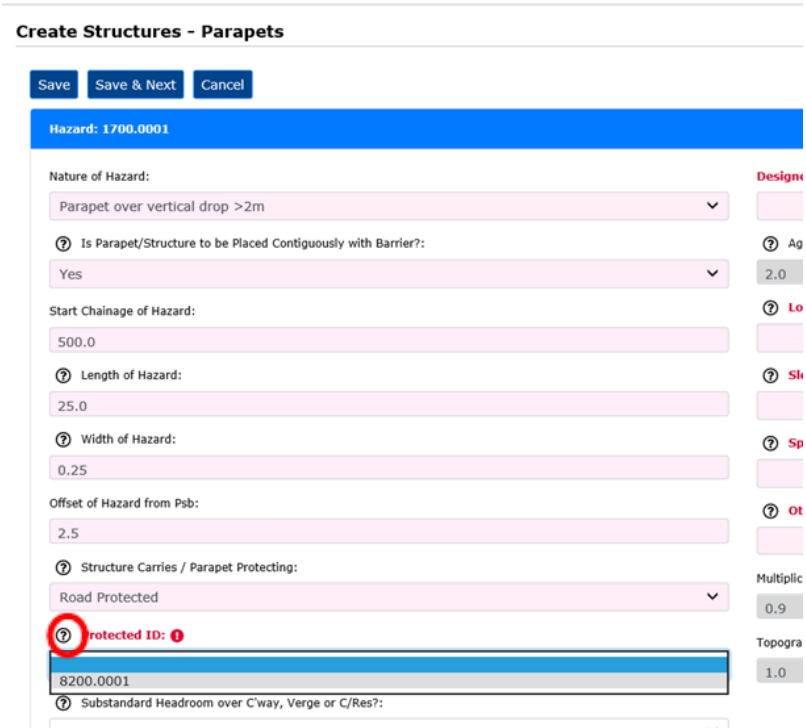


Figure 8-30 Parapets data entry and road/rail hazard protected ID

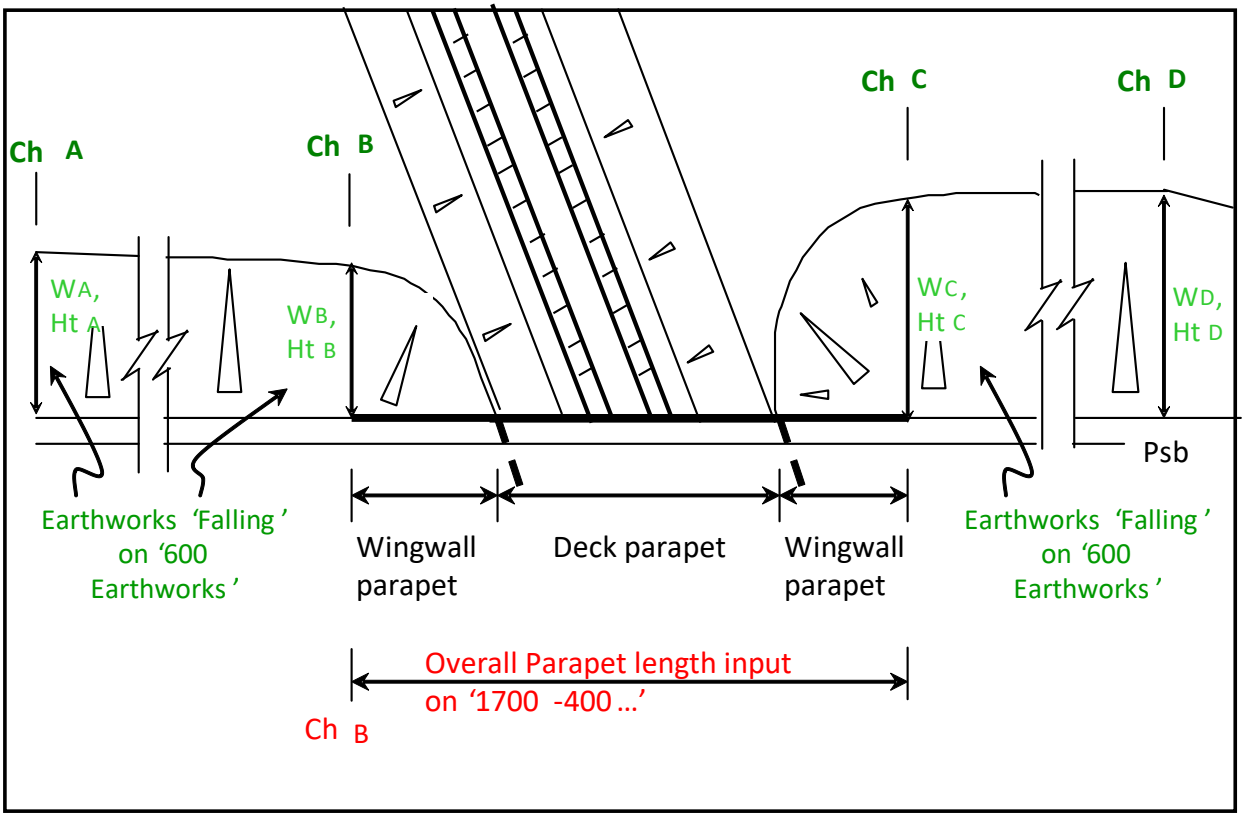
If the 'Nature of hazard' or the 'Structure carries / Parapet protecting' fields do not indicate a road or rail hazard, then the field will not be mandatory and the list under the drop-down menu will be blank.

8.10.3 **Minimum length of VRS at overbridges with piers and adjacent abutments**

At overbridges where piers may be placed in the verge in front of an abutment and wing wall which are located at a greater offset in the verge, the designer must ensure sufficient details are entered to ensure the RRRAP length of VRS provided gives an acceptable level of risk for each of the pier, the abutment and the wingwall.

8.10.4 **Guidance on inputting data for Parapets**

The following figures identify how information relating to Parapets, Earthworks and Railway or Road is input into the respective data entry pages.



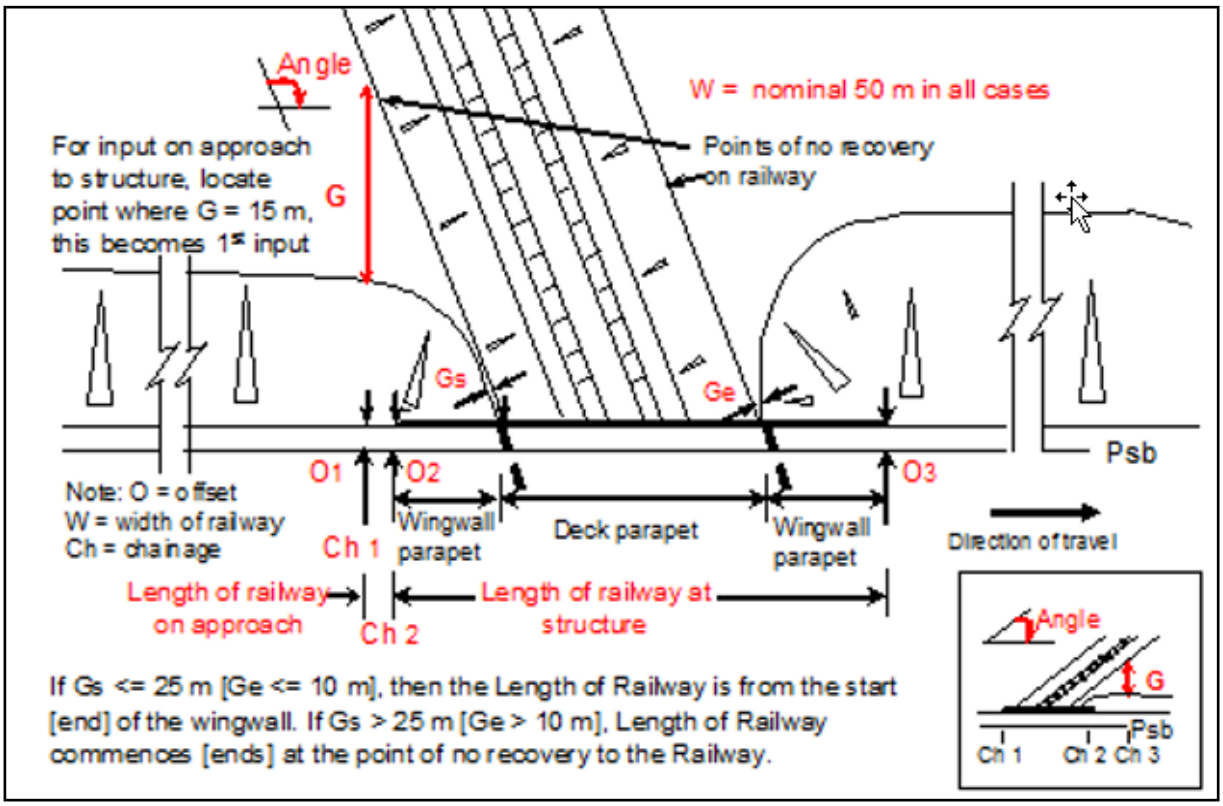
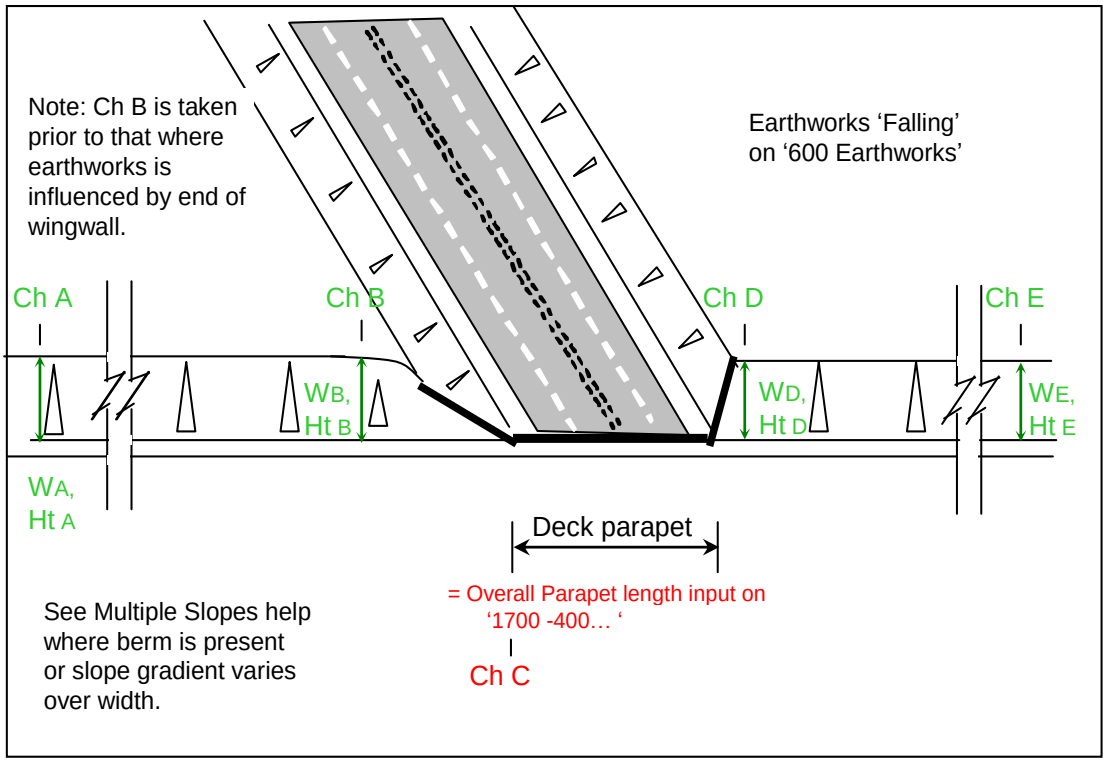


Figure 8-31 Parapet, Earthworks and Railway Inputs at Underbridge with Parallel Wingwalls (Road Inputs broadly similar)



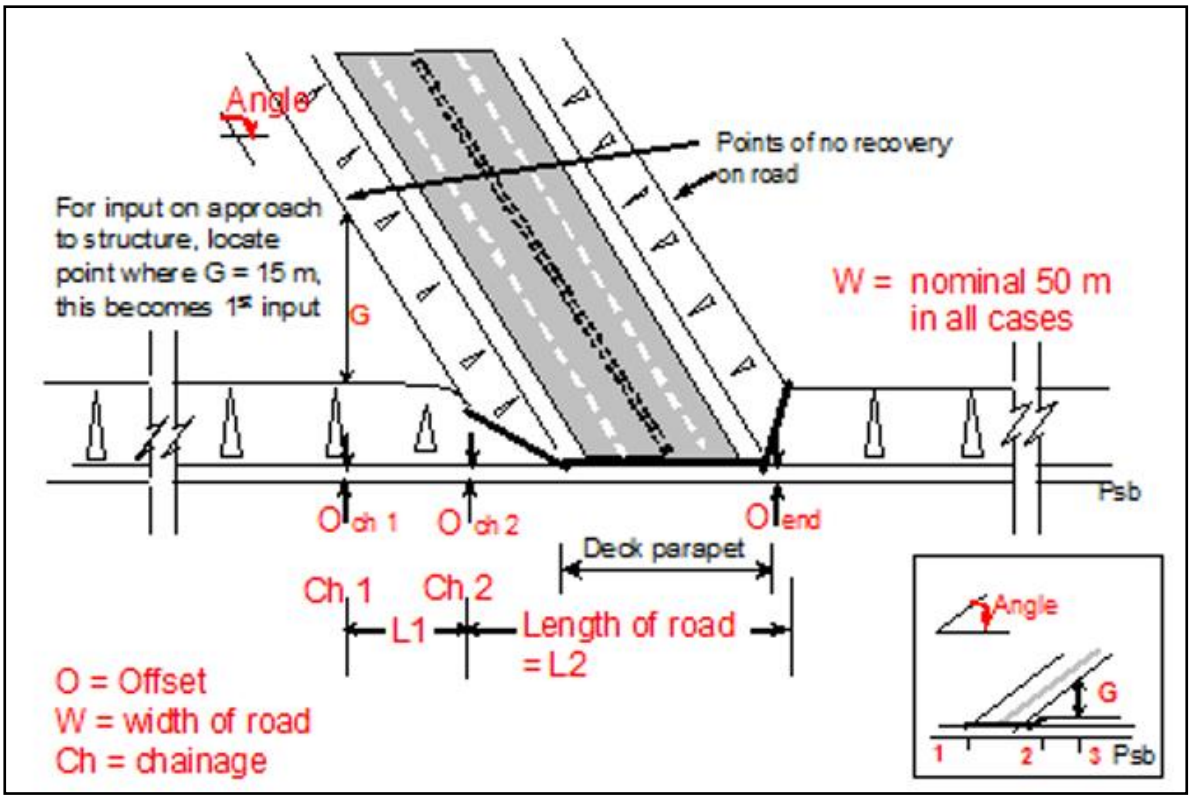
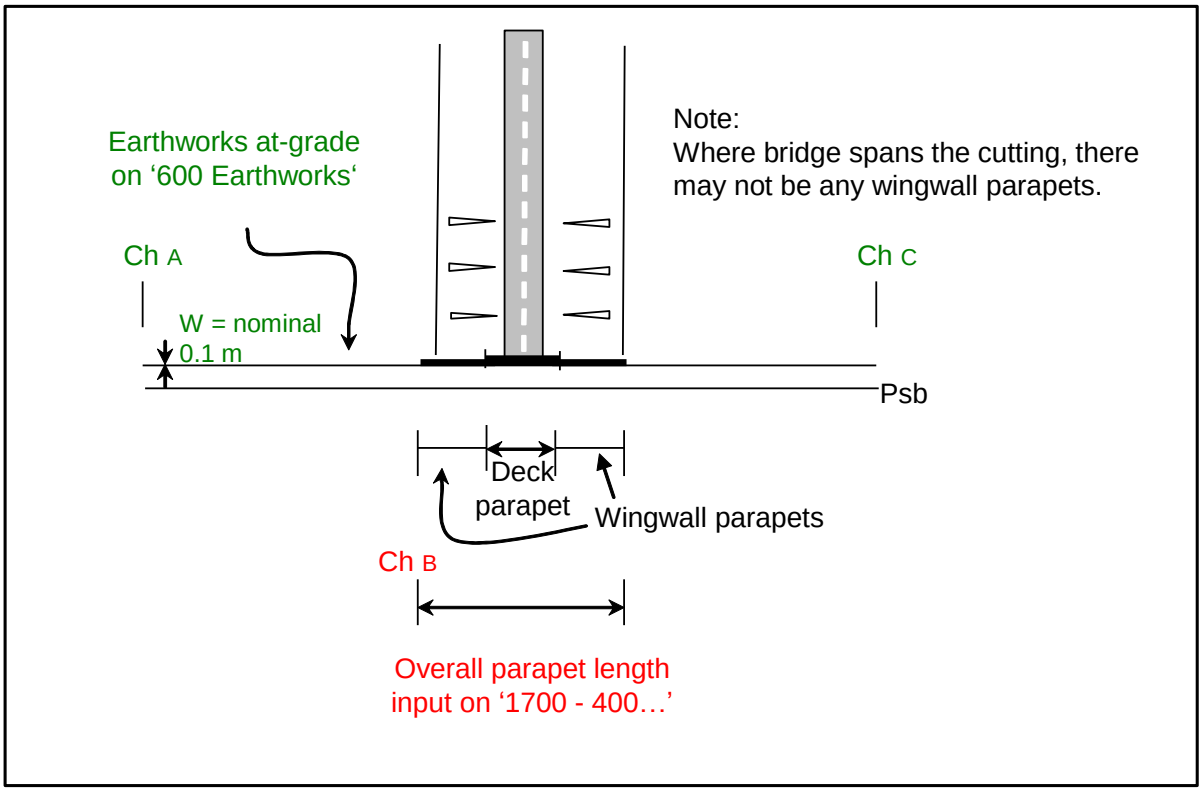


Figure 8-32 Parapet, Earthworks and Road Inputs at Underbridge with Splayed Wingwalls (Railway input broadly similar)



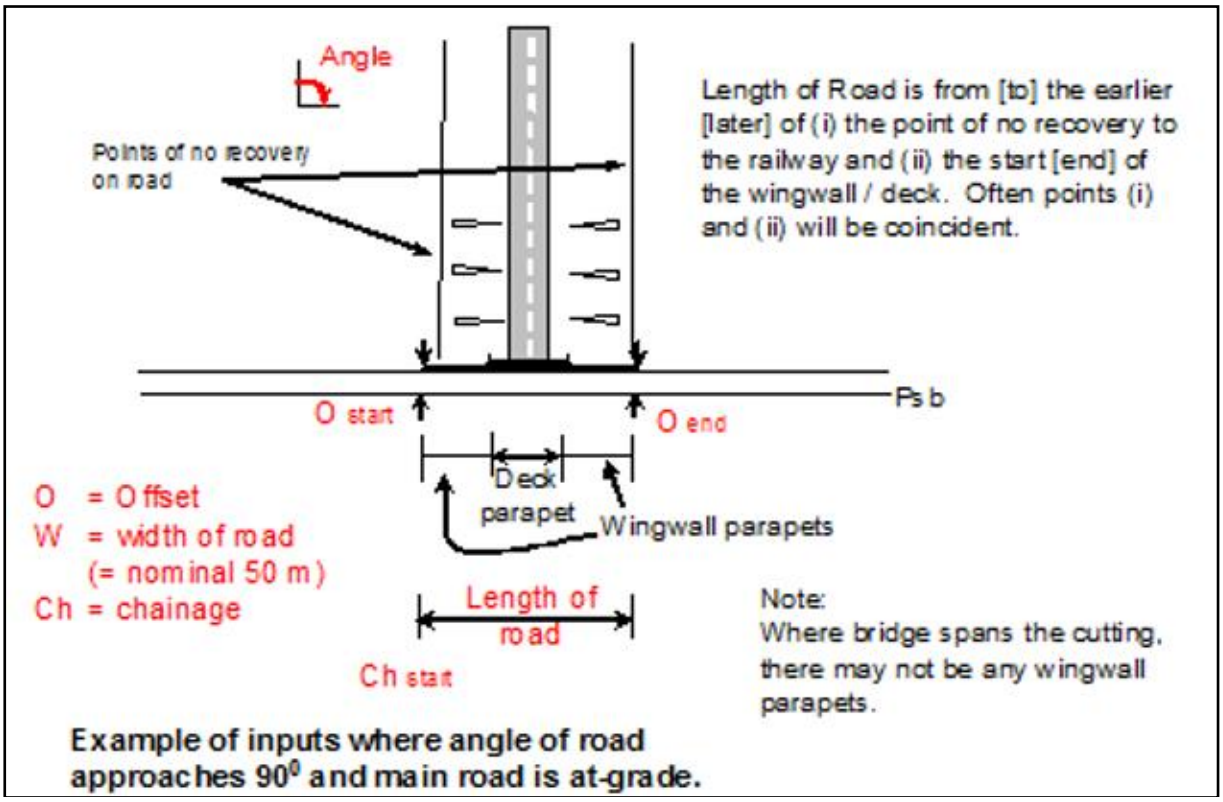
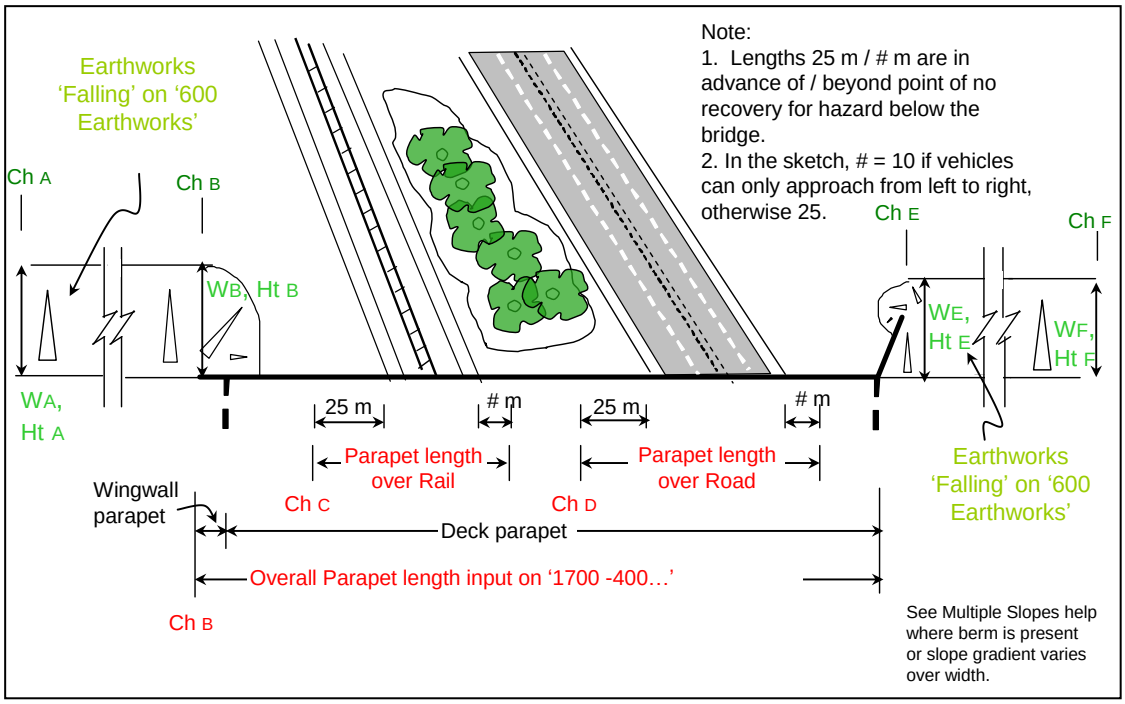


Figure 8-33 Parapet, Earthworks and Road Inputs at Underbridge when road is at-grade (Railway input broadly similar)

8.10.5 **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 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 category, as indicated in Figure 8-34 (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.



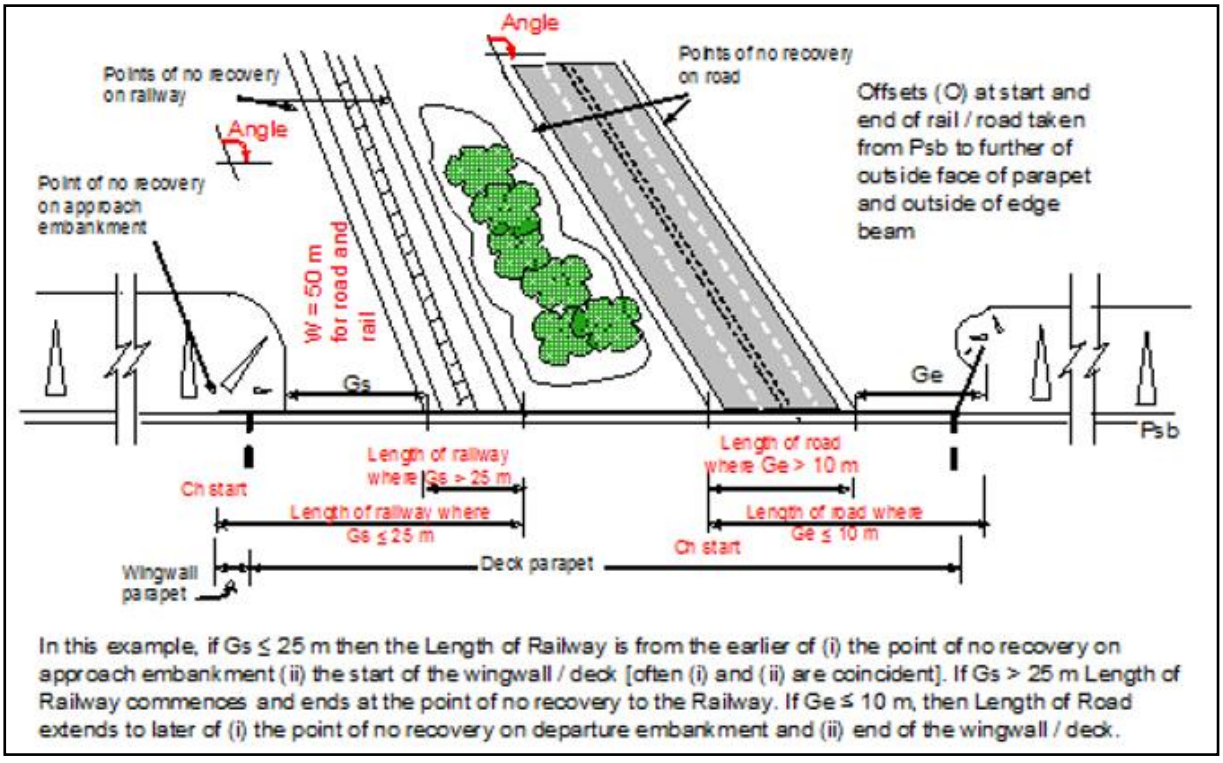
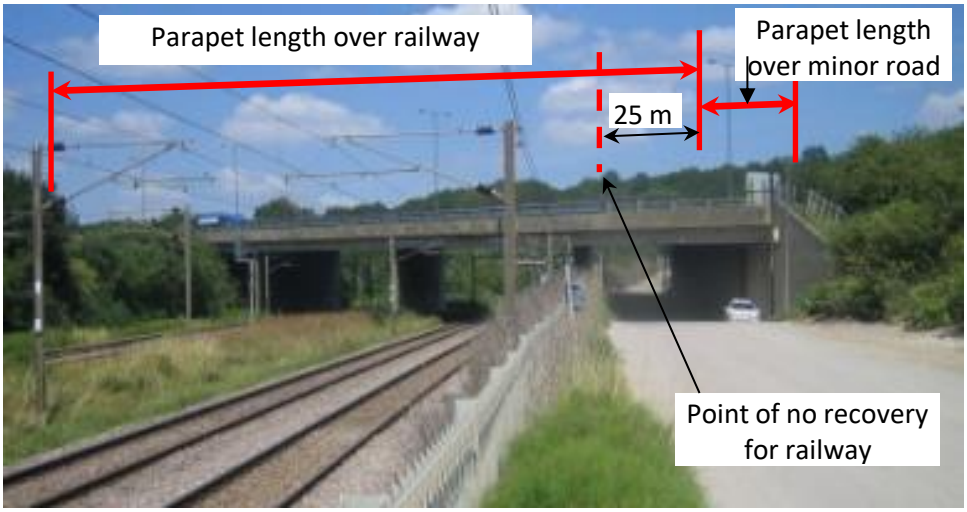


Figure 8-34 Parapet, Earthworks and Road/Rail inputs on a Viaduct or other long structure



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.

Note that only hazards that are high risk, namely drops over 2 m, 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 and include the background to decisions made in respect of provision in the hazard 'Comment' field.

8.10.6 **Note about how the RRRAP calculates Parapet risk**

In the calculation process, the RRRAP 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' 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 page (refer to Section 8.3.3) which will identify whether a VRS is required. There may be a need to install a pedestrian restraint system to prevent falls over the vertical edge where a VRS is not required in order to achieve an acceptable level of risk.

8.10.7 **Parapet Working Width**

Designers should check and specify the greatest working width that meets the requirements of CD 377 which may be greater than the default of W2 that the RRRAP returns. Note that parapets (and safety barriers) that have a low working width are likely to be more costly than those with a high working width and potentially require modifications to the supporting structure to take the higher loads that might be realised with low working widths.

8.10.8 **Pedestrian Restraints**

Pedestrian Restraints may take the form of pedestrian parapets, pedestrian guardrails, or pedestrian protection e.g. 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. Designers should ensure that pedestrian restraints are sited such that they do not interfere with the action of an adjacent parapet or safety barrier. Reference should also be made to CD 377 section 8 regarding pedestrian guardrails.

8.10.9 **Structural Collision Loading and Collapse**

Designers should check the requirements of CS 453 'The assessment of highway bridge supports' and of BS EN 1991-1-7: 'National Annex to Eurocode 1: Actions on structures – Part 1-7: Accidental actions' 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 hazard 'Comment' field.

8.10.10 **Example layout and corresponding inputs for Earthworks, Parapet and Road and Rail**

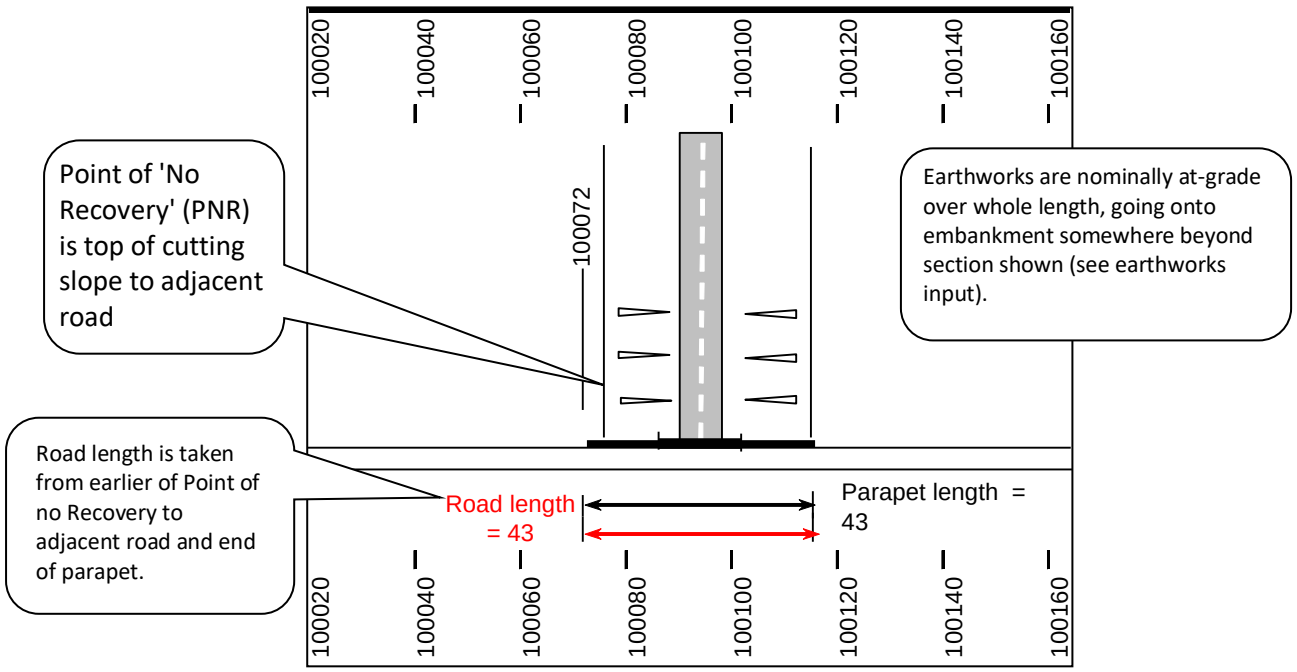


Figure 8-35 Adjacent Road crossing at-grade and or at around 90 degrees

600 Earthworks

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0001	Nominally at Grade	100000.0	1.5	0.1	0.0	0.0	296.0
		0600.0002	Falling at 50%	100296.0	1.5	0.1	-0.05	-50.0	22.0

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

1700 – 400 Structures - Parapets

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Structure Carries / Parapet protecting
		1700.0001	Parapet over vertical drop >2m (over road)	100072.0	43.0	0.25	1.75	Road Protected

Viewing the details of hazard 1700.0001 shows the Id of the road hazard protected:

Is Parapet/Structure to be Placed Contiguously with Barrier?	Yes

...

Structure Carries / Parapet Protecting	Road Protected
Protected ID	8200.0001

Check that these match

8200 OH's - Roads

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Offset of hazard from PSB (End of Hazard)
		8200.0001	Adjacent Road Single	100072.0	43.0	50.0	1.75	1.75

Note that a copy of the output from this and the following examples relating to Figure 8-35, Figure 8-36, Figure 8-37, and Figure 8-38 are shown at the end of this section in Figure 8-39 and Figure 8-40.

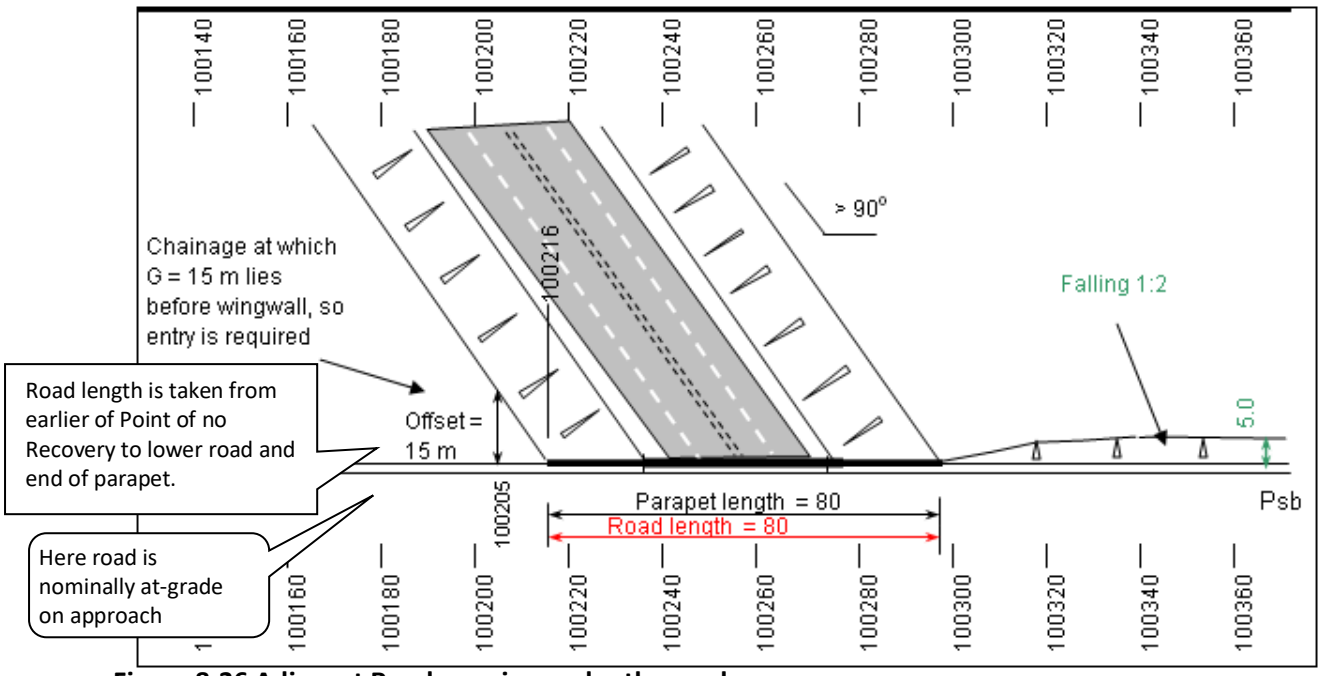


Figure 8-36 Adjacent Road crossing under the road

600 Earthworks

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0001	Nominally at Grade	100000.0	1.5	0.1	0.0	0.0	296.0
		0600.0002	Falling at 50%	100296.0	1.5	0.1	-0.05	-50.0	22.0
		0600.0003	Falling at 50%	100318.0	1.5	3.0	-1.5	-50.0	20.0
		0600.0004	Falling at 50%	100338.0	1.5	4.6	-2.3	-50.0	2.0
		0600.0005	Falling at 50%	100340.0	1.5	5.0	-2.5	-50.0	940.0

Here the start of section that is falling is picked up

1700 – 400 Structures - Parapets

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Structure Carries / Parapet protecting
		1700.0002	Parapet over vertical drop >2m (over road)	100216.0	80.0	0.25	1.75	Road Protected

Viewing the details of hazard 1700.0002 shows the Id of the road hazard protected:

?	Is Parapet/Structure to be Placed Contiguously with Barrier?	Yes

...

?	Structure Carries / Parapet Protecting	Road Protected
?	Protected ID	8200.0003

Check that these match

8200 OH's - Roads

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Offset of hazard from PSB (End of Hazard)
		8200.0001	Adjacent Road Single	100072.0	43.0	50.0	1.75	1.75
		8200.0002	Adjacent Road D3M	100205.0	11.0	50.0	1.75	1.75
		8200.0003	Adjacent Road D2M	100216.0	80.0	50.0	1.7	1.75

Refer to Adj Road help on page for details of how measurements are determined.

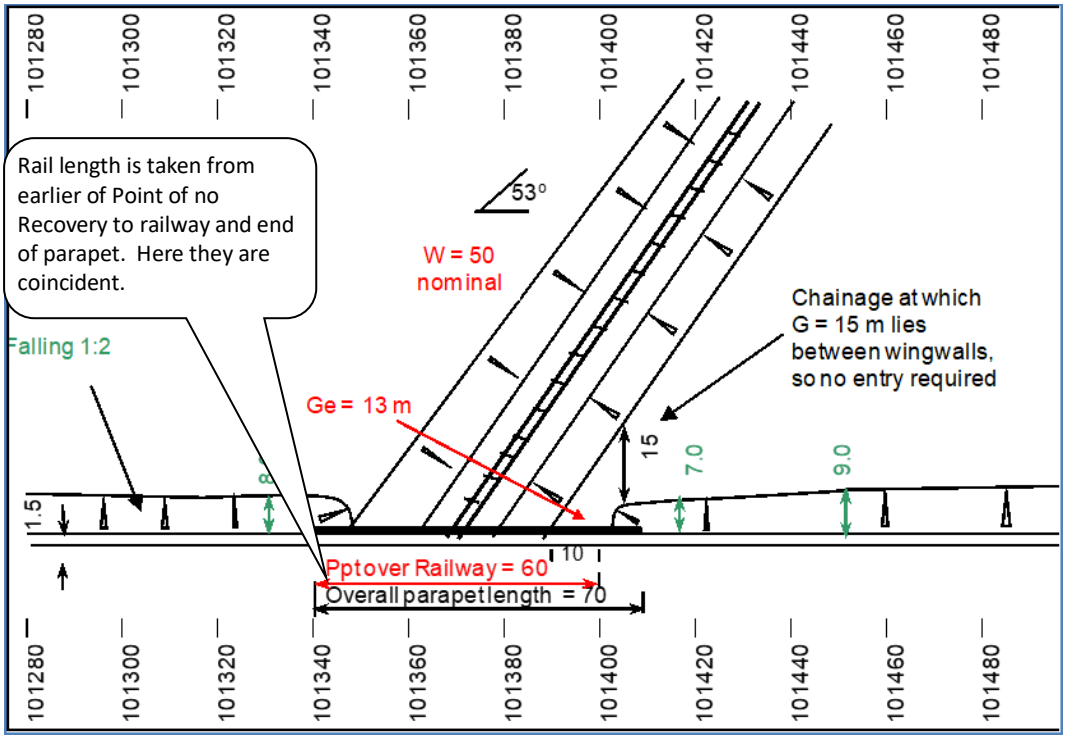


Figure 8-37 Adjacent Railway crossing under Road

600 Earthworks

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0006	Falling at 50%	101280.0	1.5	7.0	-3.5	-50.0	40.0
		0600.0007	Falling at 50%	101320.0	1.5	8.0	-4.0	-50.0	90.0
		0600.0008	Falling at 50%	101410.0	1.5	6.0	-3.0	-50.0	10.0
		0600.0009	Falling at 50%	101420.0	1.5	7.0	-3.5	-50.0	30.0
		0600.0010	Falling at 50%	101450.0	1.5	9.0	-4.5	-50.0	268.0
		0600.0011	Falling at 50%	101718.0	1.5	9.0	-4.5	-50.0	208.0

1700 – 400 Structures - Parapets

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Structure Carries / Parapet protecting
		1700.0003	Parapet over vertical drop >2m (over railway)	101340.0	60.0	0.25	1.75	Railway Protected
		1700.0004	Parapet over vertical drop >2m	101400.0	10.0	0.25	1.75	Substantially open land Protected

?	Is Parapet/Structure to be Placed Contiguously with Barrier?	Yes

Parapet protects railway

8100 OH's - Railways

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Offset of hazard from PSB (End of Hazard)
		8100.0001	Railway	101340.0	70.0	50.0	1.75	1.75

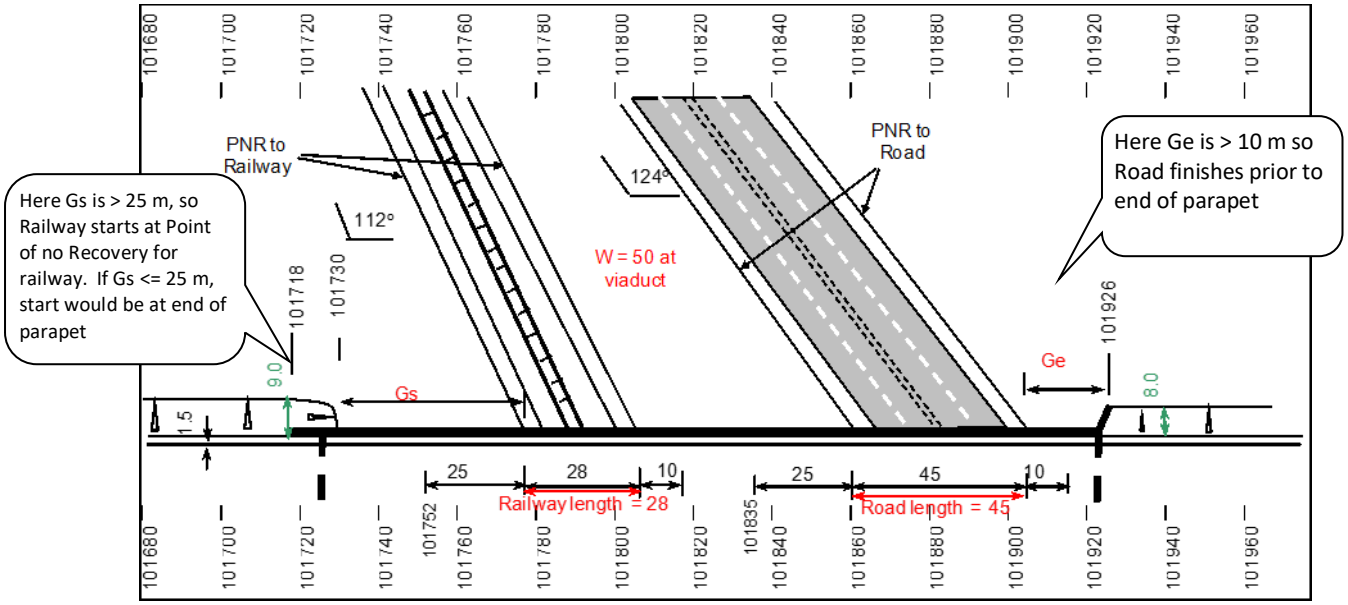


Figure 8-38 Adjacent Railway and Road crossing under Viaduct

600 Earthworks

		Id number	Earthworks profile	Start chainage of profile	Offset of hazard from PSB	Width of slope	Overall Height slope	Ave gradient of Slope %	Length of profile
		0600.0010	Falling at 50%	101450.0	1.5	9.0	-4.5	-50.0	268.0
		0600.0011	Falling at 50%	101718.0	1.5	9.0	-4.5	-50.0	208.0
		0600.0012	Falling at 50%	101926.0	1.5	8.0	-4.0	-50.0	34.0
		0600.0013	Falling at 50%	101960.0	1.5	8.0	-4.0	-50.0	End Earthwork for section

1700 – 400 Structures – Parapets

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

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Structure Carries / Parapet protecting
		1700.0005	Parapet over vertical drop >2m	101718.0	208.0	0.25	1.75	Substantially open land Protected
		1700.0006	Parapet over vertical drop >2m (over railway)	101752.0	63.0	0.25	2.75	Railway Protected
		1700.0007	Parapet over vertical drop >2m (over road)	101835.0	80.0	0.25	1.75	Road Protected

8100 OH's - Railways

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Offset of hazard from PSB (End of Hazard)
		8100.0002	Railway	101777.0	28.0	50.0	2.75	2.75

Parapet protects railway / road

8200 OH's - Roads

		Id number	Nature of hazard	Start chainage	Length of hazard	Width of hazard	Offset of hazard from PSB	Offset of hazard from PSB (End of Hazard)
		8200.0004	Adjacent Road D2AP	101860.0	45.0	50.0	1.75	1.75

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containm		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	100000.0	100296.0	1.5	Yes						N/A
☐	i	8200.0001	Adjacent Road Single	100072.0	100115.0	1.75 / 1.75	No	Acceptable	40		W2	N2	N/A
☐	i	1700.0001	Parapet over vertical drop >2m (over road)	100072.0	100115.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	8200.0002	Adjacent Road D3M	100205.0	100216.0	1.75 / 1.75	No	Acceptable	46		W2	N2	N/A
☐	i	8200.0003	Adjacent Road D2M	100216.0	100296.0	1.75 / 1.75	No	Acceptable	39		W2	N2	N/A
☐	i	1700.0002	Parapet over vertical drop >2m (over road)	100216.0	100296.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	0600.0002	Falling at 50%	100296.0	100318.0	1.5	Yes						N/A
☐	i	0600.0003	Falling at 50%	100318.0	100338.0	1.5	Yes						N/A
☐	i	0600.0004	Falling at 50%	100338.0	100340.0	1.5	Yes						N/A
☐	i	0600.0005	Falling at 50%	100340.0	101280.0	1.5	No	Acceptable	43		W2	N2	N/A
☐	i	0600.0006	Falling at 50%	101280.0	101320.0	1.5	No	Acceptable	43		W2	N2	N/A
☐	i	0600.0007	Falling at 50%	101320.0	101410.0	1.5	No	Acceptable	42		W2	N2	N/A
☐	i	8100.0001	Railway	101340.0	101410.0	1.75 / 1.75	No	Acceptable	39		W2	N2	N/A
☐	i	1700.0003	Parapet over vertical drop >2m (over railway)	101340.0	101400.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	1700.0004	Parapet over vertical drop >2m	101400.0	101410.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	0600.0008	Falling at 50%	101410.0	101420.0	1.5	No	Acceptable	42		W2	N2	N/A
☐	i	0600.0009	Falling at 50%	101420.0	101450.0	1.5	No	Acceptable	43		W2	N2	N/A
☐	i	0600.0010	Falling at 50%	101450.0	101718.0	1.5	No	Acceptable	42		W2	N2	N/A
☐	i	0600.0011	Falling at 50%	101718.0	101926.0	1.5	No	Acceptable	42		W2	N2	N/A
☐	i	1700.0005	Parapet over vertical drop >2m	101718.0	101926.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	1700.0006	Parapet over vertical drop >2m (over railway)	101752.0	101815.0	2.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	8100.0002	Railway	101777.0	101805.0	2.75 / 2.75	No	Acceptable	42		W2	N2	N/A
☐	i	1700.0007	Parapet over vertical drop >2m (over road)	101835.0	101915.0	1.75	N/A	N/A	N/A	N/A	N/A	N/A	H2
☐	i	8200.0004	Adjacent Road D2AP	101860.0	101905.0	1.75 / 1.75	No	Acceptable	49		W2	N2	N/A
☐	i	0600.0012	Falling at 50%	101926.0	101960.0	1.5	No	Acceptable	43		W2	N2	N/A

The length beyond only populates if there is 2-way flow on the road under consideration e.g. for single carriageways

Requirements for single c'way situation in Figure 8-35

Requirements for D2M situation in Figure 8-36

Approach and departure embankment requires VRS.

Requirements for single track railway situation in Figure 8-37. But see CD 377 requirements.

Approach embankment requires VRS.

Requirements on viaduct and for single track railway and dual carriageway road situation in Figure 8-38. But see CD 377 requirements relating to railways.

Departure embankment requires VRS.

Requirements for road and railway approaches and parapet containment depend on input factors (not shown here) relating to likelihood of reaching, flow speeds and rates on the road and railway, as well as the AADT and % LGV and MGV road type, etc on the road being considered.

Figure 8-39 Extract from Collation of Data relating to the situations shown in the previous examples

Road Restraint Risk Assessment Process (RRRAP) VRS Summary

Id	Nature of Hazard	Start chainage	End chainage	Offset from Psb at start	Min Length VRS in advance (m)	Min Length VRS beyond (m)	Containment Level	VRS working width class	Parapet Containment	VRS working width (m)	Set-back of VRS from PSb	Relaxation / Departure required?
8200.0001	Adjacent Road Single	100072.0	100115.0	1.75	40.0		N2	W2		0.8	0.6	None
1700.0001	Parapet over vertical drop >2m (over road)	100072.0	100115.0	1.75					H2		1.75	
8200.0002	Adjacent Road D3M	100205.0	100216.0	1.75	46.0		N2	W2		0.8	0.6	None
8200.0003	Adjacent Road D2M	100216.0	100296.0	1.75	39.0		N2	W2		0.8	0.6	None
1700.0002	Parapet over vertical drop >2m (over road)	100216.0	100296.0	1.75					H2		1.75	
0600.0005	Falling at 50%	100340.0	101280.0	1.5	43.0		N2	W2		0.8	0.6	None
0600.0006	Falling at 50%	101280.0	101320.0	1.5	43.0		N2	W2		0.8	0.6	None
0600.0007	Falling at 50%	101320.0	101410.0	1.5	42.0		N2	W2		0.8	0.6	None
8100.0001	Railway	101340.0	101410.0	1.75	39.0		N2	W2		0.8	0.6	None
1700.0003	Parapet over vertical drop >2m (over railway)	101340.0	101400.0	1.75					H2		1.75	
1700.0004	Parapet over vertical drop >2m	101400.0	101410.0	1.75					H2		1.75	
0600.0008	Falling at 50%	101410.0	101420.0	1.5	42.0		N2	W2		0.8	0.6	None
0600.0009	Falling at 50%	101420.0	101450.0	1.5	43.0		N2	W2		0.8	0.6	None
0600.0010	Falling at 50%	101450.0	101718.0	1.5	42.0		N2	W2		0.8	0.6	None
0600.0011	Falling at 50%	101718.0	101926.0	1.5	42.0		N2	W2		0.8	0.6	None
1700.0005	Parapet over vertical drop >2m	101718.0	101926.0	1.75					H2		1.75	
1700.0006	Parapet over vertical drop >2m (over railway)	101752.0	101815.0	2.75					H2		2.75	
8100.0002	Railway	101777.0	101805.0	2.75	42.0		N2	W2		0.8	1.2	None
1700.0007	Parapet over vertical drop >2m (over road)	101835.0	101915.0	1.75					H2		1.75	
8200.0004	Adjacent Road D2AP	101860.0	101905.0	1.75	49.0		N2	W2		0.8	0.6	None
0600.0012	Falling at 50%	101926.0	101926.0	1.5	43		N2	W2		0.8	0.6	None

Figure 8-40 Extract from VRS Summary relating to the situations shown in the previous examples

8.11 2500 Special Structures

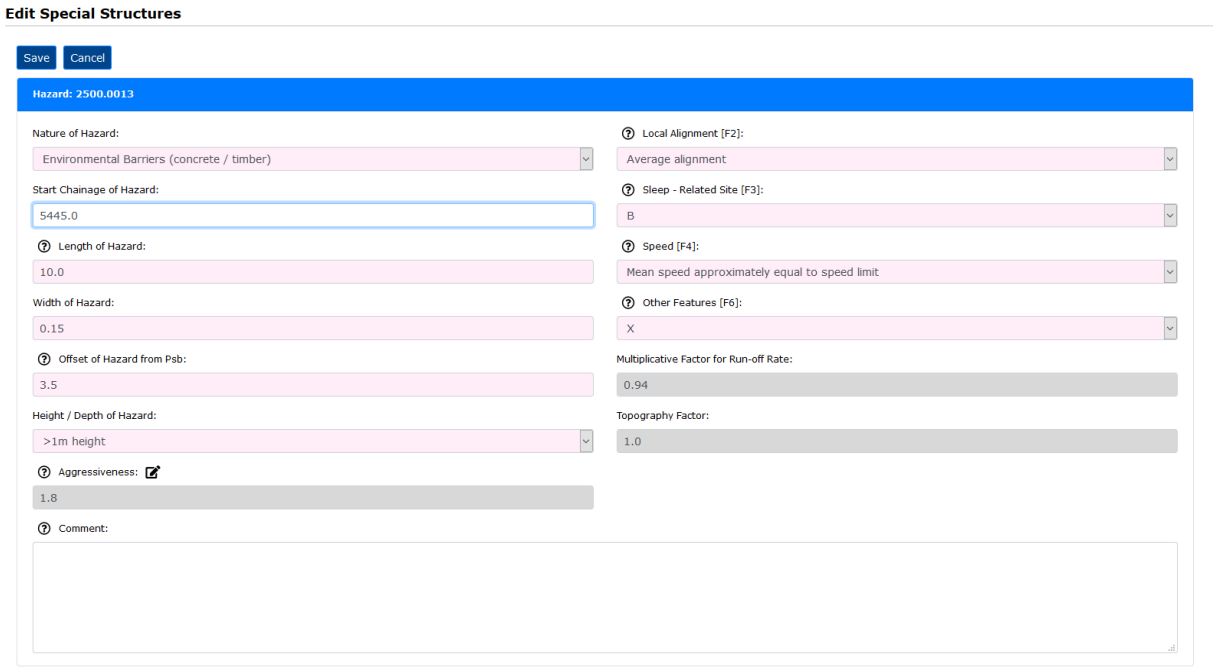
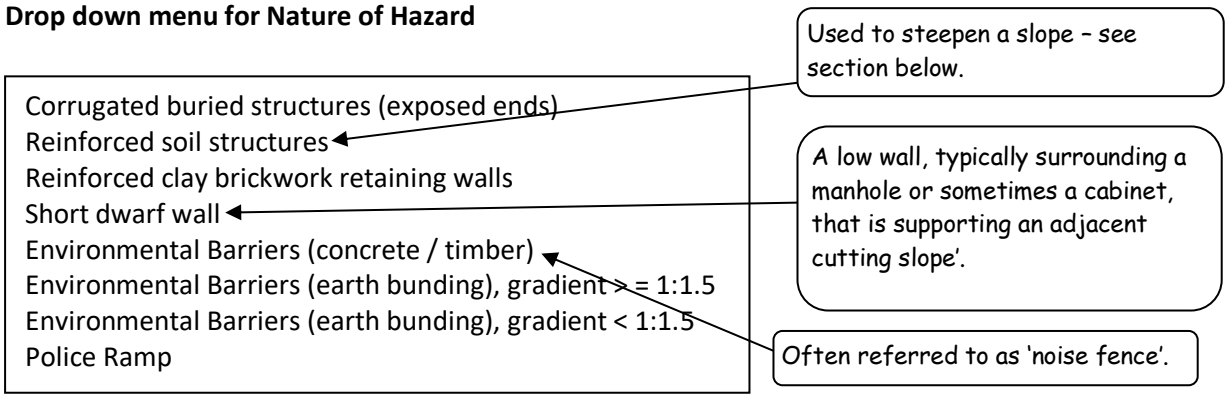


Figure 8-41 Special Structures data entry

Drop down menu for Nature of Hazard



8.11.1 **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' page. The overall width and height of the slope are entered in the normal way. There is no entry of a hazard in the 2500 Special Structures page.

(ii) If the reinforcing is only over a relatively short length, say 50 m, e.g. where the cutting or embankment is locally steepened due to land-take difficulties, it may be easiest to assume the earthworks continue 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' page, and then to add the details for the strengthened length into the '2500 Special Structures' section.

Figure 8-42 illustrates the situation.

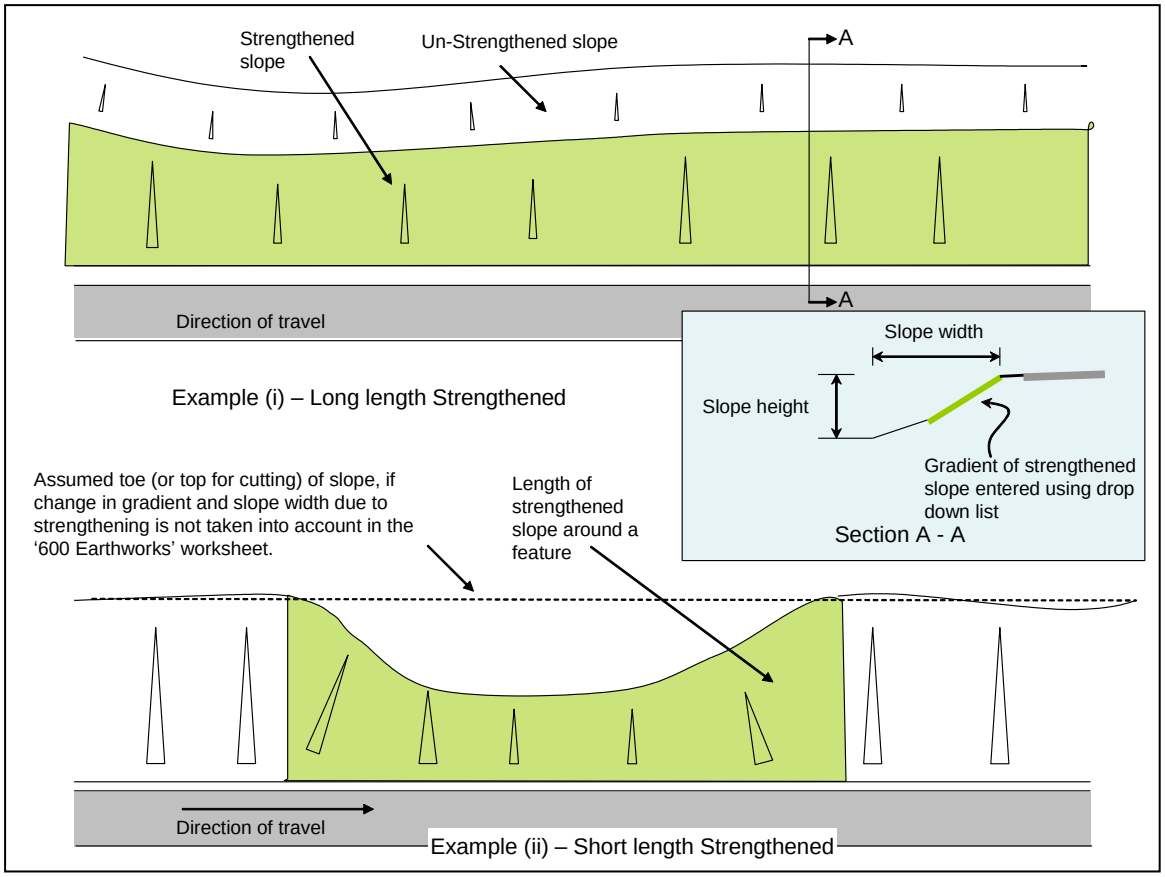


Figure 8-42 Strengthened Slopes

8.11.2 Police Access Ramps

Police access ramps are included in the nature of hazard drop down. This is because the Police require VRS, but the variety of configurations of police access ramps makes it difficult to be specific on the length of need in advance of the hazard.

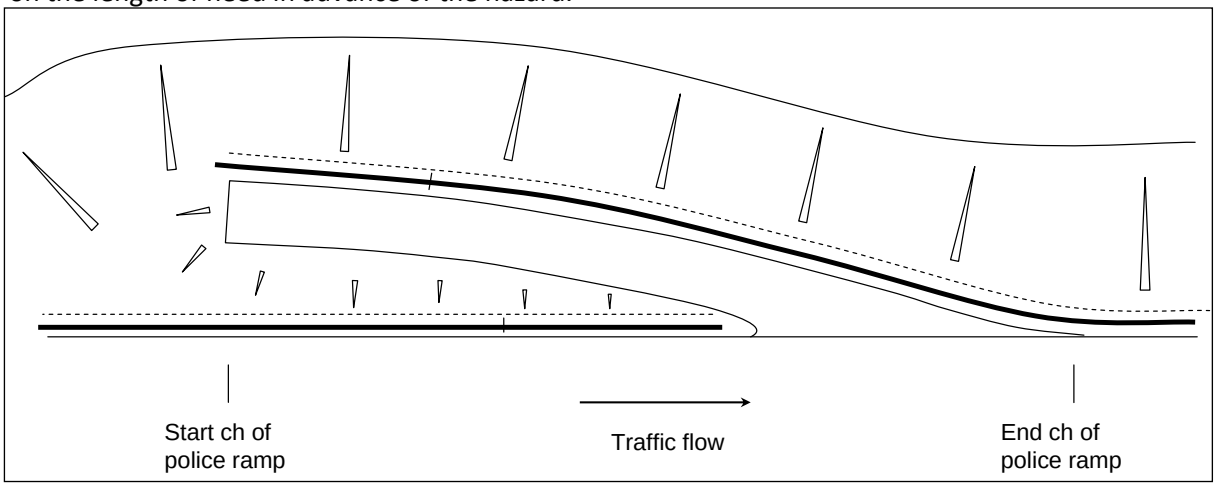


Figure 8-43 Police Access Ramps

The RRRAP does not quantify the risk; it flags the presence of the ramp, that the level of risk without VRS is unacceptable and, under the heading of "Level of risk with optimum length VRS", it refers the

user to the Guidance Manual. N2 containment VRS is indicated in the 'Collation & Reports' and 'VRS Summary' pages. Very often there is a need to link VRS provision for the ramp with adjacent lengths that are required to protect other hazards. Figure 8-43 illustrates a typical layout.

8.11.3 **Environmental Barrier**

It is assumed that Environmental Barriers will be installed either on 'Nominally At-Grade' ground or at the top of an embankment or cutting slope, rather than at the bottom or part way down an embankment (their noise attenuating effectiveness will be greatly reduced in these latter locations).

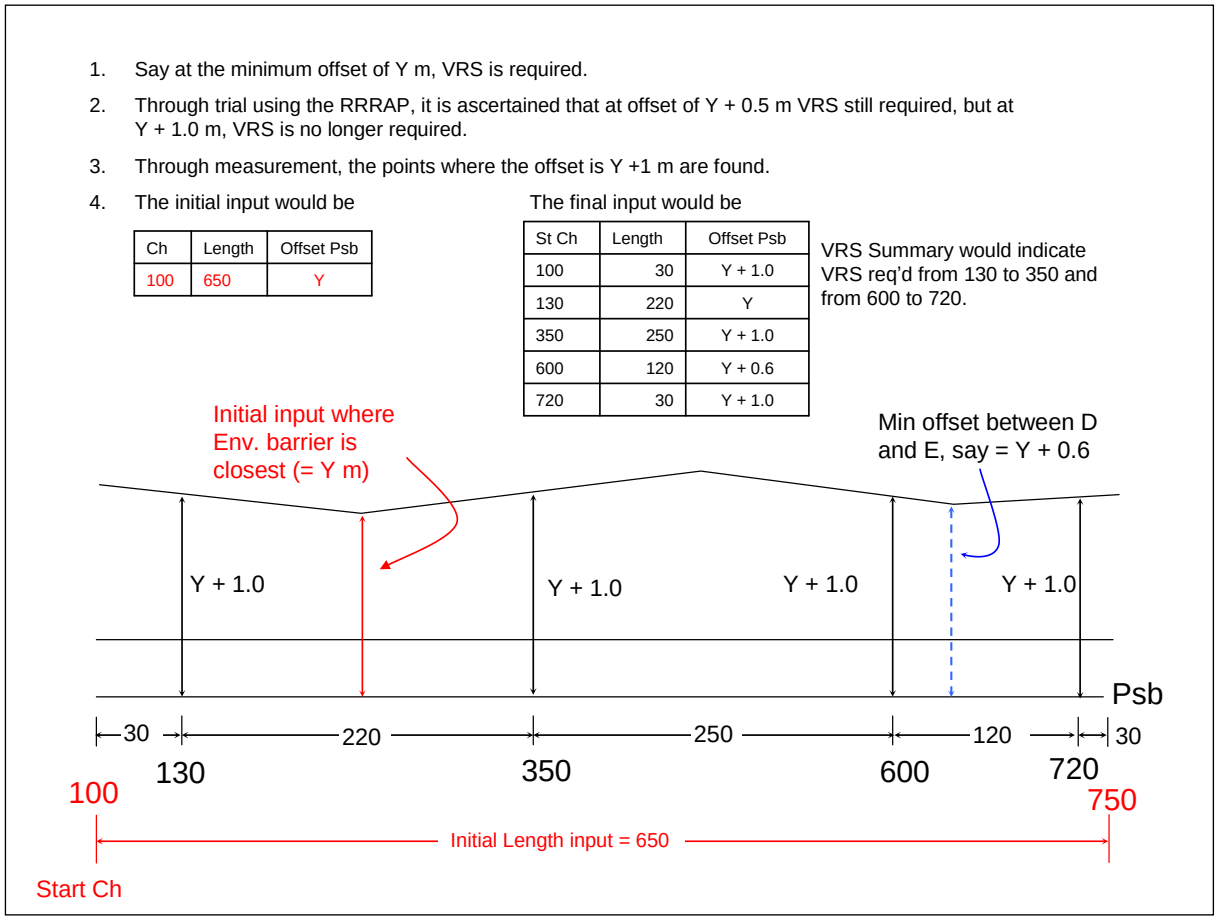


Figure 8-44 Environmental Barrier example

Data entry requires the start chainage, length, width and one offset value for an Environmental Barrier. It is therefore necessary to initially record the closest offset to Psb and to see, for this offset, whether VRS is required. If it is not required at this offset, then it will not be required at greater offsets. If it is required, then further points should be entered, say at 0.5 m offset increments and the RRRAP risk calculation re-run to ascertain the offset at which at which VRS is no longer required. Using this information, the corresponding chainages can be ascertained. Entries should then be put into the RRRAP for the start chainage and length of each section that does not require and that does require VRS, as indicated in Figure 8-44.

8.12 Poles or Pylons

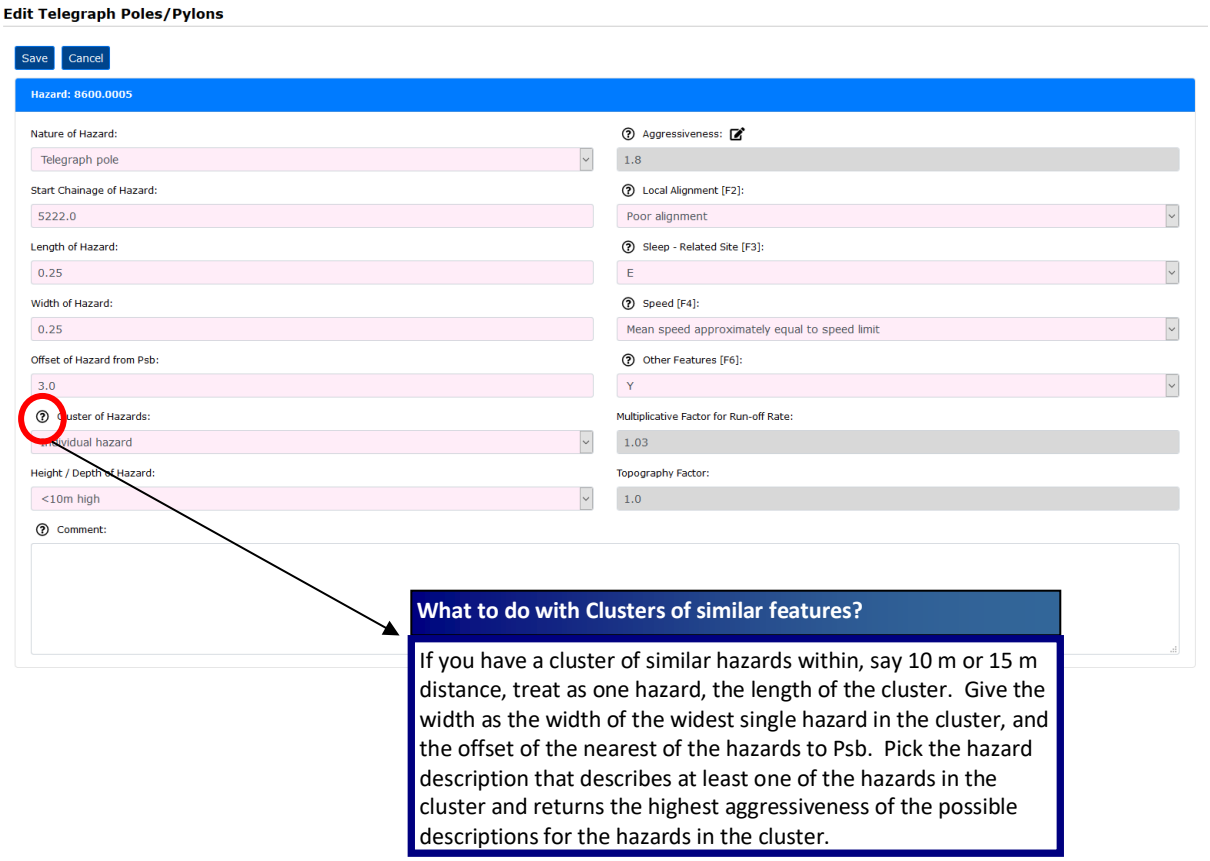


Figure 8-45 Telegraph Poles / Pylons data entry

Drop down menu for Nature of Hazard

Electricity station
Gas substation
Telegraph pole
Pylon
Electricity pole
Post e.g. TrafficMaster
Post e.g. TrafficMaster (Passively Safe)

For guidance on passively safe signs, see section 8.6.2.

8.12.1 Utility Poles

Utility poles may or may not have supporting 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 may fail before the stay. If the ground anchor and connections hold, the pole may be either pulled directly toward the vehicle or the tensioned cable stay may slice through the vehicle, or there may 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 hazard 'Comment' field 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 hazard 'Comment' field to explain that the stay has a frangible connection.

The RRRAP does not take into account the effect of the overhead powerlines or other cables falling onto whatever is below them. The Designer should therefore consider all the circumstances and decide whether a safety barrier is warranted including where the RRRAP suggests that one may not be needed.

8.12.2 **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 or possibly H4a safety barrier is warranted. Details of the factors considered and the decision process should be entered in the hazard 'Comment' field.

8.13 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.

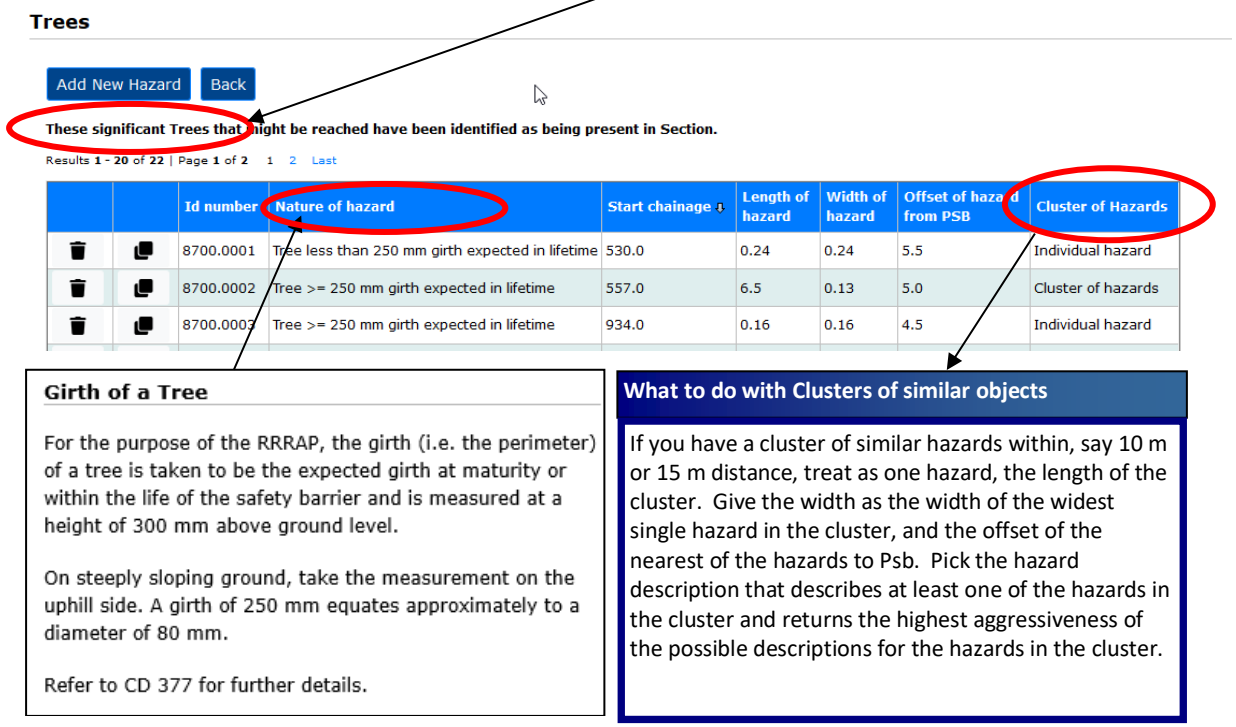


Figure 8-46 Trees details

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 the life of the 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).

8.14 Water

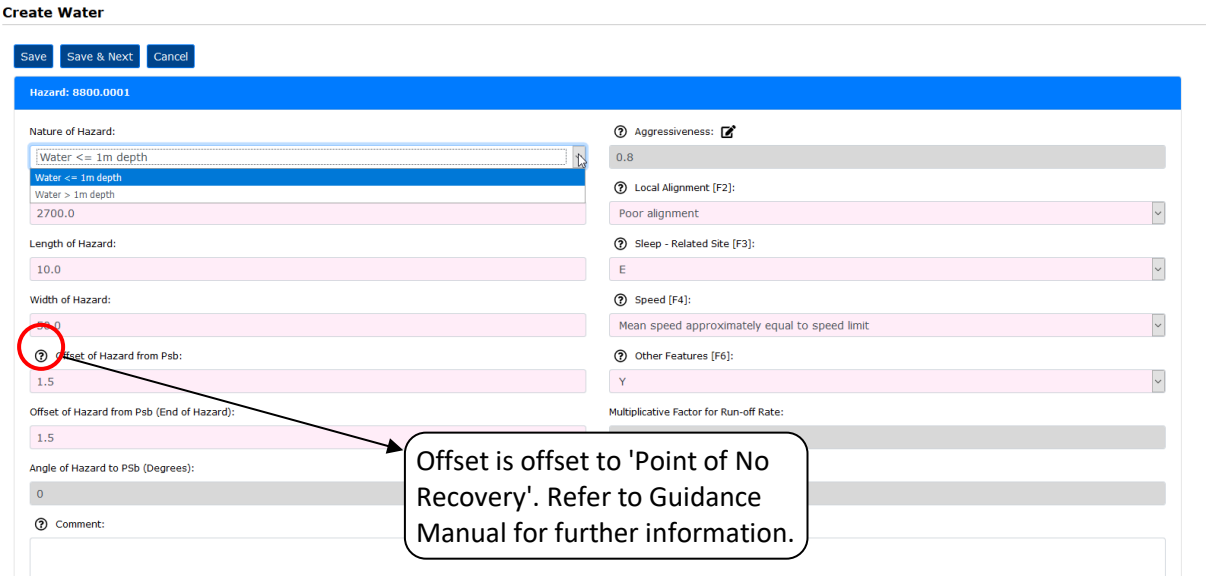


Figure 8-47 Water data entry

Include standing, running and tidal water hazards. Water hazards have been split into depth ranges (as indicated in Figure 8-47). 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.

8.14.1 Point of No Recovery for Adjacent Water situations

Point of No Recovery - Water

1. Where the road is on embankment or sidelong ground falling towards the body of water or there is a false cutting of height < 2.5 m prior to an embankment or sidelong ground that falls towards the body of water follow the 'Offset for Adjacent Road' and 'Point of No Recovery' helps for OH's Roads.
2. Where the road is nominally at grade, and the water hazard less than 15 m from 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).

Figure 8-48 Point of No Recovery for Adjacent Water situation

8.15 Other Hazards – Railways

'Other Hazards' or 'Other Parties', or just 'Others' are defined in the Terms and definitions section of CD 377 and cover situations where users on such as Railways and Roads could be injured by an errant vehicle. The RRRAP is used to make an assessment of the number of people as a group using the railway that might be injured by an errant vehicle or by a hazard hit by an errant vehicle on the road and hence the protection in the form of a vehicle restraint or parapet, its length of need and its containment level that is warranted to give an acceptable level of risk to both the vehicle occupants and the railway users.

Figure 8-49 Record data entry

The various factors input in this section relating to the railway combined with the factors relating to the road, its usage and characteristics entered into the RRRAP elsewhere are used to calculate the length of need and containment level of the VRS (safety barrier and or parapet) to protect the railway.

The various Railway specific help menus are shown on the next several pages.

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

8.15.1 Likelihood of reaching the hazard

The Designer must assess the circumstances and assess the likelihood of an errant vehicle reaching the hazard from the Point of No Recovery. Steeply sloping ground leading directly to the hazard will be easier to traverse than shallow sloping ground or a slope that is running at an angle to the hazard.

The following will reduce the likelihood of the hazard being reached but may not prevent it being reached.

- A ditch more than 1 m deep and 3 m wide.
- Heavy vegetation, e.g. trees greater than 500 mm girth at spacings less than 2 m, but be aware, especially on Network Rail property, trees may be cut to reduce incidence of leaves and branches on the line.
- Shallow gradient, with rough ground
- Bunds or uphill gradients especially when near to the adjacent railway, where vehicle speeds are likely to be reduced.

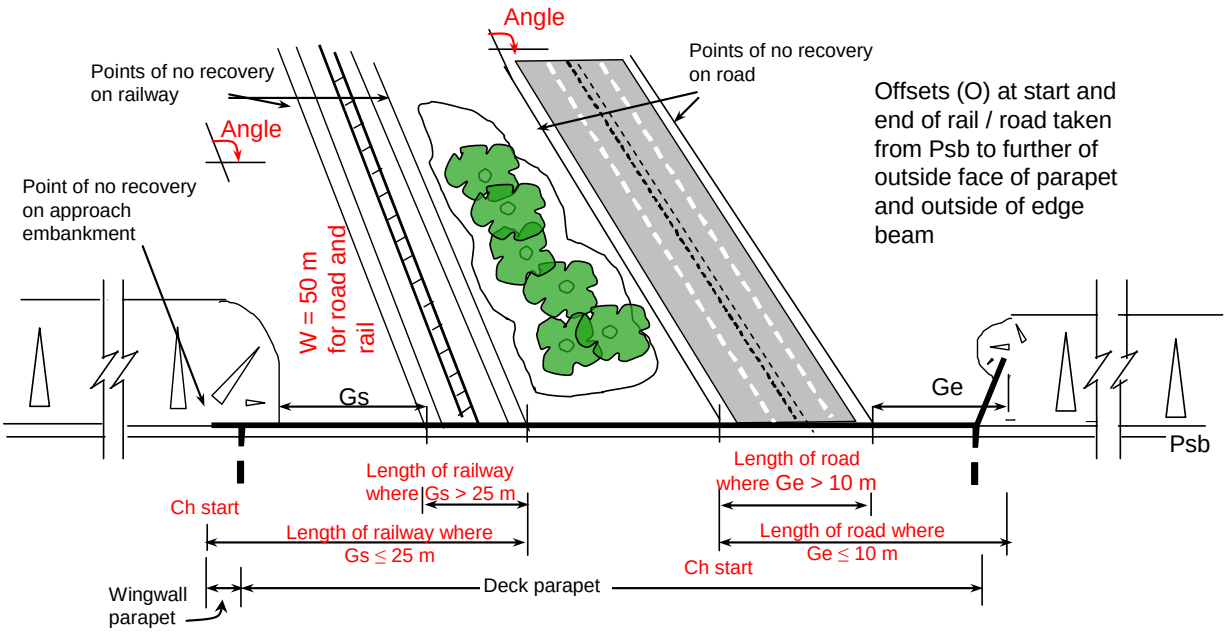
Likelihood of reaching?

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 parts of Figures Figure 8-51 & Figure 8-52 will make it more likely that the hazard will be reached than the situation in the inset diagrams 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'.

It is recommended that the sensitivity of the outcome to changes in the various factors is looked at and a note regarding this is made in the hazard 'Comment' field.

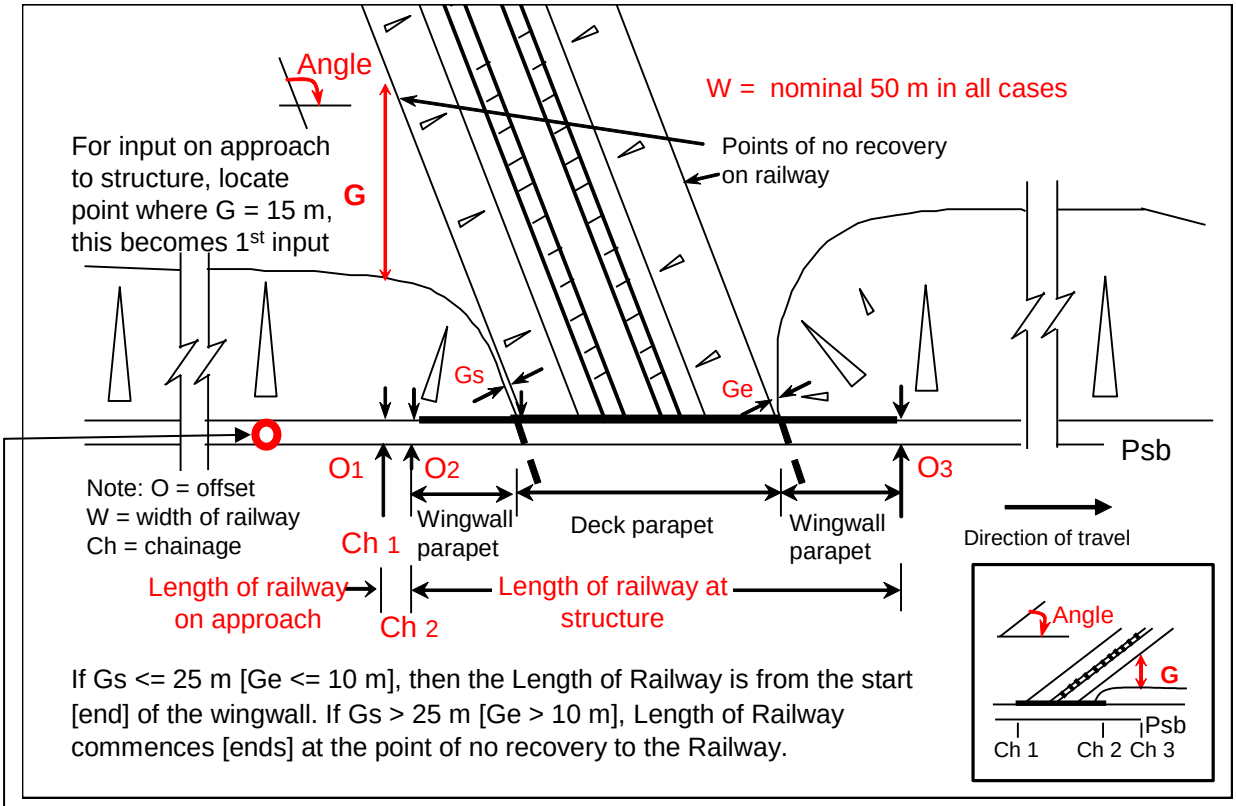
On the structure itself, the likelihood of reaching is 'Extremely likely'; on the approach to and departure from the structure the factor will change according to the factors outlined above. See also Figure 8-51.



In this example, if Gs ≤ 25 m then the Length of Railway is from the earlier of (i) the point of no recovery on approach embankment (ii) the start of the wingwall / deck [often (i) and (ii) are coincident]. If Gs > 25 m Length of Railway commences and ends at the point of no recovery to the Railway. If Ge ≤ 10 m, then Length of Road extends to later of (i) the point of no recovery on departure embankment and (ii) end of the wingwall / deck.

Figure 8-50 Viaduct with Railway and Road crossing under the Road

See also Section 8.10.5 of the Guidance for treatment and examples of inputs for long span structures such as viaducts that cross one or more hazards.



Verge may need to be widened locally to accommodate safety barrier on approaches to parapet. If so, ensure that 'H-S & Verge Widths' page reflects requirements.

Figure 8-51 Railway crossing under Road at structure with parallel wingwalls

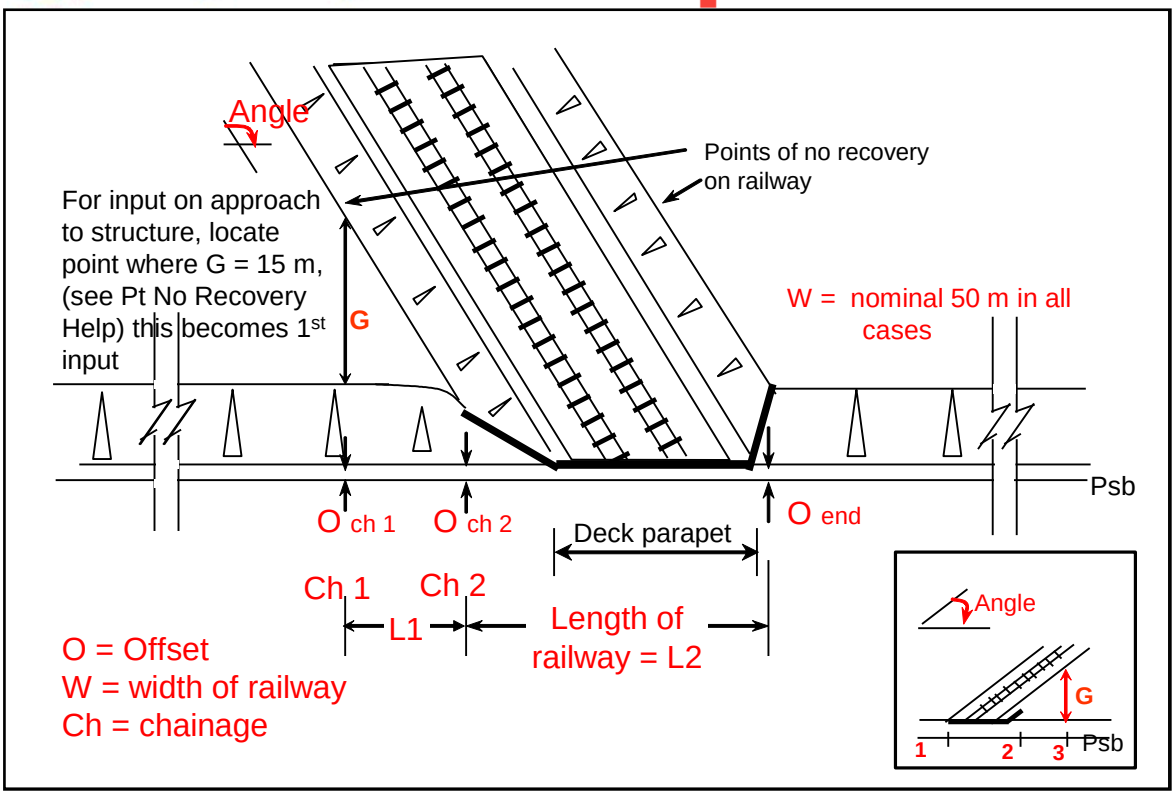


Figure 8-52 Railway crossing under Road at structure with splayed wingwalls

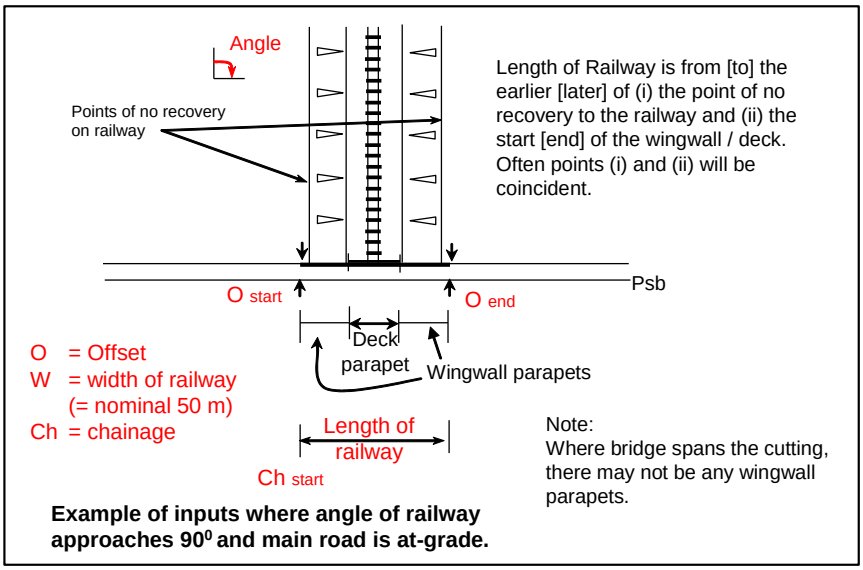
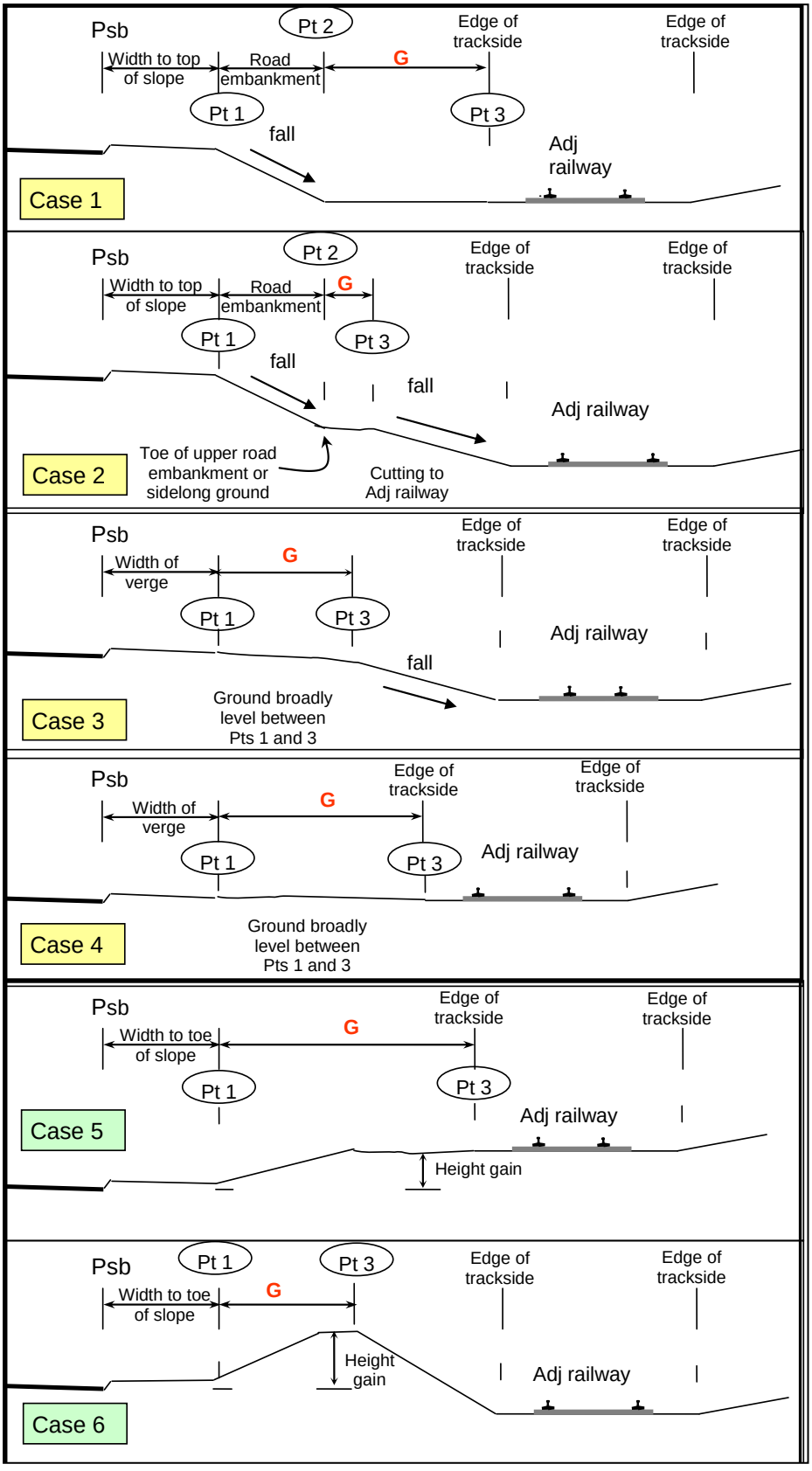


Figure 8-53 Railway crossing under Road where at-grade and or at 90 degrees



In cases 1 to 4 where G <= 15 m offset to railway becomes offset to Pt 1. (PNR = Pt 1).

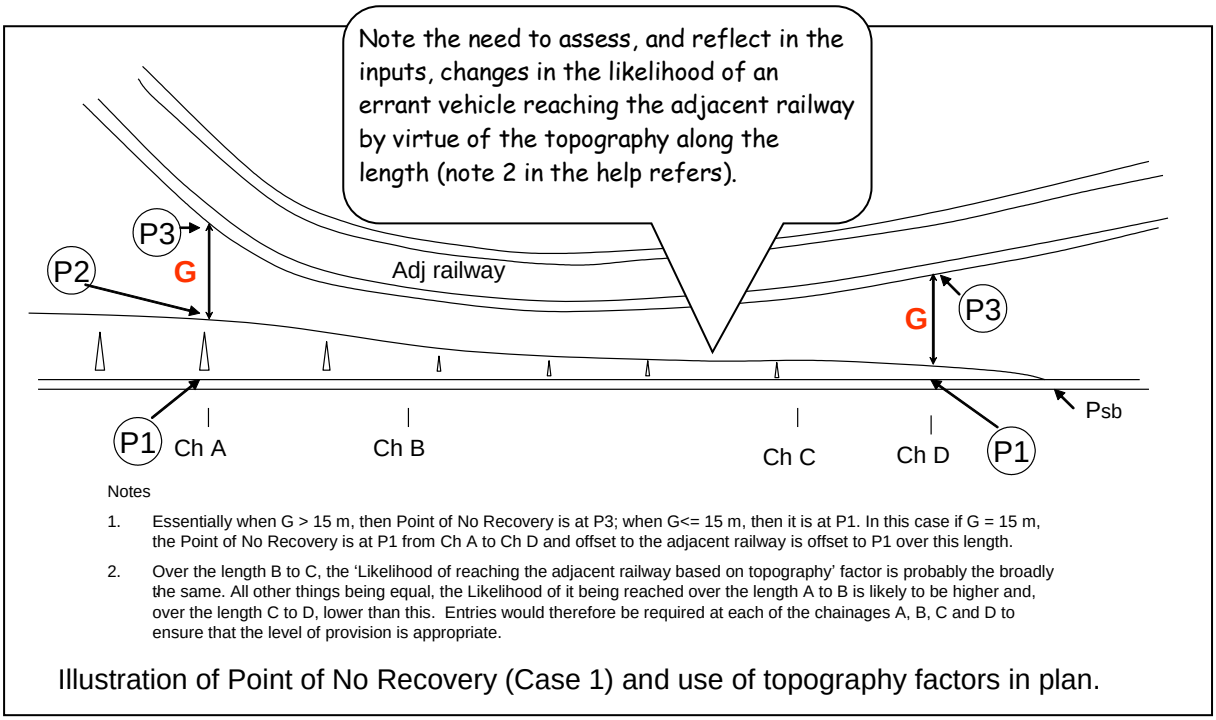
Where G> 15 m offset to railway becomes offset to Pt 3 (PNR = Pt 3).

PNR = Point of No Recovery

In cases 5 and 6 where G<= 15 m offset to railway (PNR) becomes closer of offset to P3, and
Pt 1 + 4x height gain.

Where height gain > 2.5 m and or G > 15 m no need to assess; add note in the hazard 'Comment' field to confirm this is the case.

Figure 8-54 Offset and Point of No Recovery for Adjacent Rail for Various Typical Scenarios



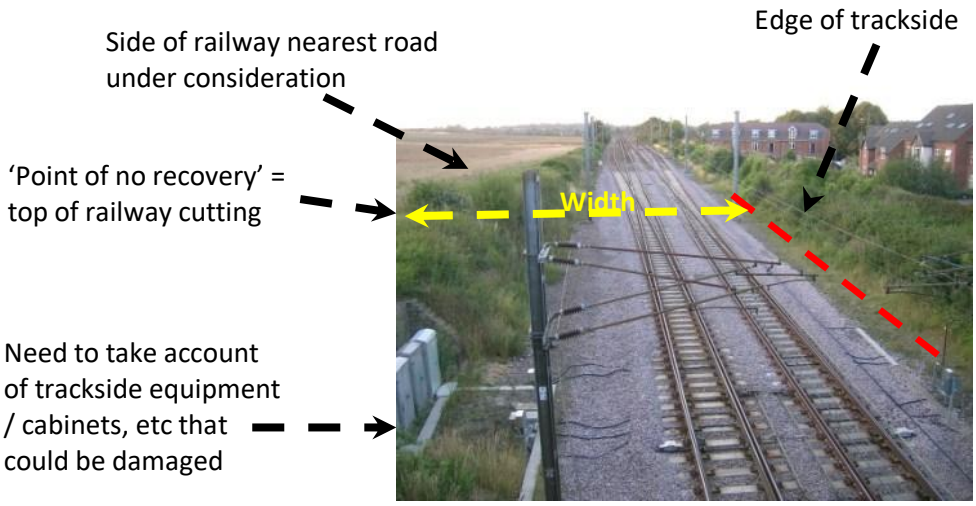
Notes

1. Essentially when G > 15 m, then Point of No Recovery is at P3; when G<= 15 m, then it is at P1. In this case if G = 15 m, the Point of No Recovery is at P1 from Ch A to Ch D and offset to the adjacent railway is offset to P1 over this length.
2. Over the length B to C, the 'Likelihood of reaching the adjacent railway based on topography' factor is probably the broadly the same. All other things being equal, the Likelihood of it being reached over the length A to B is likely to be higher and, over the length C to D, lower than this. Entries would therefore be required at each of the chainages A, B, C and D to ensure that the level of provision is appropriate.

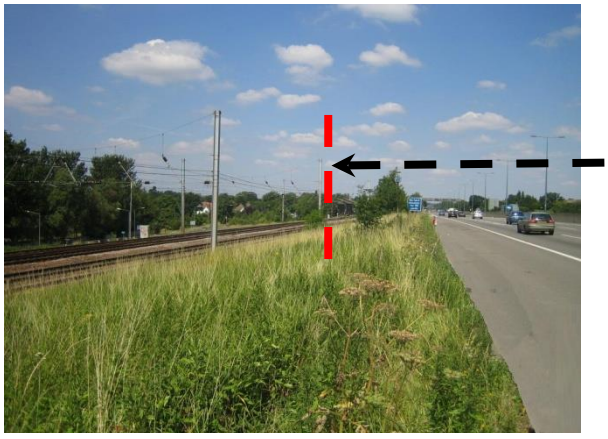
Illustration of Point of No Recovery (Case 1) and use of topography factors in plan.

Figure 8-55 Point of No Recovery for Parallel Road/ Rail situation

8.15.2 **Examples of 'Point of No Recovery'**

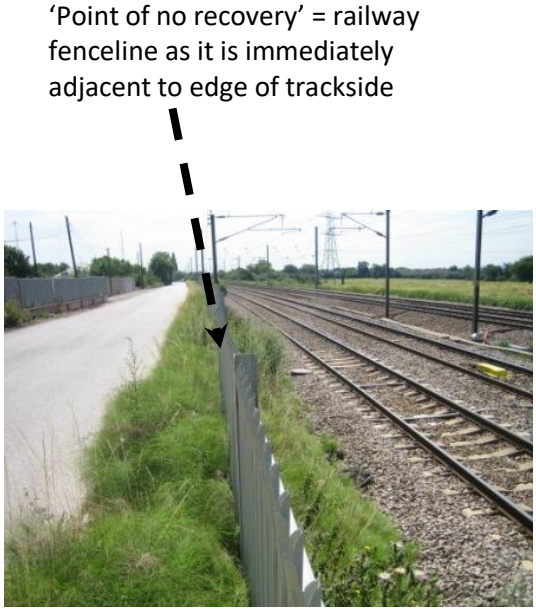


Example 1 – Railway in cutting



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

8.15.3 **CD 377 requirements and DfT assessments relating to Railways**

Where a structure takes the road over or adjacent to a railway, the Designer shall follow the requirements of CD 377 section 4 and use the output from the RRRAP as a guide only. Furthermore, the results of the assessments required under the DfT document "Managing the accidental obstruction of the railway by road vehicles", updated September 2020 and, where applicable for an existing parapet, CS 461 'Assessment and upgrading of in-service parapets' should be taken into account in determining VRS and parapet requirements and other mitigation measures.

8.15.4 **Additional note regarding parallel road / rail situations**

In Section 2 of this Guide, the way in which the RRRAP calculates requirements for VRS is outlined. At present the RRRAP cannot accurately determine the level of risk of a very long hazard, it only looks at the level of protection required to protect the leading edge of the hazard at each of the various points entered into RRRAP 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 to the hazards "Comment" field. 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.

8.15.5 **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' reports.

8.16 Other Hazards – Roads

The RRRAP is used to make an assessment of the number of people as a group using the adjacent road that might be injured by an errant vehicle or by a hazard hit by an errant vehicle from the road for which provision is being assessed. And hence the protection in the form of a vehicle restraint or parapet, its length of need and its containment level that is warranted to give an acceptable level of risk to both the vehicle occupants on the road being assessed and the adjacent road users.

The various factors input in this section relating to the adjacent road combined with the factors relating to the road being assessed, its usage and characteristics entered into the RRRAP elsewhere are used to calculate the length of need and containment level of the VRS (safety barrier and or parapet) to protect the adjacent road.

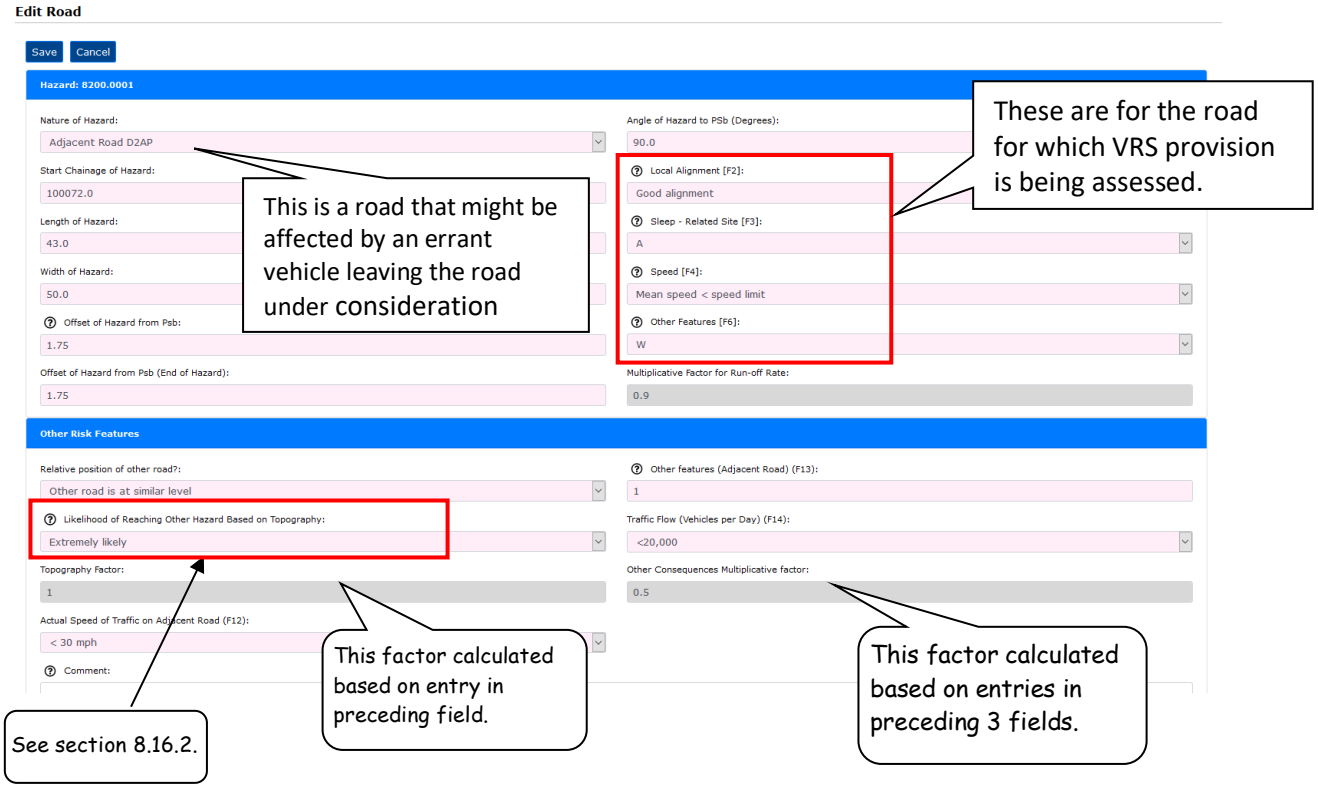


Figure 8-56 Road data entry

Drop down lists for Nature of Hazard

Adjacent Road D2M
Adjacent Road D3M
Adjacent Road D4M
Adjacent Road Smart Motorway (MM ALR or MM HSR)
Adjacent Road Motorway Slip
Adjacent Road Motorway Link
Adjacent Road D2AP
Adjacent Road D3AP
Adjacent Road Single

The various help menus available for Roads are shown on the following pages.

See also section 8.10 of the Guidance for treatment of long span structures such as viaducts that cross one or more hazards.

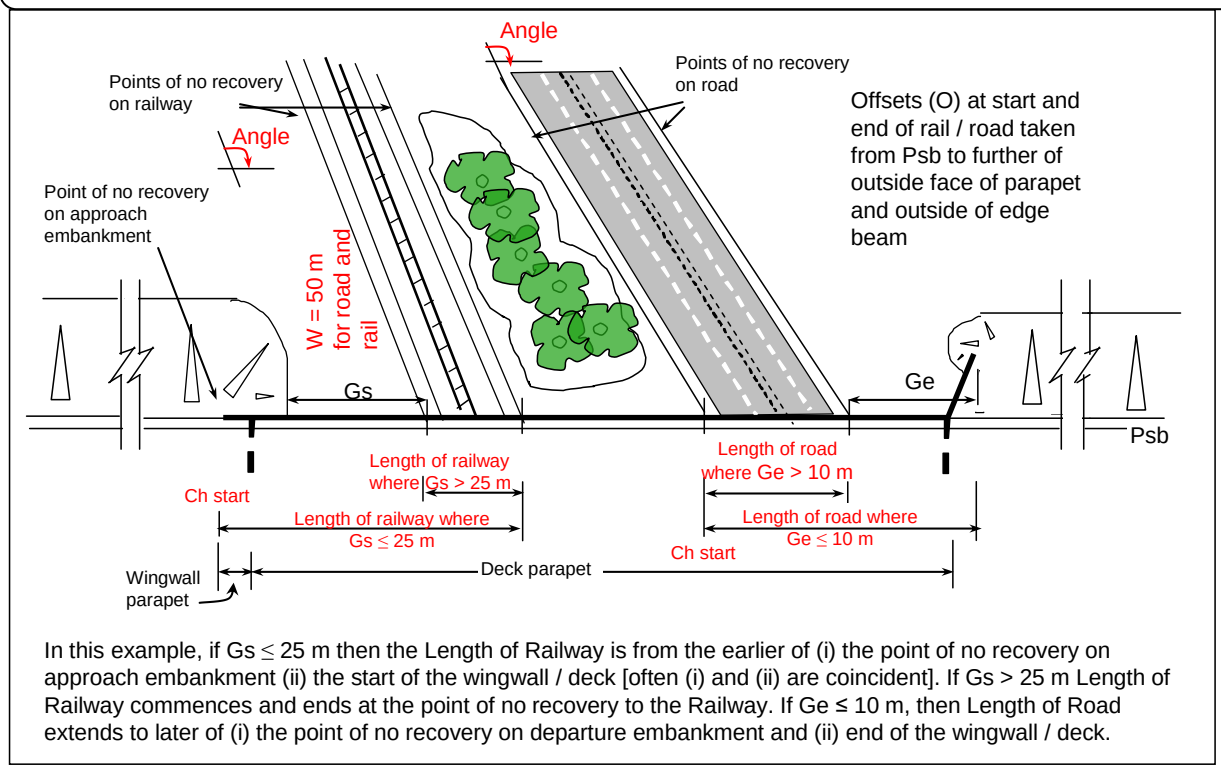
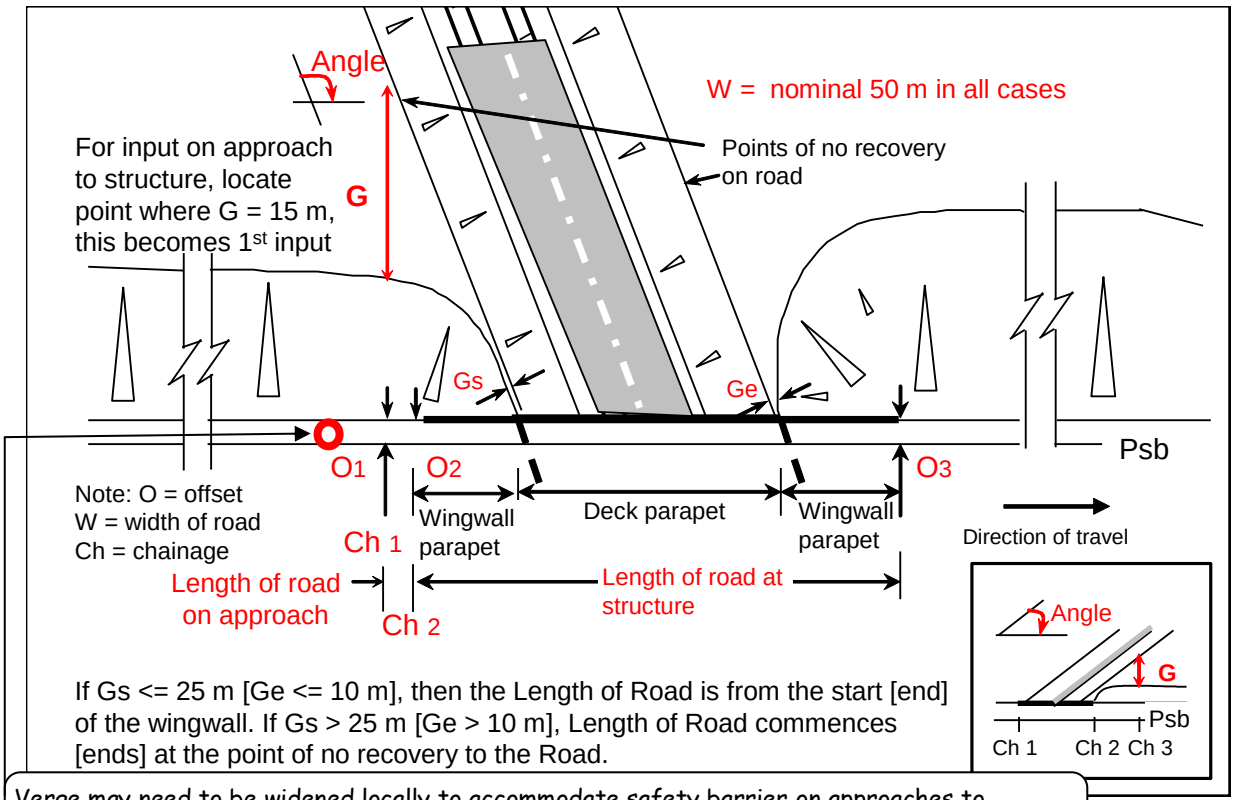


Figure 8-57 Viaduct with Road and Railway crossing under the Road



Verge may need to be widened locally to accommodate safety barrier on approaches to parapet. If so, ensure that 'H-S & Verge Widths' page reflects requirements.

Figure 8-58 Road crossing under Road at structure with parallel wingwalls

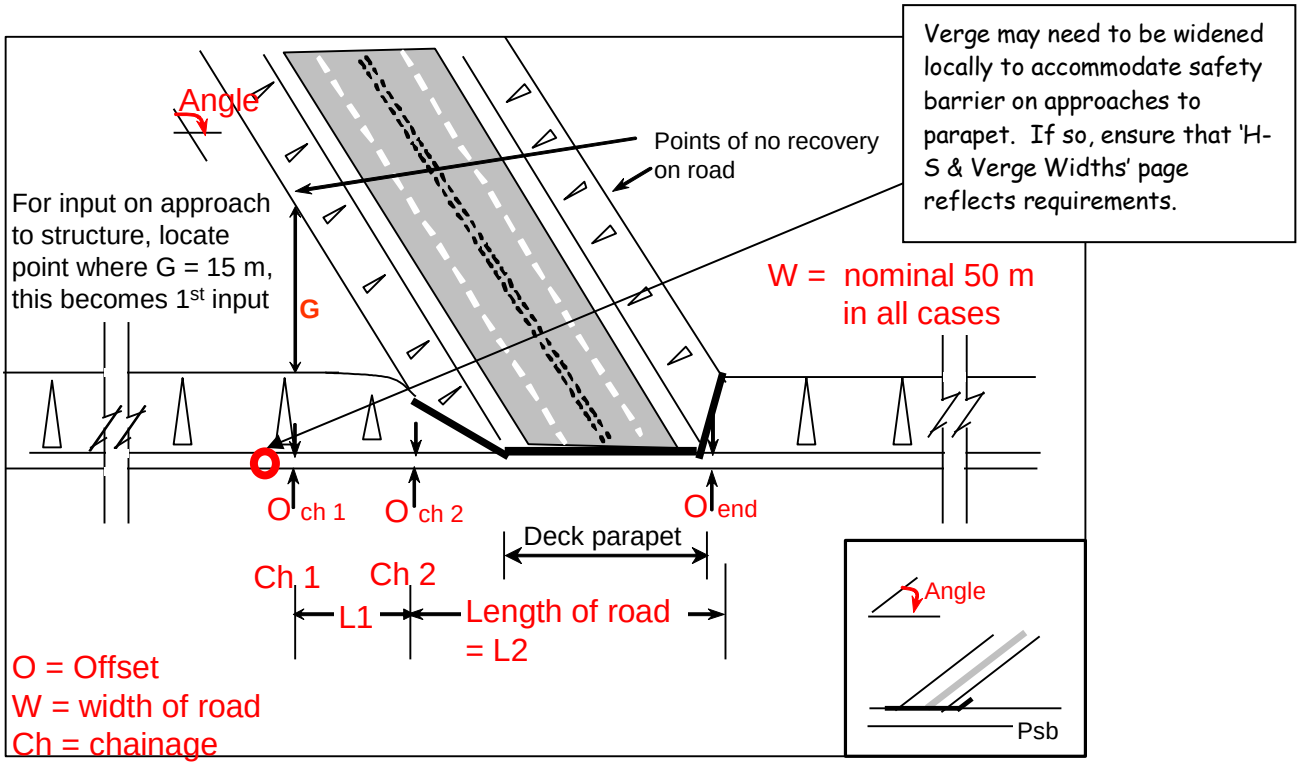


Figure 8-59 Road crossing under Road at structure with splayed wingwalls

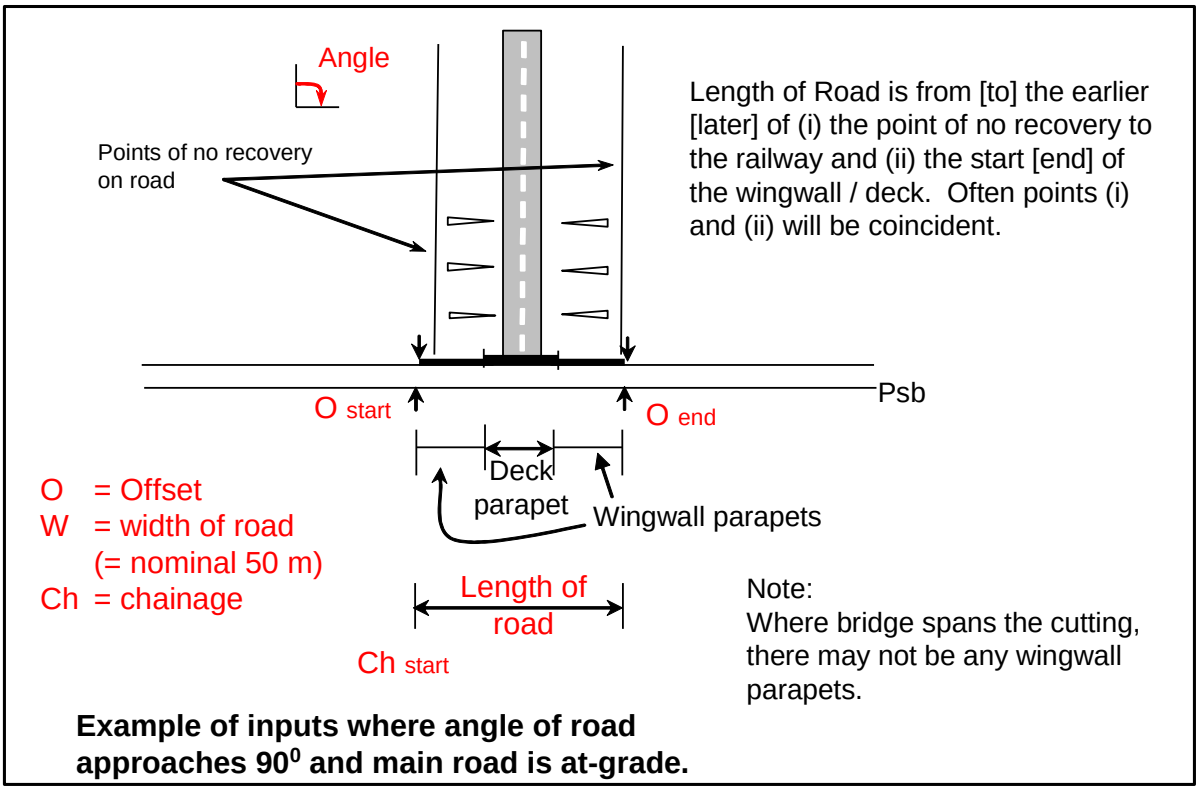
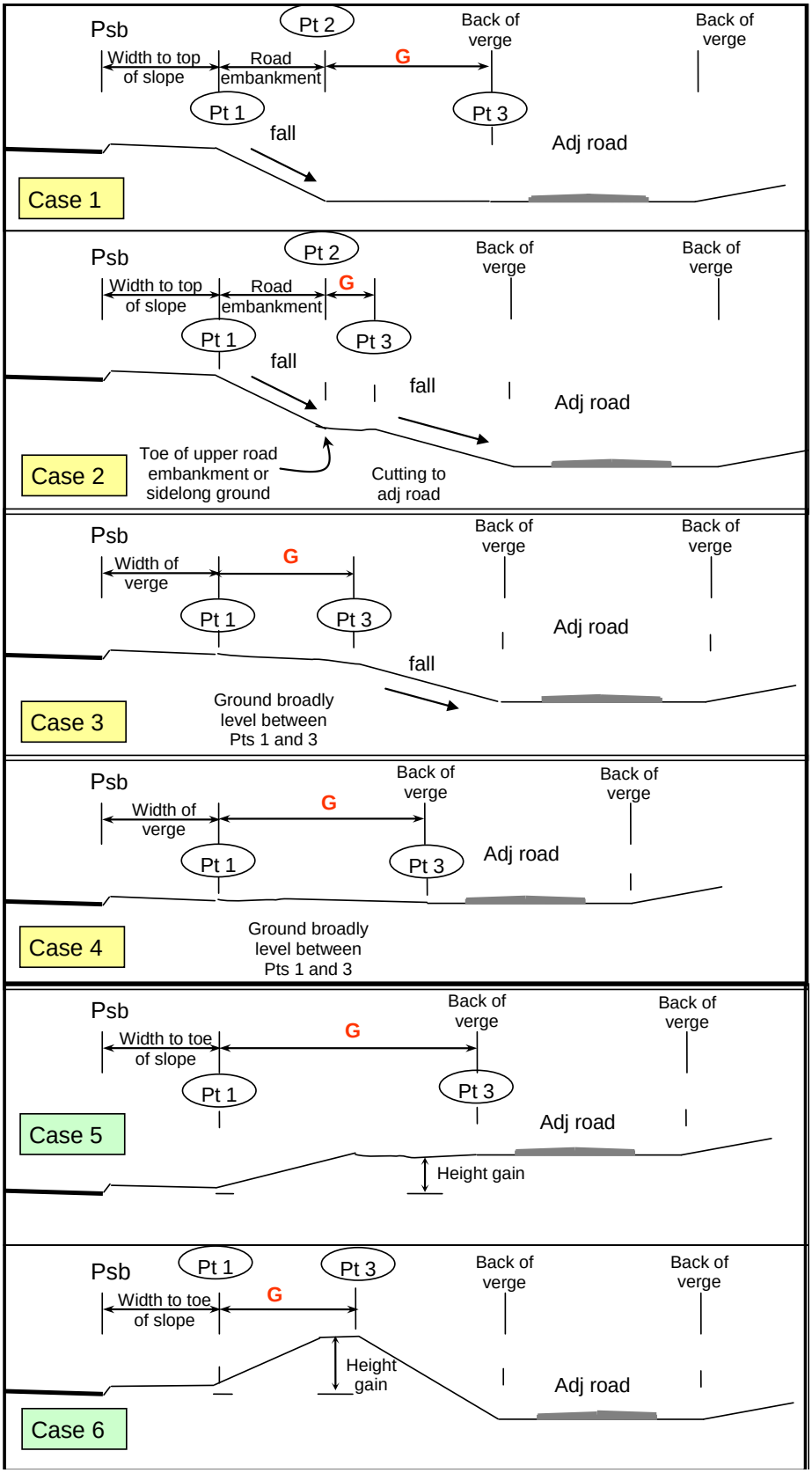


Figure 8-60 Road crossing under Road where at-grade and or at 90 degrees

8.16.1 **Point of no recovery for adjacent road situation**



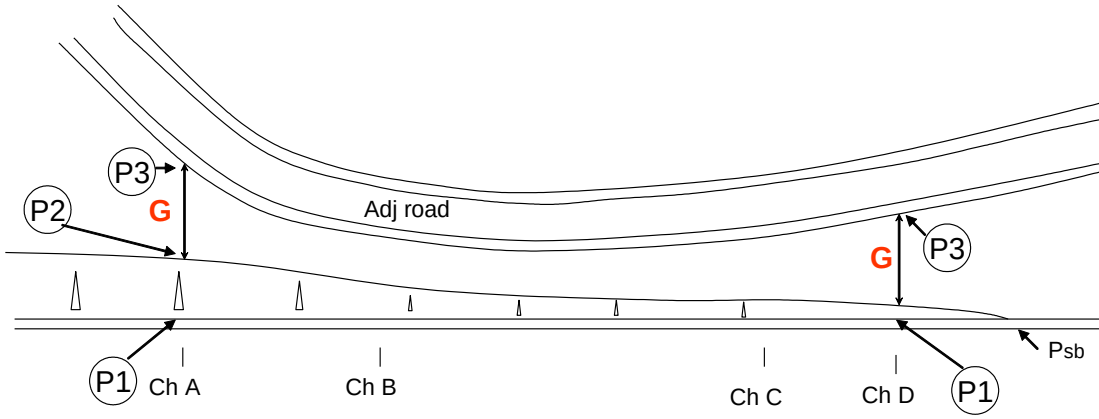
In Cases 1 to 4 where G <= 15 m offset to road becomes offset to Pt 1. (PNR = Pt 1).

Where G> 15 m offset to road becomes offset to Pt 3. (PNR = Pt 3).

In Cases 5 and 6 where G<= 15m, offset to road (PNR) becomes closer of offset to Pt 3 and Pt 1 + 4x height gain.

Where height gain > 2.5 m and or G > 15 m no need to assess; add note in the hazard 'Comment' field to confirm this is the case.

Figure 8-61 Offset and Point of No Recovery for Adjacent Road for Various Typical Cross-Section Scenarios



Notes

1. Essentially when G > 15 m, then Point of No Recovery is at P3; when G<= 15 m, then it is at P1. In this case if G = 15 m, the Point of No Recovery is at P1 from Ch A to Ch D and offset to the adjacent road is offset to P1 over this length.
2. Over the length B to C, the 'Likelihood of reaching the adjacent road based on topography' factor is probably the broadly the same. All other things being equal, the Likelihood of it being reached over the length A to B is likely to be higher and, over the length C to D, lower than this. Entries would therefore be required at each of the chainages A, B, C and D to ensure that the level of provision is appropriate.

Illustration of Point of No Recovery (Case 1) and use of topography factors in plan.

Figure 8-62 Point of No Recovery for Parallel Road situation - Typical plan

8.16.2 **Likelihood of reaching the hazard**

The Designer must assess the circumstances and assess the likelihood of an errant vehicle reaching the hazard from the Point of No Recovery. Steeply sloping ground leading directly to the hazard will be easier to traverse than shallow sloping ground or a slope that is running at an angle to the hazard.

The following will reduce the likelihood of the hazard being reached but may not prevent it being reached.

- A ditch more than 1 m deep and 3 m wide.
- Heavy vegetation, e.g. trees greater than 500 mm girth at spacings less than 2 m, but be aware, trees may be cut to maintain clear zones or visibility or due to disease.
- Shallow gradient, with rough ground
- Bunds or uphill gradients especially when near to the adjacent railway, where vehicle speeds are likely to be reduced.

Likelihood of reaching?

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.

It is recommended that the sensitivity of the outcome to changes in factor is looked at and a note regarding this is made in the hazard 'Comment' field.

On the structure itself, the likelihood of reaching is 'Extremely likely'; on the approach to and departure from the structure, the factor will change according to the factors outlined above.

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.

Figure 8-63 Adjacent Road Hazard Marking

8.16.3 **Note regarding parallel road situations**

In Section 2 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 only looks at the level of protection required to protect the leading edge of the hazard at each of the various points entered into RRRAP 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 hazards 'comment' field. 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.

Farm access tracks are unlikely to be sufficiently trafficked to pose a risk requiring vehicle restraint systems on the main road.

8.16.4 **If H1 or H4a containment is required on embankments**

Refer to Section 8.15.5 above.

8.16.5 **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. Figure 8-64 below illustrates a typical situation.

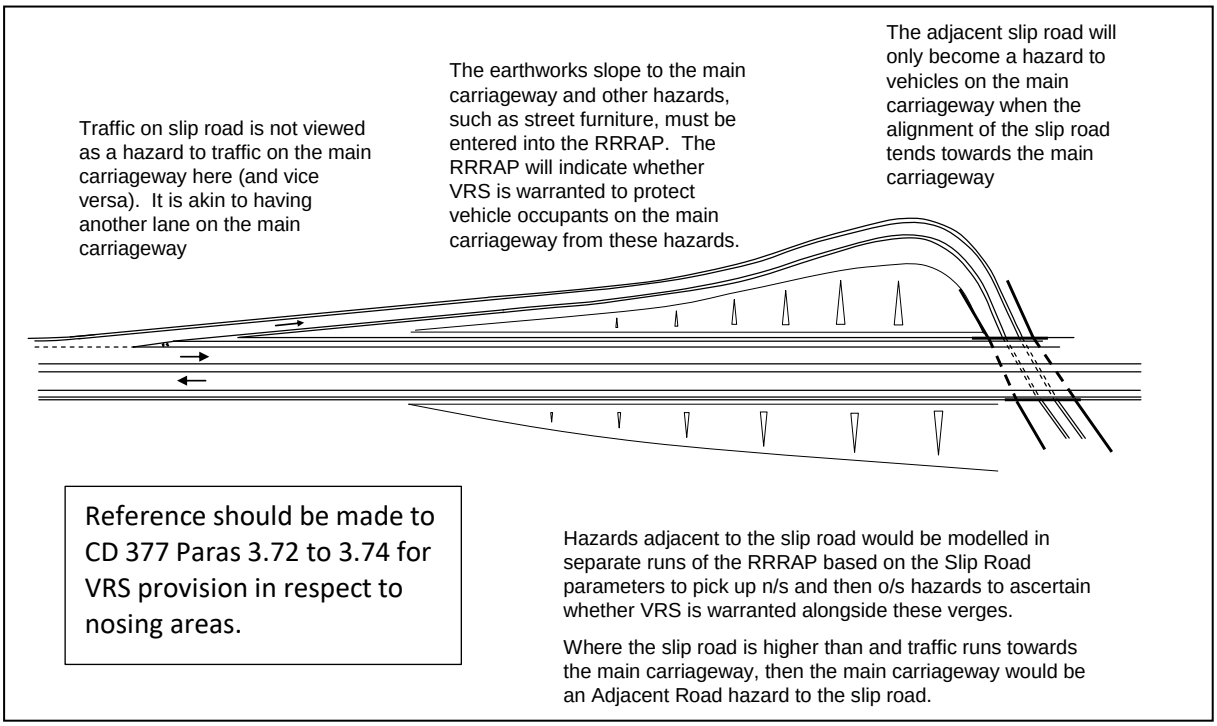
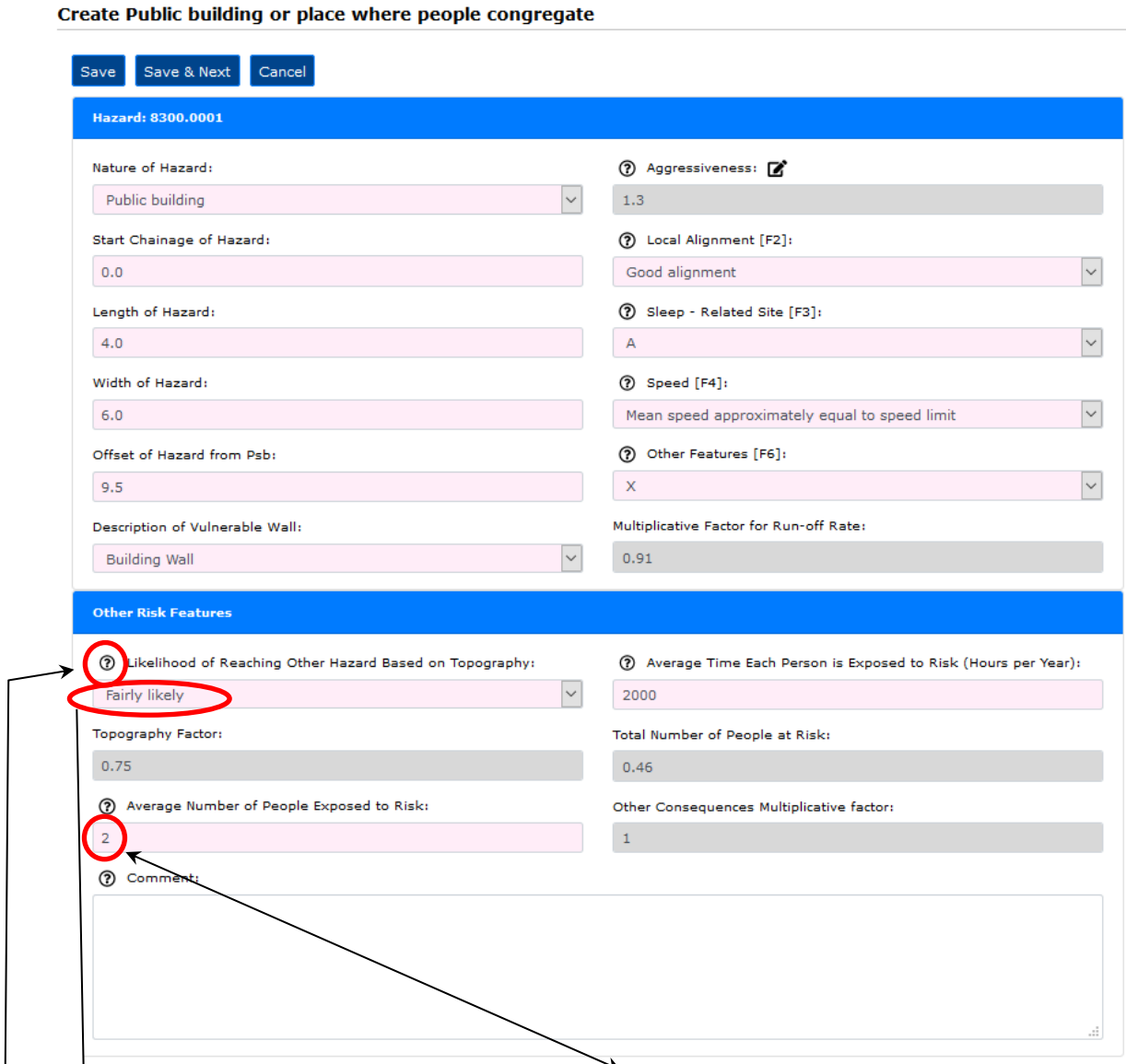


Figure 8-64 When a Slip Road is viewed as a Hazard, and when it isn't.

8.17 Other Hazards Buildings and also Other Hazards – Chemical or Fuel



Likelihood reaching hazard

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

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.

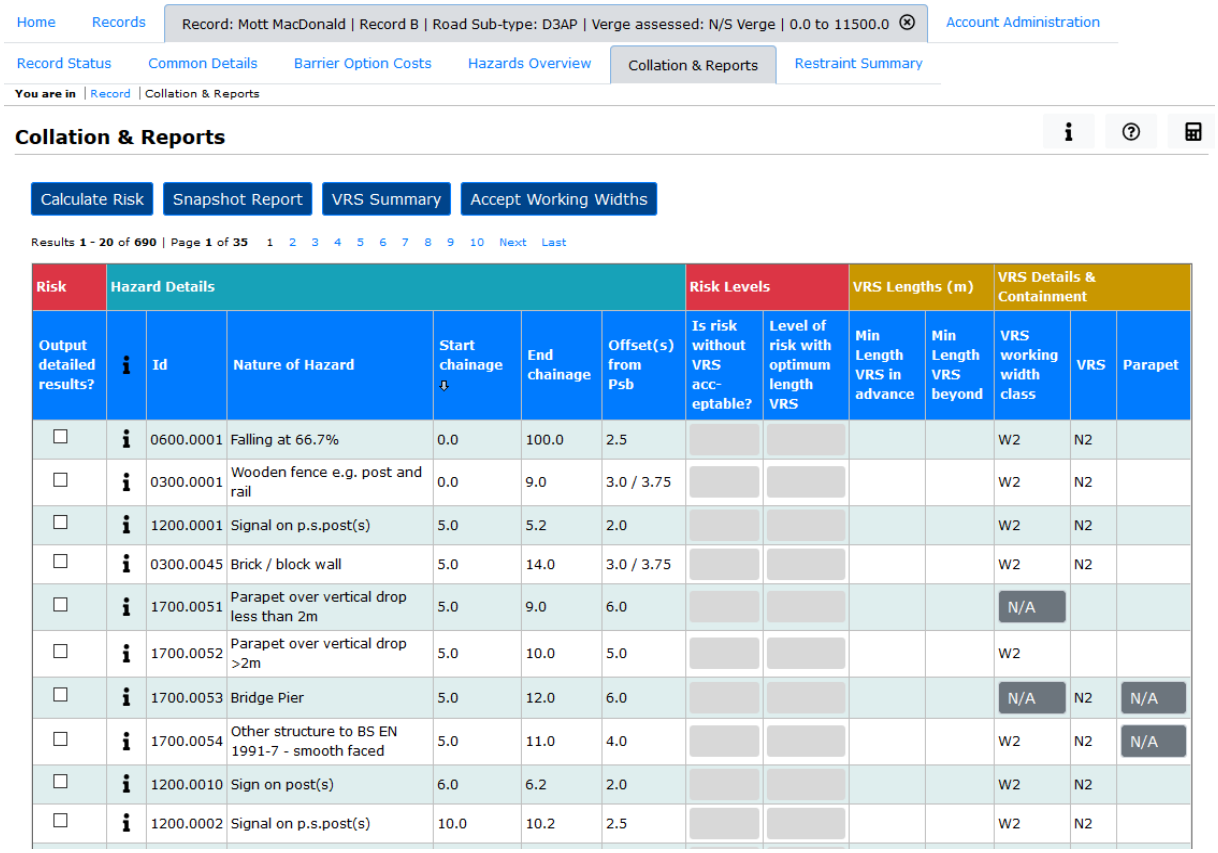
If a public building is likely to be less resistant to impact, or the impact might be particularly severe, as for example with a vehicle leaving a flyover and falling onto a building, the number at risk should be increased. Users should assume the outcome for impact by a car.

Figure 8-65 Building data entry

9 Collation of Data on Hazards, Calculation of Risk and Detailed Results

9.1 Hazard Collation

All hazard data previously entered via 'Hazards Overview' page (see section 7) is automatically collated and listed on the 'Collation & Reports' page (shown in Figure 9-1), except for Kerb and Verge hazards.



Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Falling at 66.7%	0.0	100.0	2.5					W2	N2	
☐	i	0300.0001	Wooden fence e.g. post and rail	0.0	9.0	3.0 / 3.75					W2	N2	
☐	i	1200.0001	Signal on p.s.post(s)	5.0	5.2	2.0					W2	N2	
☐	i	0300.0045	Brick / block wall	5.0	14.0	3.0 / 3.75					W2	N2	
☐	i	1700.0051	Parapet over vertical drop less than 2m	5.0	9.0	6.0					N/A		
☐	i	1700.0052	Parapet over vertical drop >2m	5.0	10.0	5.0					W2		
☐	i	1700.0053	Bridge Pier	5.0	12.0	6.0					N/A	N2	N/A
☐	i	1700.0054	Other structure to BS EN 1991-7 - smooth faced	5.0	11.0	4.0					W2	N2	N/A
☐	i	1200.0010	Sign on post(s)	6.0	6.2	2.0					W2	N2	
☐	i	1200.0002	Signal on p.s.post(s)	10.0	10.2	2.5					W2	N2	

Figure 9-1 Collation & Reports page

By default the hazards are listed by increasing chainage order. If you wish to view the hazards in a different order (if for instance the Section is in decreasing chainage order), click the table headings to alter hazard ordering (see section 2.4.10).

To view and edit a hazard, click on a row in the table (see section 9.3).

To calculate risk, click the 'Calculate Risk' button (see section 9.4).

To generate a summary report that contains information on all the hazards in the record and all hazard detailed results that are available, click the 'Snapshot Report' button (see section 9.7).

To view VRS Summary details, click the 'VRS Summary' button (see section 11).

To accept the current barrier working width class when an alternative has been suggested, click the 'Accept Working Width' button (see section 2.10.6).

9.2 Overview of Collation of Data on Hazards

Prior to pressing the 'Calculate Risk' button, the 'Collation & Reports' page looks as in Figure 9-2.

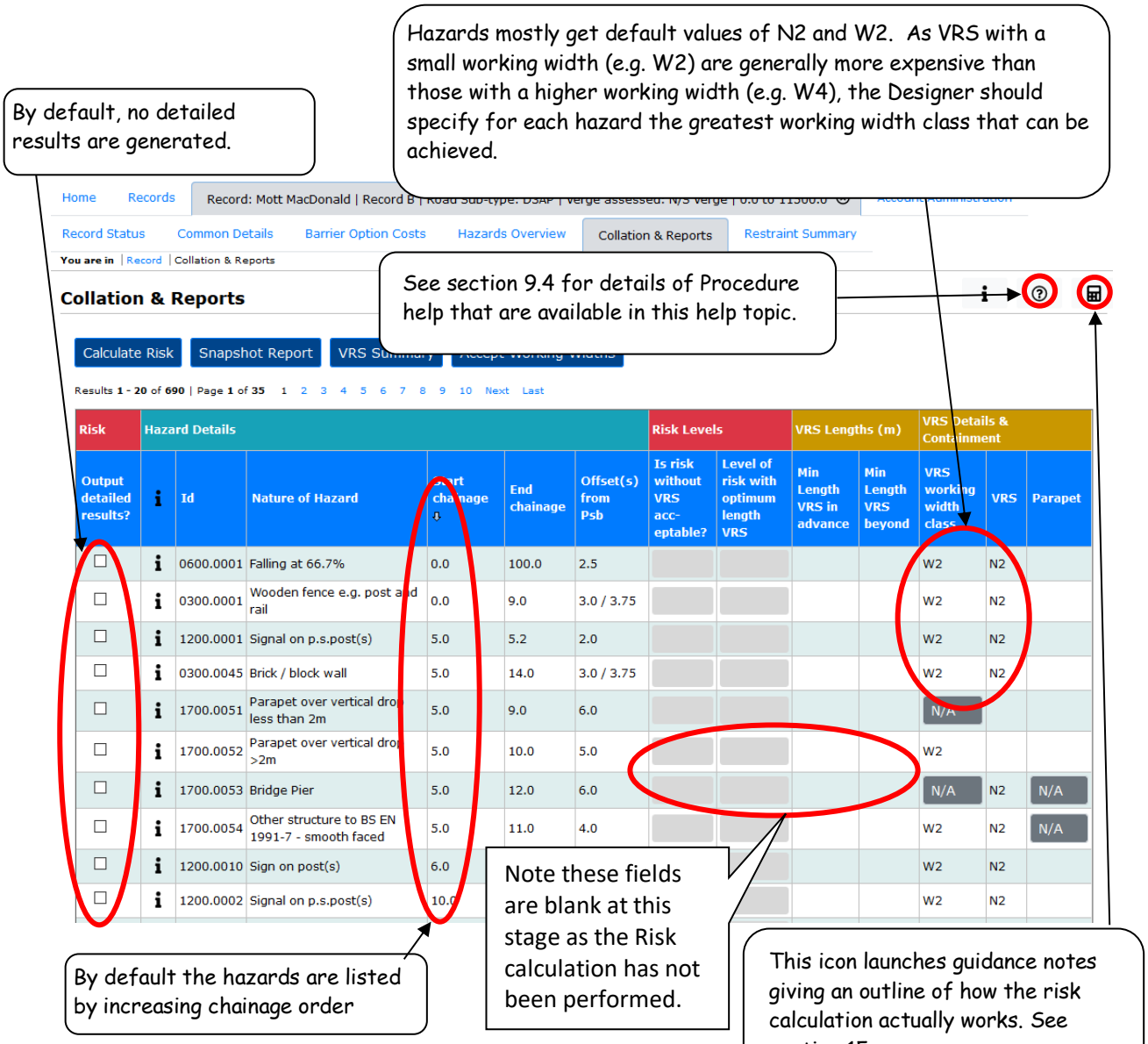


Figure 9-2 Collation & Reports page before calculating risk

By default, no detailed results are generated for hazards. For more details see section 9.5.

9.3 View and Edit Hazards

Clicking on a row in the table on the 'Collation and Reports' page will display a page showing all the values associated with the hazard, including both the original data entered to define the hazard and any data generated via the risk calculation. From here, clicking the 'Edit' button will allow you to modify the hazard.

In Figure 9-3 below,

1. The original data entered via the 'Hazards Overview' page to define the hazards in the section being assessed is displayed initially.
2. If the hazard could give rise to a significant secondary incident, after calculating risk the user can indicate whether the risk level is accepted in this section.
3. Risk levels and VRS Details. Values are populated by running the risk calculation. Some of these values can be altered when investigating different options to protecting a hazard, e.g. altering working width class, barrier containment, or barrier set-back.

Important Note – Editing Hazard Details

In the RRRAP web application, there is only one set of data that represents a hazard. If you edit a hazard via the 'Hazards Overview' page or via the 'Collation & Reports' page, you are editing the same underlying hazard data. This differs from previous versions of the RRRAP spreadsheet.

Before starting to edit hazards to determine optimal risk levels and barrier requirements, you may wish to either export a copy of the record (see section 4.4) or generate a full report to capture a copy of the original data entered (see section 11.3).

If any changes made here are adopted in the final solution, the Designer must explain the changes made in the hazard 'Comment' field.

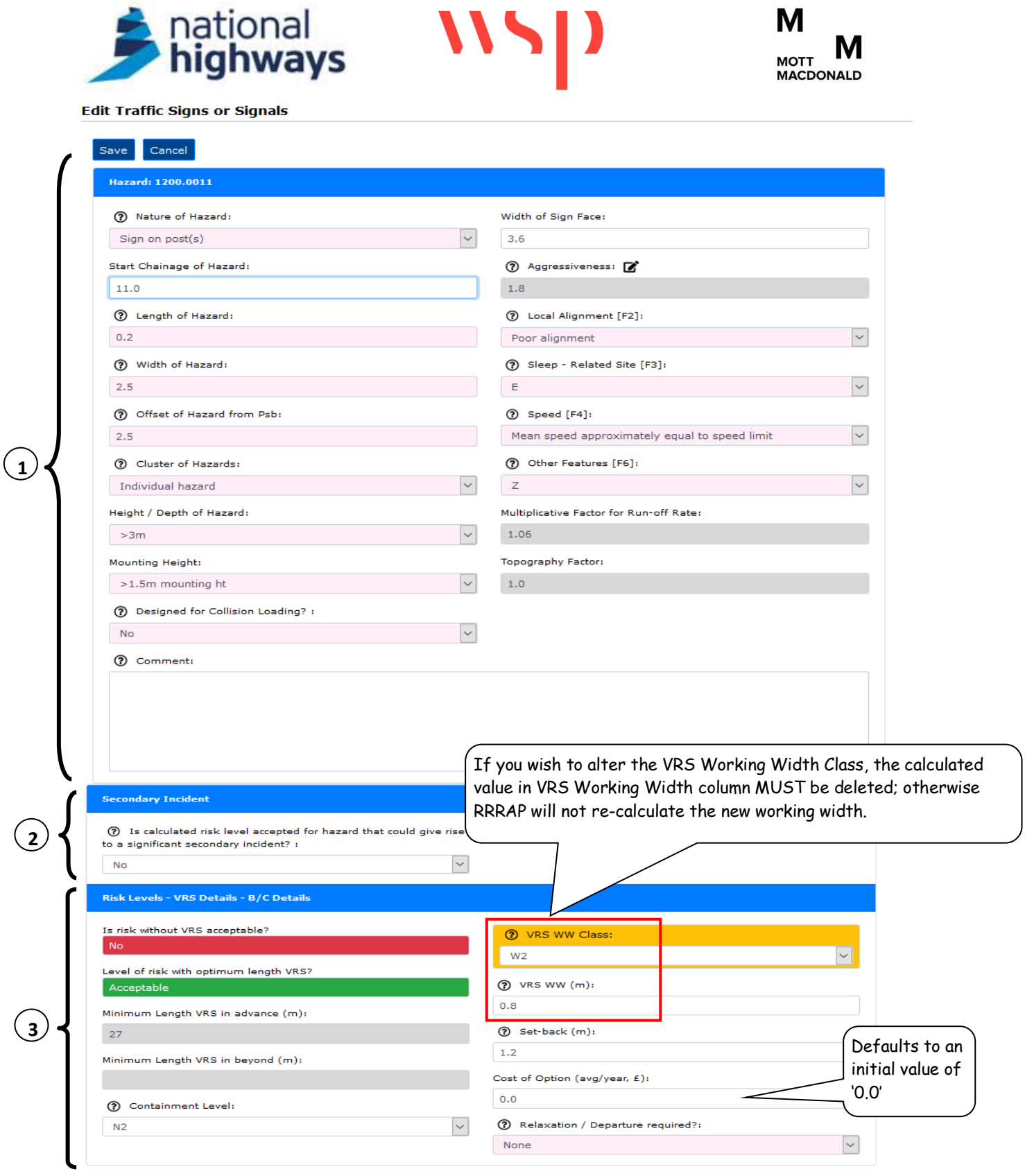


Figure 9-3 Edit a hazard via the 'Collation and Report' page

9.4 Calculation of Risk

9.4.1 Procedure Help

When entering the 'Collation and Reports' page, the hazards are listed in increasing chainage order. This ordering can be changed by clicking on the column headers.

If the risk calculation has never been performed for this record or there are hazards that have been added since the last time risk was calculated, then there will be no details relating to the level of risk or safety barrier requirements other than the default barrier containment N2 and working width class W2.

'Calculate Risk' button
When the 'Calculate Risk' button is pressed, 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 displayed in the 'Is risk without VRS acceptable?' column 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 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 section 3.12 to 3.14 of CD 377 may require a longer length of barrier be provided.

Minimum VRS Lengths
Barrier lengths in compliance with CD377 are determined on the basis of the full containment length (determined through the RRRAP) required for the hazard, combined with the additional lengths of the product being purchased required to achieve that containment level.

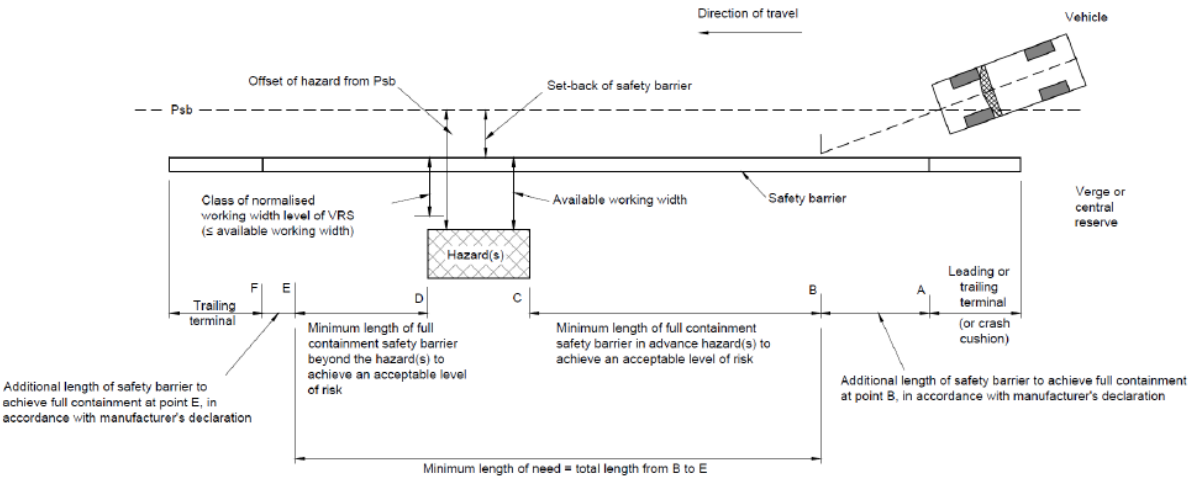
The full containment length of need is shown in Figure 3-19 of CD 377, copied below, by sectors B to C and D to E. The length D to E is normally 0m (zero) for dual carriageways, link roads and slip roads and may be the same as or less than B to C for single carriageways (two way) roads, depending on the road characteristics. Hazards where the point of no recovery is applied require further consideration to identify the combined end point of the hazard under examination.

As long as the system achieves the appropriate containment level from point B to point E, the hazard will be protected. Barrier lengths from points A to B and points E to F are added to the containment lengths and hazard length produced through RRRAP. These are manufacturer / product specific and may vary depending upon the system preceding point A and following point F, i.e., a terminal, crash cushion, transition or similar profile safety barrier type.

The designer has the opportunity to specify site specific conditions where applicable (e.g. access road, observation point, maintenance turnaround, structure) where the contractor can make considered purchase decisions in regard to total system length (terminal - safety barrier - transition - parapet, etc) to determine the best product range whilst ensuring full containment performance is achieved between points B and E.

The designer may need to limit the choice of VRS systems that can be selected to avoid ending up with large numbers of differing and potentially non-compatible systems being installed on a section of the network leading to storage and component maintenance issues.

Manufacturer's need to have robust data in regard to the effective lengths of their systems required to achieve full containment performance when connected to a different barrier type or make and they should be prepared to justify those specifications should the system's in-service performance be called into question.



CD 377 Figure 3.19 Set-back, working width and length of need of safety barrier

Re-calculating Risk

Once risk has been calculated for all hazards, subsequent runs of the risk calculation will in general only calculate risk for those hazards that have been edited, added, or now require the generation of 'Detailed Results'. The following are exceptions to this and will cause the RRRAP to re-calculate risk for all hazards:

- Edit the record 'Common Details'
- Add, edit or delete an 'Earthwork' hazard.
- Add, edit or delete a 'Hard shoulder and Verge Width' hazard.

'Detailed Risk' and 'Benefit Cost' Results

The Designer is then able to review the 'Detailed Risk' and 'Cost Benefit' results for any one or all of the hazards. For the hazards to be looked at in more detail, this is done by clicking the checkbox in the 'Output detailed results?' column - which should now show a tick. 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.

Having put a tick in the checkbox in the 'Output detailed results?' column, press the 'Calculate Risk' button. Once the calculation has completed, an icon will appear in the 'Output detailed results?' column for each hazard that has a 'Detailed Results' to view. Clicking the icon will display a dialog that will ask if you wish to open or save a PDF file. This contains the Detailed Results. See section 9.5 for more details.

Changing Containment Level

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 (or H2 or H4a for parapets). Click on a row in the table on the 'Collation' page to view the hazard and then click the 'Edit' button to edit the hazard details. In the 'Edit' page, change the barrier containment level. Save the altered hazard. Back on the 'Collation & Reports' page, when the 'Calculate risk' button is pressed, the RRRAP will calculate the new risk level with the optimum length of VRS of the new containment level. Should the risk level still be 'Tolerable' or 'Unacceptable' with H1 (or H2) containment, the process will have to be repeated with the H4a containment level.

Changing other parameters in the Collation of Data worksheet

The designer can edit hazards via the 'Collation & Reports' page by clicking on the specific row in the table to view the hazard and then click the 'Edit' button to edit the hazard details. The Designer can edit any hazard values at this point. When modifying hazards due to results from the risk calculation, fields traditionally focused on include safety barrier set-back, working width class, offset of hazard, etc.

There may be some instances where the RRRAP returns a length of a particular level of containment safety barrier in advance of the hazard (and beyond on a two-way road) as having an acceptable level of risk and a positive benefit cost ratio, but where the 'Detailed Results' identifies that an increase in length in advance and or containment level has a significantly higher benefit cost but broadly similar risk level. In such instances the adoption of the longer length in advance or higher containment level may be justifiable.

If, based on the data in the 'Detailed Results' output, the Designer proposes to use a VRS length in advance of and or beyond the hazard that is different from the minimum proposed (e.g. as outlined above), the proposed length and the reasoning for the difference must be added to the hazards 'Comment' field. This can be done by editing the hazard via the 'Collation' page (click the row in the table to view the hazard and then click the 'Edit' button). Similarly with any other changes that are made, such as to working width class, additional notes should be added to the hazards 'Comment' field.

Working Width Classes

Safety barriers with smaller working widths are generally more expensive than those with larger working widths. It is therefore important that the Designer checks and specifies the greatest working width class that can practicably be achieved in the circumstances taking into account the requirements of set-back of the safety barrier, the location of the hazard and of other hazards adjacent to it, and the minimum distances to top or toe of slope (CD 377 figures 3.19, 3.28, 3.29 and 3.54 refer).

To help highlight which hazards have a potential alternative VRS working width, when risk is calculated for the hazard, if an alternative VRS working width class is possible, RRRAP will highlight the working width class cell in tables (see section 2.10.6 for more detail). The Designer should check and specify the greatest VRS working width class that can practicably be achieved for each of these hazards.

9.4.2 Risk Calculation Issues

If there are any issues that occur during the risk calculation, these are displayed on the 'Risk Calculation Issues' page shown once the risk calculation process has completed (an example is shown in Figure 9-4).

See sections 2.10.3 and 9.6.1 for more details on the types of messages that can appear here.

If no changes are made to the record data, then clicking the 'Calculate Risk' button again on the 'Collation and Reports' page will not re-calculate risk for any hazards, and the 'Risk Calculation Issues' page will be re-displayed if there are any existing issues.

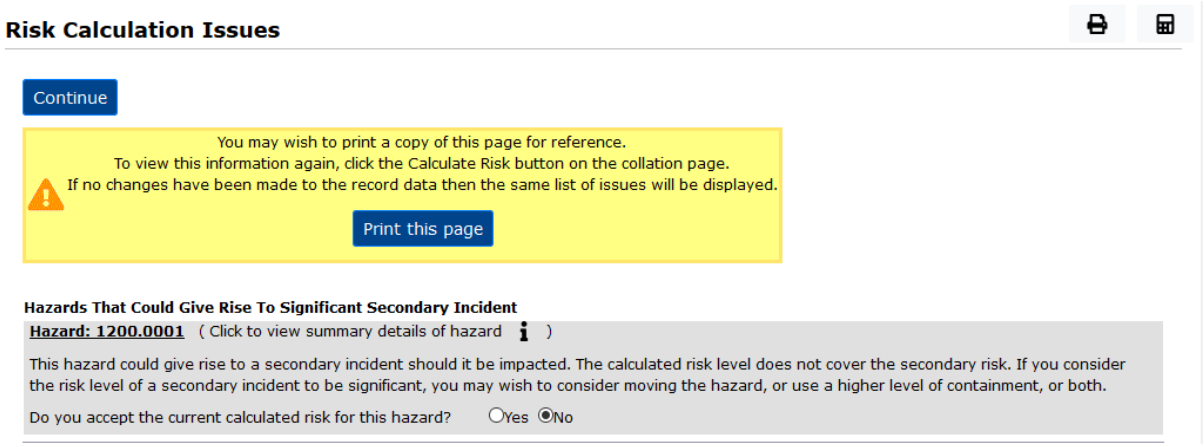
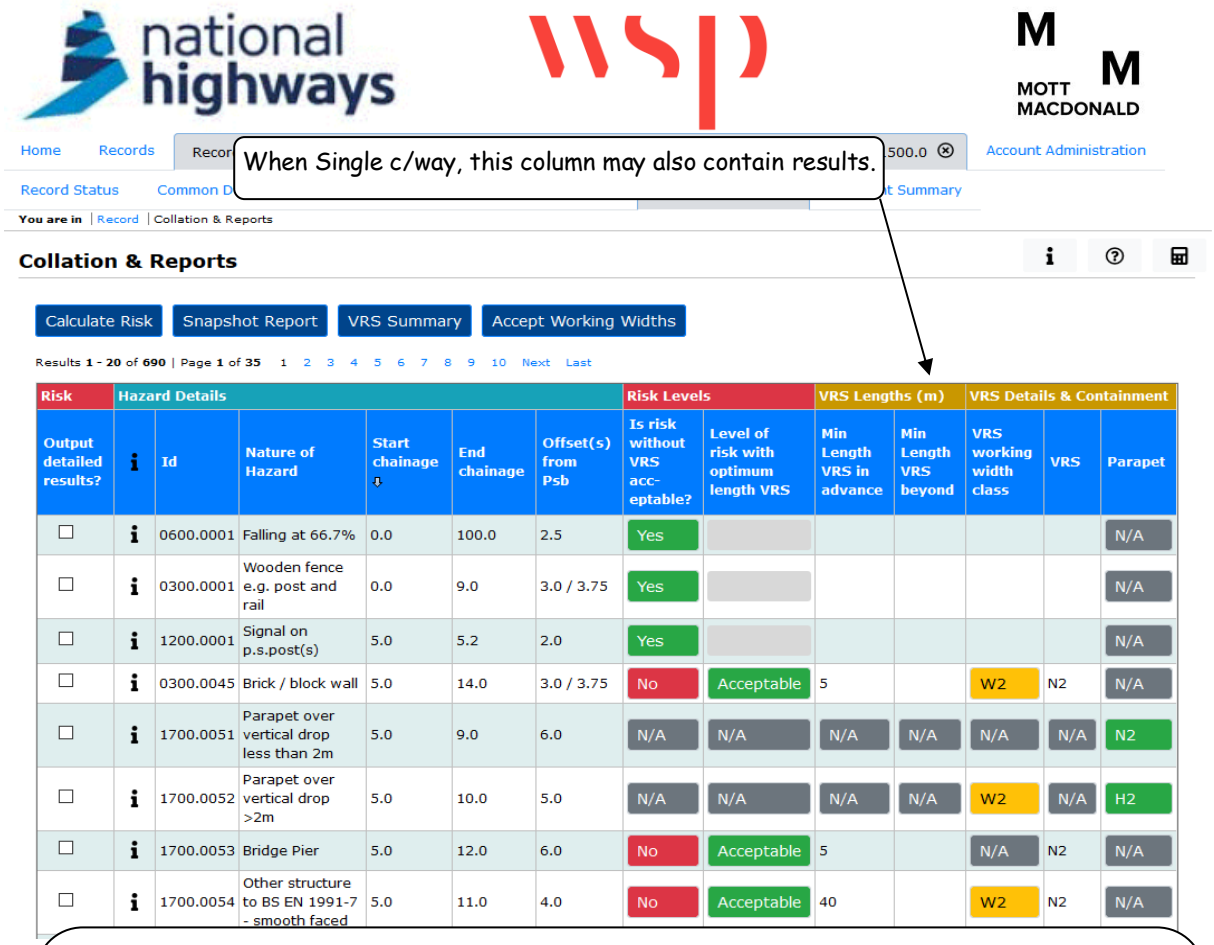


Figure 9-4 Risk Calculation Issues page

9.4.3 Risk Calculation Results

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 & Reports' page. If it is not acceptable, 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.



Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Falling at 66.7%	0.0	100.0	2.5	Yes						N/A
☐	i	0300.0001	Wooden fence e.g. post and rail	0.0	9.0	3.0 / 3.75	Yes						N/A
☐	i	1200.0001	Signal on p.s.post(s)	5.0	5.2	2.0	Yes						N/A
☐	i	0300.0045	Brick / block wall	5.0	14.0	3.0 / 3.75	No	Acceptable	5		W2	N2	N/A
☐	i	1700.0051	Parapet over vertical drop less than 2m	5.0	9.0	6.0	N/A	N/A	N/A	N/A	N/A	N/A	N2
☐	i	1700.0052	Parapet over vertical drop >2m	5.0	10.0	5.0	N/A	N/A	N/A	N/A	W2	N/A	H2
☐	i	1700.0053	Bridge Pier	5.0	12.0	6.0	No	Acceptable	5		N/A	N2	N/A
☐	i	1700.0054	Other structure to BS EN 1991-7 - smooth faced	5.0	11.0	4.0	No	Acceptable	40		W2	N2	N/A

Here the first hazard [0600.0001] does not require VRS protection.

The fourth hazard, Brick / block wall, requires 5 m of N2 barrier in advance to give an acceptable level of risk. The level of risk brought about by vehicles approaching from the other direction is acceptable with no VRS provided.

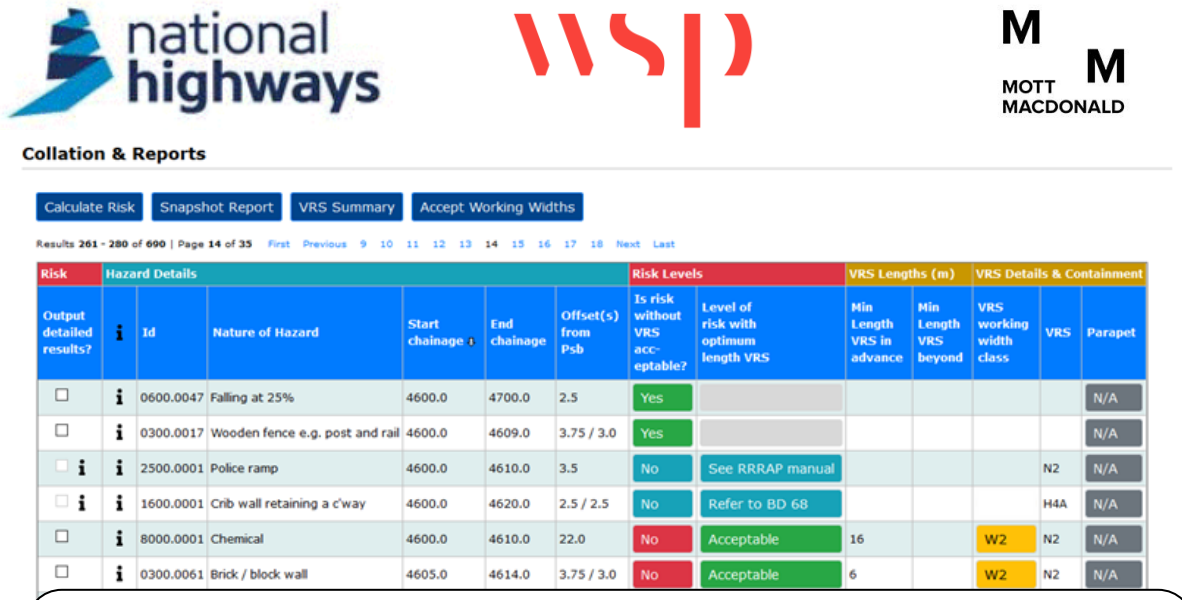
In practice the minimum length required by CD 377 para 3. 12 to 3.14. must be provided in advance of and beyond the hazard.

Figure 9-5 Hazards and their protection requirements

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Nominally at Grade	0.0	10000.0	1.4	Yes						N/A
☐	i	1500.0001	Gantry designed to CD 365	100.0	102.0	2.0	No	Must be agreed with TAA	13		W2	H4A	N/A

Figure 9-6 Typical output for Sign on Gantry

Safety barrier containment and length for Gantry is determined by TAA or CD 377.



Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0047	Falling at 25%	4600.0	4700.0	2.5	Yes						N/A
☐	i	0300.0017	Wooden fence e.g. post and rail	4600.0	4609.0	3.75 / 3.0	Yes						N/A
☐	i	2500.0001	Police ramp	4600.0	4610.0	3.5	No	See RRRAP manual				N2	N/A
☐	i	1600.0001	Crib wall retaining a c'way	4600.0	4620.0	2.5 / 2.5	No	Refer to BD 68				H4A	N/A
☐	i	8000.0001	Chemical	4600.0	4610.0	22.0	No	Acceptable	16		W2	N2	N/A
☐	i	0300.0061	Brick / block wall	4605.0	4614.0	3.75 / 3.0	No	Acceptable	6		W2	N2	N/A

For the Police Ramp, users are referred to the RRRAP Guidance Manual as the Police require VRS for their own protection, rather than due to the need to protect motorists from injury.

Crib walls indicate refer to CD 622

Figure 9-7 Risk results for Police Ramps and Crib Walls

Here the RRRAP has indicated that the risk for the **Public building** that is at the bottom of a steep slope is 'Tolerable' with 30 m of N2 containment VRS in advance.

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Falling at 50%	200.0	224.0	2.5	No	Acceptable	39		W2	N2	N/A
☐	i	8300.0001	Public building	221.0	246.0	18.0	No	Tolerable	30		W2	N2	N/A
☐	i	0600.0002	Falling at 50%	224.0	250.0	2.5	No	Acceptable	39		W2	N2	N/A

Figure 9-8 Risk results for Public Building

In Figure 9-8, the RRRAP has indicated that the risk at the Public Building hazard is 'Tolerable' with 30 m of N2 containment safety barrier in advance. This will need to be investigated further by generating a 'Detailed Results' report containing the risk and benefit cost calculation information (for more details see section 9.5).

Click the checkbox in the 'Output detailed results?' column - the checkbox should now have a tick. Click the 'Calculate Risk' button. Once the calculation has completed, a magnifying glass icon will appear in the 'Output detailed results?' column. Clicking the icon will display a browser specific dialog that will ask if you wish to open or save a PDF file. This contains the detailed result (see section 9.5.2 for the detailed results for the hazards shown in Figure 9-8).

For the Public Building hazard, changing the Barrier Containment from N2 to H1 and pressing 'Calculate Risk' again will calculate the new level of risk with the higher containment safety barrier (shown in Figure 9-9).

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
☐	i	0600.0001	Falling at 50%	200.0	224.0	2.5	No	Acceptable	39		W2	N2	N/A
☐	i	8300.0001	Public building	221.0	246.0	18.0	No	Acceptable	26		W2	H1	N/A
☐	i	0600.0002	Falling at 50%	224.0	250.0	2.5	No	Acceptable	39		W2	N2	N/A

Figure 9-9 Risk result for Public Building hazard after changing barrier containment

Now the risk is shown as Acceptable with 26m of H1 barrier containment in advance of the Public Building.

The Detailed Results for the revised Public Building hazard are the second set of Detailed Results shown in section 9.5.2.

9.5 Generating Detailed Results

Detailed Results for a hazard are generated via the 'Collation & Reports' page. To generate a 'Detailed Results report' for a hazard, click the checkbox in the 'Output detailed results?' column in the row of the hazard you are interested in. The checkbox should now have a tick.

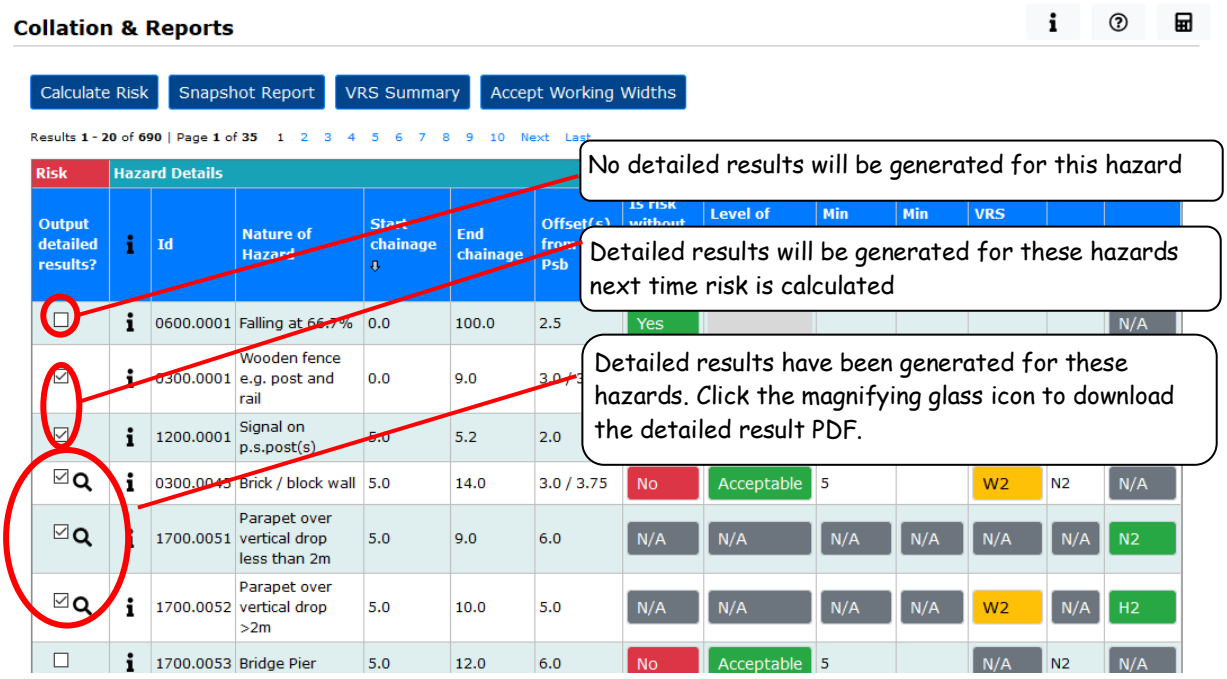


Figure 9-10 Generating Detailed Results for a hazard

Having put a tick in the checkbox in the 'Output detailed results?' column, press the 'Calculate Risk' button. Once the calculation has completed, an icon will appear in the 'Output detailed results?' column for each hazard that has a 'Detailed Result report' to view. Clicking the icon will display a browser specific dialog that will ask if you wish to open or save a PDF file. This contains the Detailed Results.

9.5.1 Comparing Detailed Results

If a hazard is edited and already has Detailed Results from a previous risk calculation run, then the next time risk is calculated, the old Detailed Results data is superseded by the new data.

If you want to compare Detailed Results as you change specific values of a hazard, you should generate and save Detailed Results reports locally. You can then either open both up to view on your screen or print them out.

If, for evidential reasons, you need to maintain the Detailed Results for different risk calculation runs for a particular hazard, you should generate and keep multiple Detailed Results files. You can also generate either a snapshot report (see section 9.7) or full report (see section 11.3) which contains both all hazard data and any currently generated Detailed Results.

9.5.2 Detailed Results Report

If the level of risk without VRS is 'Tolerable' or 'Unacceptable', the detailed risk and benefit cost levels of VRS provision must be looked at. Click the checkbox in the 'Output detailed results?' column - the checkbox should now have a tick. Click the 'Calculate Risk' button. Once the calculation has completed, a magnifying glass icon will appear in the 'Output detailed results?' column. Clicking the icon will display a browser specific dialog that will ask if you wish to open or save a PDF file.

The example shown is for a D2AP All Purpose Road from section 9.4.3.

Road Classification	Road sub type	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT
All Purpose Road	D2AP	N/S Verge	70	17000

ID Number	Nature of Hazard	Cost of Option	Offset from PSb	Aggressiveness	Containment Level	Set-back(s) of VRS from PSb
8300.0001	Public building		18.0	1.3	N2	

Barrier length is length of VRS in advance of Hazard

Barrier Advance

Barrier Length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.15216	0.13842	0.08387	0.05463	0.03934	0.03177	0.02845	0.02747	0.02779	0.02882	0.03025	0.0319
Est risk: Other	0.22238	0.20125	0.13546	0.10697	0.09899	0.09899	0.09899	0.09899	0.09899	0.09899	0.09899	0.09899
Estimated B/C	0	0.98	1.96	2.94	3.82	3.53	3.24	2.95	2.66	2.37	2.08	1.78

1st column shows risk and benefit cost levels with no length of VRS in advance of Hazard

Figure 9-11 Public Building hazard detailed result with default N2 barrier containment

The first run of Detailed Results with N2 containment for the VRS on the approach to the Public Building shows that risk to vehicle occupants increases with a short length of VRS, then initially decreases as the length of VRS increases, before rising again, as the additional length of VRS provides no additional risk benefit.

With the N2 containment VRS, the risk posed to the occupants of the Public Building only ever gets to Tolerable regardless of the length of VRS.

Changing the Barrier Containment for the **Public Building** hazard from N2 to H1 and then clicking on the 'Calculate Risk' button again will calculate the risk with H1 safety barrier. Here the risk is shown as acceptable with 26 m of H1 containment barrier in advance.

Road Classification	Road sub type	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT
All Purpose Road	D2AP	N/S Verge	70	17000

ID Number	Nature of Hazard	Cost of Option	Offset from PSb	Aggressiveness	Containment Level	Set-back(s) of VRS from PSb
8300.0001	Public building		18.0	1.3	H1	

Barrier Advance

Barrier Length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.15216	0.13756	0.08266	0.05306	0.03742	0.02949	0.02581	0.02448	0.02445	0.02513	0.0262	0.02749
Est risk: Other	0.22238	0.18897	0.11091	0.07015	0.04989	0.04092	0.03815	0.03815	0.03815	0.03815	0.03815	0.03815
Estimated B/C	0	0.74	1.48	2.22	2.89	2.67	2.44	2.22	1.99	1.77	1.55	1.32

Figure 9-12 Public Building hazard detailed result with altered H1 barrier containment

The second run of Detailed Results with H1 containment for the VRS on the approach to the Public Building shows that this time Risk to both vehicle occupants and building users is acceptable with H1 containment VRS on the approach to the building. There is also a reasonable benefit cost of providing a VRS. Note that the risk and benefit cost levels do not necessarily peak at the same VRS lengths.

If the 'Cost of Option' field is blank, this shows that the default cost of the H1 containment VRS has not been overridden yet – see sections 8.15.5 and 8.16.4.

Shown below is an example of a Parapet detailed result.

Road Classification	Road sub type	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT
Motorway	D2M	N/S Verge	70	90000

ID Number	Nature of Hazard	Cost of Option	Offset from PSb	Aggressiveness	Set-back(s) of VRS from PSb
1700.0006	Parapet over vertical drop >2m		2.75		

Parapet containment	N2	H2
Est risk: Vehicle occupant	0.0408	0.0121
Est risk: Other	0.0764	0.0227
Estimated B/C		0.39

Parapet risk and benefit cost levels with N2 and H2 containment.

Figure 9-13 Parapet hazard detailed result

9.5.3 Example of Detailed Results output on a single carriageway

Figure 9-14 shows the output contained within a Detailed Result for a hazard on a single carriageway.

Risk	Hazard Details						Risk Levels		VRS Lengths (m)		VRS Details & Containment		
Output detailed results?	i	Id	Nature of Hazard	Start chainage	End chainage	Offset(s) from Psb	Is risk without VRS acc-eptable?	Level of risk with optimum length VRS	Min Length VRS in advance	Min Length VRS beyond	VRS working width class	VRS	Parapet
	i	1200.0011	Sign on post(s)	240.0	245.0	2.5	No	Acceptable	27	7	W2	N2	N/A

Detailed Results

Road Classification	Road sub type	Nearside or Offside Verge being assessed?	Permanent Speed Limit (mph)	AADT
All Purpose Road	Single	N/S Verge	70	6967

ID Number	Nature of Hazard	Cost of Option	Offset(s) from PSb	Aggressiveness	Containment Level	Set-back(s) of VRS from PSb
1200.0011	Sign on post(s)		2.5	1.8	N2	0.6

Barrier Advance

Barrier Length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.04099	0.02897	0.01658	0.01184	0.01041	0.01039	0.01098	0.01184	0.01281	0.01383	0.01487	0.01592
Est risk: Other	0											
Estimated B/C	0	0.11	0.22	0.25	0.23	0.2	0.17	0.15	0.12	0.09	0.07	0.04

Barrier Beyond

Barrier Length	0	10	20	30	40	50	60	70	80	90	100	110
Est risk: Vehicle occupant	0.01865	0.01217	0.00654	0.00479	0.00446	0.00466	0.00506	0.00553	0.00602	0.00652	0.00703	0.00754
Est risk: Other	0											
Estimated B/C	0	0.05	0.1	0.12	0.11	0.09	0.08	0.07	0.05	0.04	0.03	0.02

Figure 9-14 Detailed results for a hazard on a single carriageway

The 'Barrier Beyond' detailed result table shown at the bottom of the report is only returned when a single carriageway is being assessed, i.e., where vehicles can approach the hazard from either direction. Here, the risk is 'Tolerable' with no VRS. It becomes 'Acceptable' somewhere between 0 m and 10 m of N2 containment VRS, the actual minimum length required beyond of 7 m being given in the 'Collation of Data' sheet extract shown above. An additional length of safety barrier beyond the 7 m will be required to achieve full containment at 7 m beyond the hazard, in accordance with the manufacturer's declaration (CD 377 Figure 3-19 refers).
Were the RRRAP to indicate that the risk without VRS beyond the hazard is 'Acceptable', as confirmed in the 'Detailed Results', then the additional length of safety barrier beyond the hazard required to achieve full containment at the end of the hazard will still be required.

The risk in advance of the hazard is 'Unacceptable' with no VRS and with up to 10 m of N2 containment VRS. It reduces to a 'Tolerable' level with 20 m VRS and becomes 'Acceptable' level with between 20 m and 30 m of N2 containment VRS. The actual minimum length required in

advance of the hazard of 27 m being given in the 'Collation of Data' sheet extract shown above. In this case, the optimum benefit cost ratio is also best at around 30 m length (although it remains very low). Again, an additional length of safety barrier in advance of the 27 m will be required to achieve full containment at 27 m in advance of the hazard, in accordance with the manufacturer's declaration (CD 377 Figure 3-19 refers).

9.6 Hazard Groupings

The information presented by the RRRAP via the 'Collation & Reports' and 'VRS Summary' pages, as well as through the risk calculation, differs for hazards depending on the hazard category and the nature of the hazard. The following highlights what additional details should be expected, and which hazards are affected.

9.6.1 Hazards with Secondary Knock-on effect

Tall hazards can potentially have secondary knock-on effects if the hazard is hit. Tall hazards include:

- 1200 Traffic Signs or Signals: all categories (including those with 'Gantry' in description or sign store) where height is over 3 m
- 1300 Lighting columns: all categories apart from Electricity supply cabinet
- 1500 Motorway Comms: 'Comms or CCTV Mast', 'Posts', 'Posts (PS)' where height is over 2m
- 8600 Poles and Pylons: Telegraph and electricity poles, pylons, posts – all heights.

If any of these hazards are in a RRRAP record, once risk has been calculated, on the 'Risk Calculation Issues' page, you will be prompted to answer a question for each tall hazard (shown in Figure 9-15).

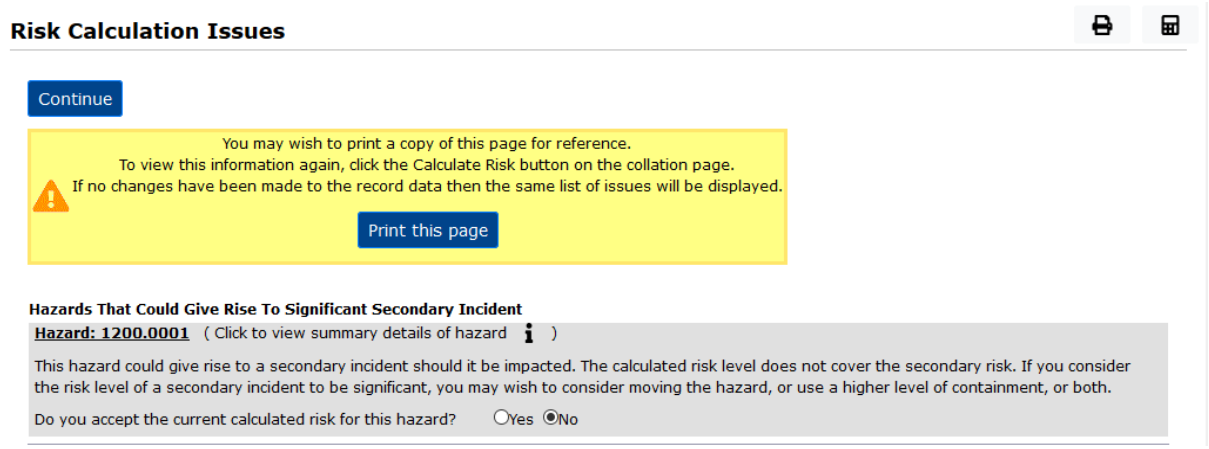


Figure 9-15 Hazard with secondary knock-on effect

By default, the question has the answer 'No'. You can leave this default value and continue back to the 'Collation' page. The 'tall hazard' warning will continue to appear on the 'Risk Calculation Issues' page (and as an issue related to the hazard in any generated full report) until answered 'Yes'.

An additional field is visible for these hazards on the 'view / edit hazard' pages accessed via the 'Collation' page, where the question can also be answered.

The question response is included in the snapshot and full reports.

9.7 Snapshot Report

You may wish to generate snapshot reports at different stages during the RRRAP process, e.g. initial data entry record, details of a particular calculation run, etc.

Click the 'Snapshot Report' button on the 'Collation & Reports' page to generate the report at any time.

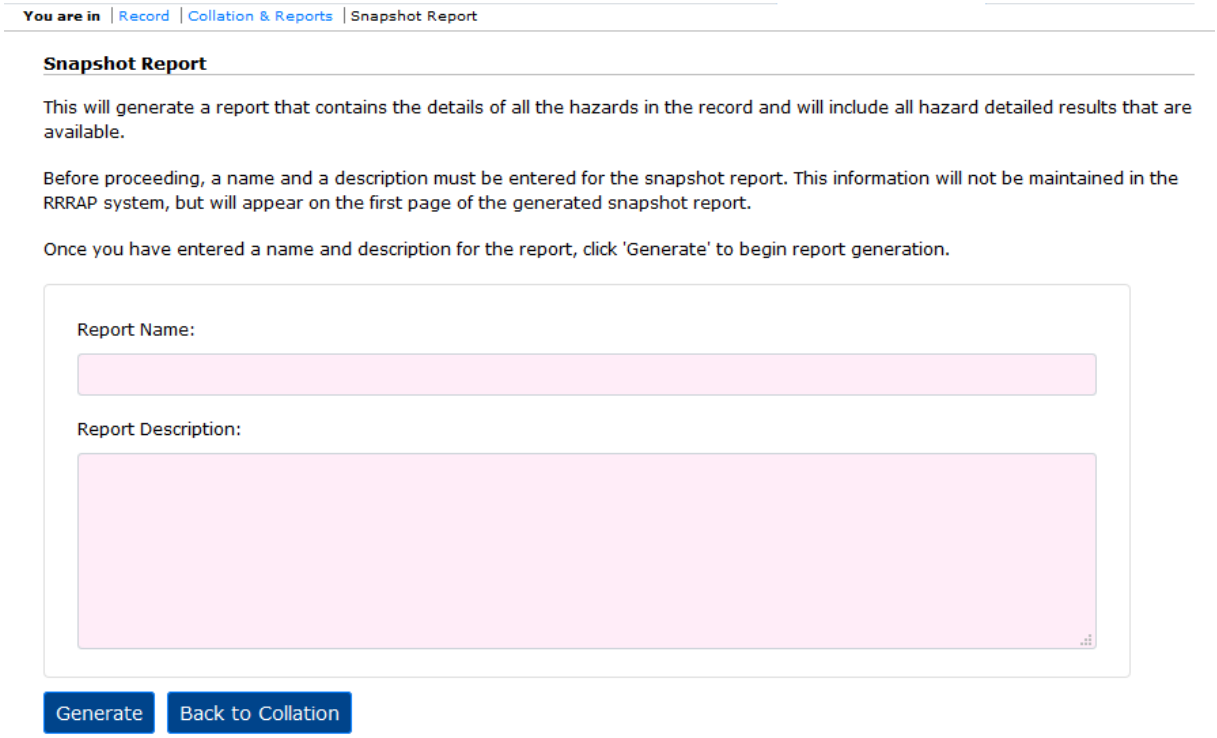


Figure 9-16 Snapshot Report page

The 'Snapshot Report' contains the details of all the hazards, as well as any detailed results that are available.

Before you can generate a 'Snapshot Report', you must enter a name and a description for the report. This information will not be maintained within the RRRAP but will appear on the first page of the generated report. The name and description should be sufficient to identify the reasons for the 'Snapshot Report' generation (e.g. calculation run X with Y changed).

9.8 Calculation of Risk – Option Testing and Selection

In the 'Collation & Reports' page, once the risk has been calculated, the designer can investigate, for instance: the change in level of risk or length of safety barrier required by altering one or more of the parameters relating to a hazard or to the safety barrier, and then recalculating the risk.

The effect for instance of changing the aggressiveness from 1.7 to that of a passively safe column (0.25) could be tried.

If the working width class is altered from the default of W2, the Designer must manually change the barrier working width and check that the hazard lies outside the revised safety barrier working width.

Hazard: 1300.0001					
	Nature of Hazard	Row of lighting columns < 40m apart		Local Alignment [F2]	Good alignment
	Start Chainage of Hazard	40.0		Sleep - Related Site [F3]	A
	Length of Hazard	140.0		Speed [F4]	Mean speed < speed limit
	Width of Hazard	0.2		Other Features [F6]	W
	Offset of Hazard from Psb	2.5		Multiplicative Factor for Run-off Rate	0.9
	Height / Depth of Hazard	<10m high		Topography Factor	1.0
	Aggressiveness	1.7			
	Comment				
Secondary Incident					
	Is calculated risk level accepted for hazard that could give rise to a significant secondary incident?				No
Risk Levels - VRS Details - B/C Details					
	Is risk without VRS acceptable?	No		VRS WW Class	W2
	Level of risk with optimum length VRS?	Acceptable		VRS WW (m)	0.8
	Minimum Length VRS in advance (m)	9		Set-back (m)	0.6
	Minimum Length VRS in beyond (m)			Cost of Option (avg/year, £)	0.0
	Containment Level	N2		Relaxation / Departure required?	None

Changing barrier from 0.6 m offset (default value when there is a hard strip or hard shoulder present) to, say 1.2 m offset, can be done if the verge width is adequate to allow VRS to be moved – see Figures 3.28 and 3.29 of CD 377 for details of constraints.

A return of 0.0 here indicates that the default costs are being used in the RRRAP. If more accurate VRS cost information is available, the default average value can be changed. Back up for new costings must be provided in the table on the 'Barrier Option Costs'

Figure 9-17 Viewing a hazard's details from the 'Collation & Results' page

10 The Designer must Check and Ensure

(i) All the hazard definitions and parameters and risk values calculated represent the final chosen option (this can be checked by either viewing individual hazards via the 'Collation & Reports' page or by viewing a 'Full Report', see section 11.3),

(ii) Detailed Results have been generated where necessary and the 'Comment' field for individual hazards has been populated with all the relevant data to back up the decisions made.

11 VRS Summary

The 'VRS Summary' can be viewed by clicking the 'VRS Summary' button on the 'Collation & Reports' page.

To add any further comments to a hazard to support the design choices, edit the hazard via either the 'Collation & Reports' or 'Hazards Overview' pages.

The 'VRS Summary' page lists all the hazards that require some form of protection.

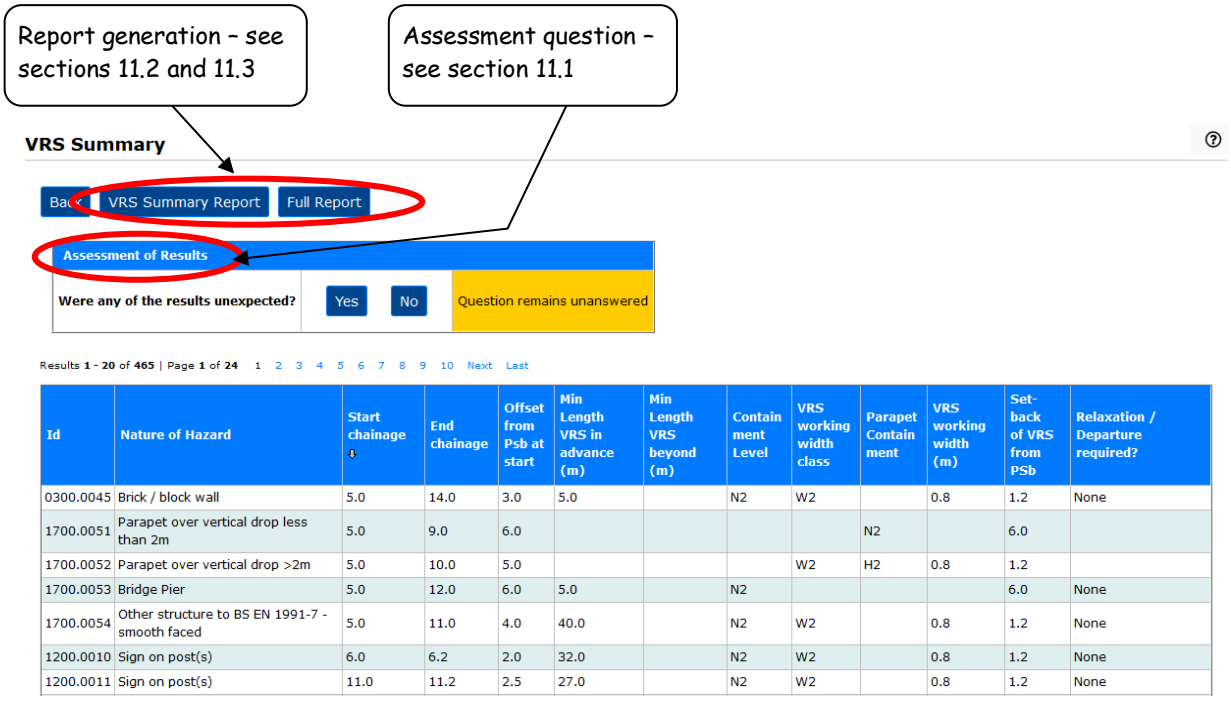
Notes

(i) This page will not list any hazards until risk has been calculated for the first time (other than the exceptions identified in point (iv).

(ii) This page will not list any hazards if, after running the risk calculation, no hazards in the record require protection (other than the exceptions identified in point (iv).

(iii) The hazards listed on this page will change if the user modifies hazard details and re-runs the risk calculation.

(iv) In addition to the hazards that require VRS protection, there are three hazard types that will always appear in the VRS Summary table if they are present. These are Parapets, Pedestrian Guardrail and Emergency Telephone hazards. This is so that they are flagged to enable designers to correctly consider design requirements for any VRS at these hazards that is required for adjacent hazards (see for instance CD 377 Figures 3.68a and 3.68b).



Id	Nature of Hazard	Start chainage	End chainage	Offset from Psb at start	Min Length VRS in advance (m)	Min Length VRS beyond (m)	Containment Level	VRS working width class	Parapet Containment	VRS working width (m)	Set-back of VRS from PSb	Relaxation / Departure required?
0300.0045	Brick / block wall	5.0	14.0	3.0	5.0		N2	W2		0.8	1.2	None
1700.0051	Parapet over vertical drop less than 2m	5.0	9.0	6.0					N2		6.0	
1700.0052	Parapet over vertical drop >2m	5.0	10.0	5.0				W2	H2	0.8	1.2	
1700.0053	Bridge Pier	5.0	12.0	6.0	5.0		N2				6.0	None
1700.0054	Other structure to BS EN 1991-7 - smooth faced	5.0	11.0	4.0	40.0		N2	W2		0.8	1.2	None
1200.0010	Sign on post(s)	6.0	6.2	2.0	32.0		N2	W2		0.8	1.2	None
1200.0011	Sign on post(s)	11.0	11.2	2.5	27.0		N2	W2		0.8	1.2	None

Figure 11-1 VRS Summary page

11.1 Assessment of Results

At the top of the 'VRS Summary' page is a small section titled 'Assessment of Results' as shown in Figure 11-1.

The Designer should only answer the question 'Were any of the results unexpected?' once risk assessments for all hazards have been completed and no further changes are to be made. The Designer's response to this question will be included within any generated 'VRS Summary' and 'Full Report'.

If significant unexpected results are found, these should be reported by email to the National Highways Vehicle Restraints team via RRRAP@nationalhighways.co.uk.

11.2 VRS Summary Report

Clicking the 'VRS Summary Report' link will generate a 'VRS Summary' report. Users can choose between a PDF or CSV file as the report format. Once the report has been generated, a browser specific dialog will be displayed. This will allow you to either open or save the generated report.

The report will contain summary details of the section being assessed (section details, location details) as well as listing details for the hazards that require protection.

11.3 Full Report

Clicking the 'Full Report' link will generate a report of the full details of the RRRAP record. Once the report has been generated, a browser specific dialog will be displayed. This will allow you to either open or save the generated PDF or CSV report.

The 'Full Report' contains all of the following details:

- Record Information (record name, project name, description, the RRRAP version number and issue date, etc)
- The answer to 'Assessment of results' question on 'VRS Summary' page
- Record declarations (i.e. any completed sign off details from the 'Record Status' tab)
- All 'Common Details'
- 'Option Costs' (if any provided)
- All data relating to each individual hazard (both entered by the user and generated via risk calculation) categorised by hazard type.
- Any available 'Detailed Results' generated for specific hazards.
- 'VRS Summary' details
- Temporary VRS details where these are applicable see section 13 'Temporary Works'

Note: The 'Full Report' does not contain any 'Restraint Summary' details entered via the 'Restraint Summary' page. A report containing these details can be created via a separate report link which is available in the 'Restraint Summary' page (see section 12.1).

The 'Full Report' can be generated at any time and does not rely on running the risk calculation or there being hazards listed in the 'VRS Summary' page.

It is **recommended** that you generate a 'Full Report' and use the 'Export' facility (see section 4.4) to back up your hazard data at key stages in the design process.

12 Restraint Summary (Specification Appendix 4/1)

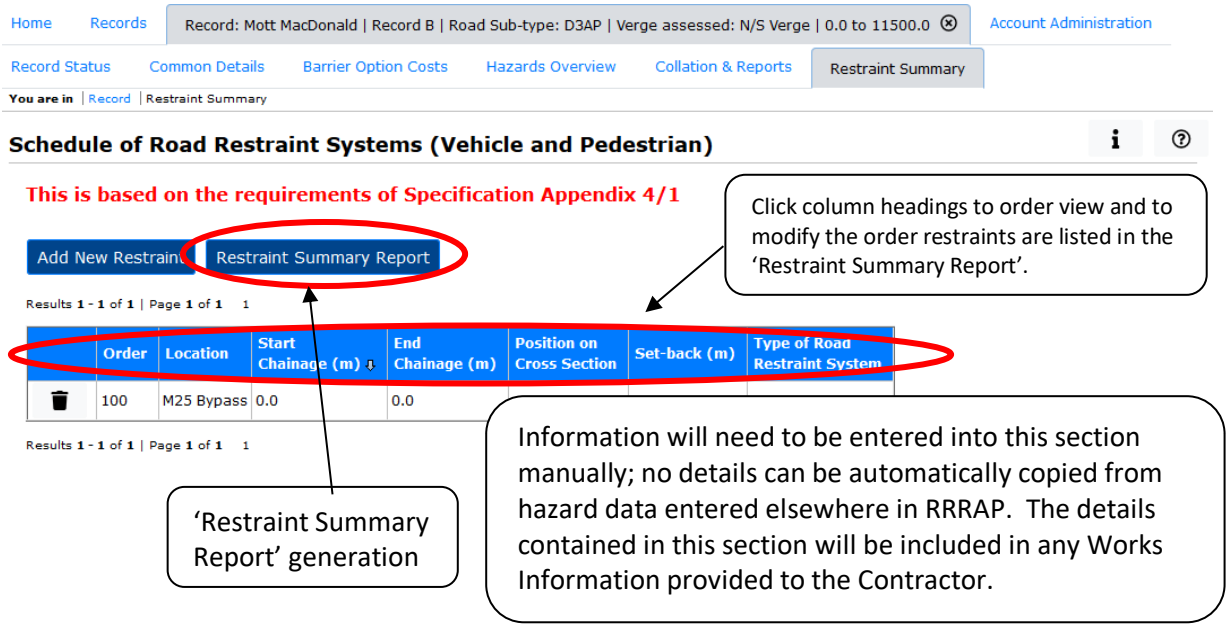


Figure 12-1 Appendix 4-1 Restraint Summary

Notes:

- Complete the schedule 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 respective Start and End Chainages of each of the proposed Road Restraint Systems should be listed.
- All the Performance Class requirements as defined in CD 377 appropriate for each of the Road Restraint Systems 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 CD 377.

12.1 Generating the Restraint Summary Report

By default, the order of hazards requiring restraints in the 'Restraint Summary Report' is by start chainage. If you wish to alter the ordering of the Report, click the column headings in the completed Appendix 4-1 Restraint Summary table (see Figure 12-1). Clicking a heading will sort the hazards and restraints by that field. Clicking the same heading multiple times will switch the details to be in either ascending or descending order based on the chosen field.

Once you have chosen your desired ordering, generate the 'Restraint Summary Report' by clicking the 'Restraint Summary Report' link. The report can be generated as a PDF or CSV file. Once the report has been generated, a browser specific dialog will be displayed. This will allow you to either open or save the generated report.

13 Temporary Works

Where VRS installations are expected to be temporary, e.g. when the VRS is required for a short period whilst a permanent VRS solution is being prepared or to protect a temporary hazard during roadworks, to enter temporary hazard information, you must answer 'Yes' to the option 'Temporary works' listed under 'Reason for Design' in the 'Common Details' section (see section 5.2).

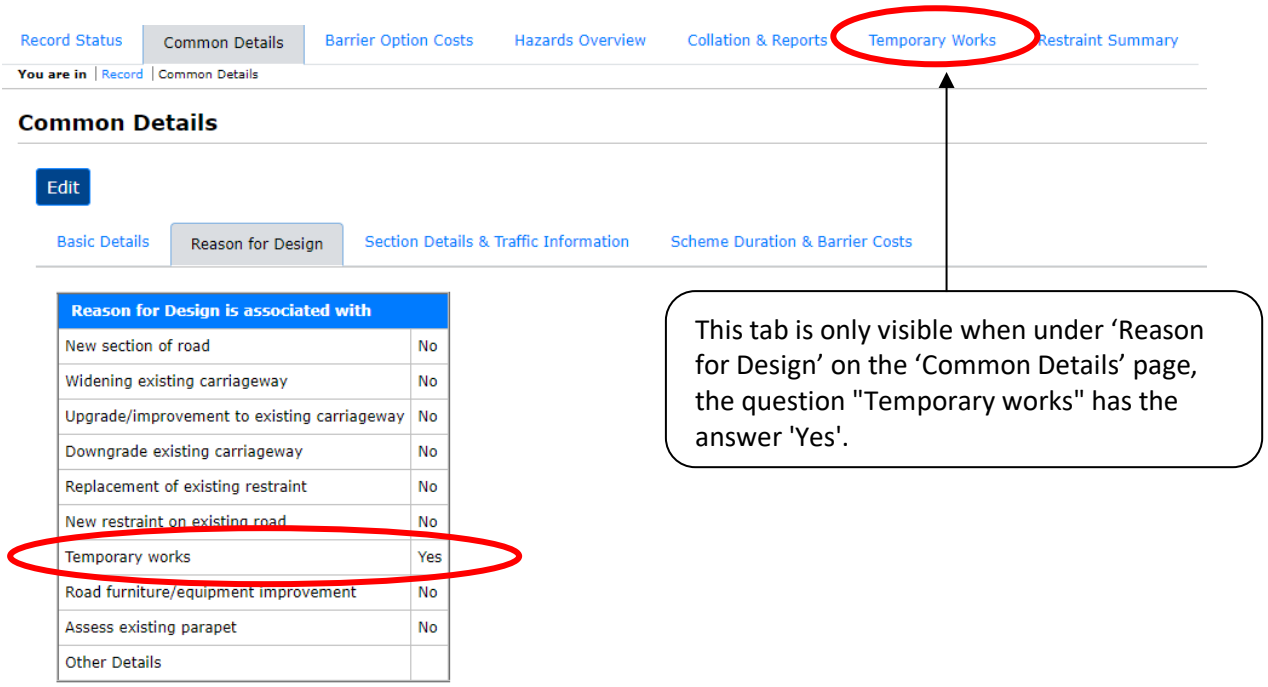


Figure 13-1 Temporary Works

In the 'Temporary Works' page (see Figure 13-12), click the 'Add New Temporary Hazard' button. This will create a new set of questions to answer relating to the temporary hazards (see Figure 13-3). Up to four copies of the question set can be created.

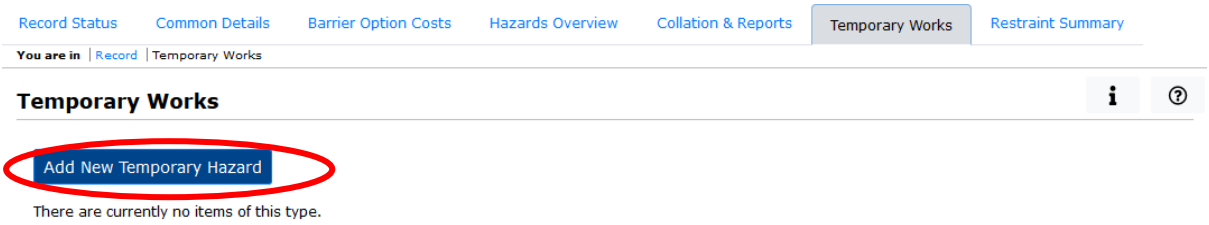


Figure 13-2 Temporary Works add new temporary hazard

.

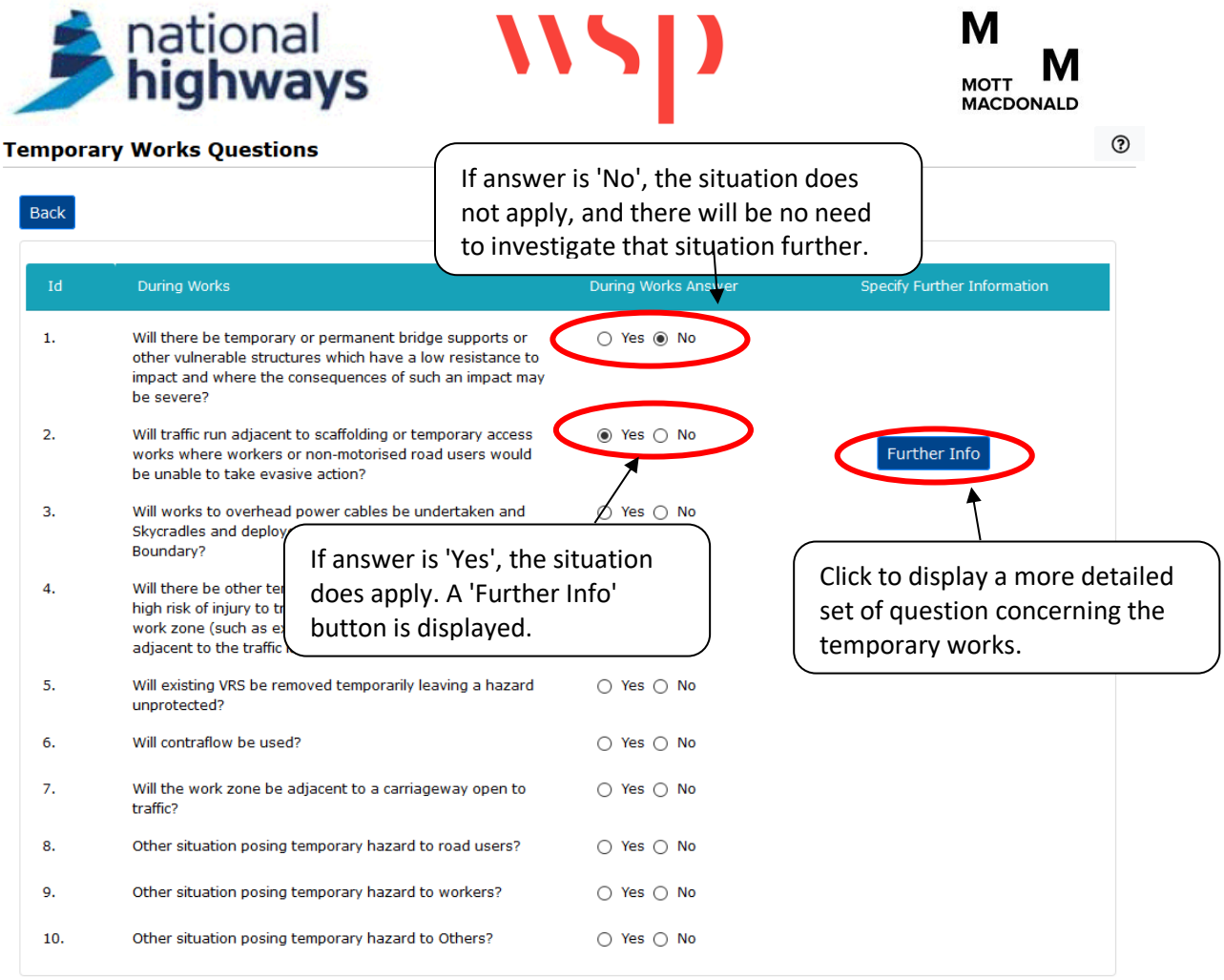


Figure 13-3 Temporary Works Questions

The set of questions describe typical situations that might be encountered during temporary works. For each question indicate either (via ‘Yes’ or ‘No’) whether or not each of the circumstances applies in the situation being assessed.

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

If the answer is 'Yes', the situation does apply; a 'Further Info' button is displayed. Clicking this button will display a more detailed set of questions concerning the temporary works. Completing these questions will assist 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.

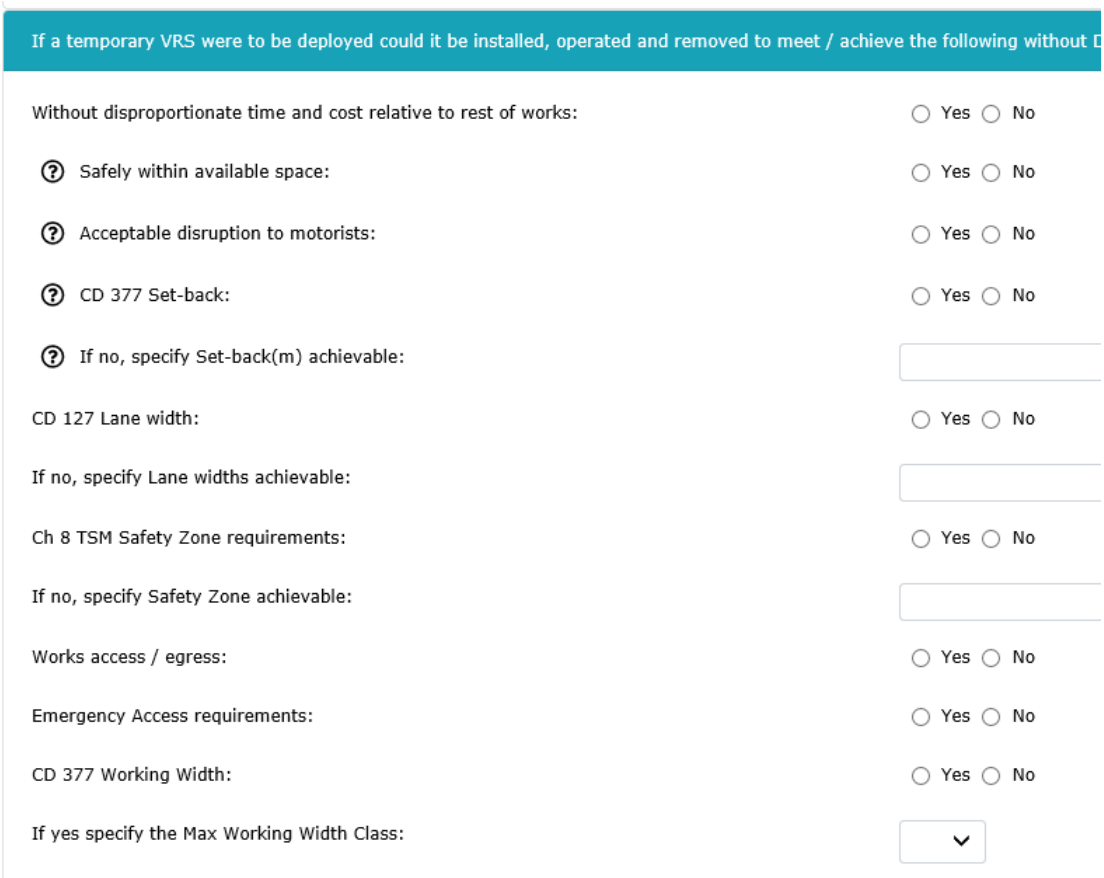


Figure 13-4 Temporary Works details (1)

Figures 13-5, 13-6 and Figure 13-7 show the set of questions and help menus available for temporary works. 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 VRS 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 recorded in the 'Comment' field.

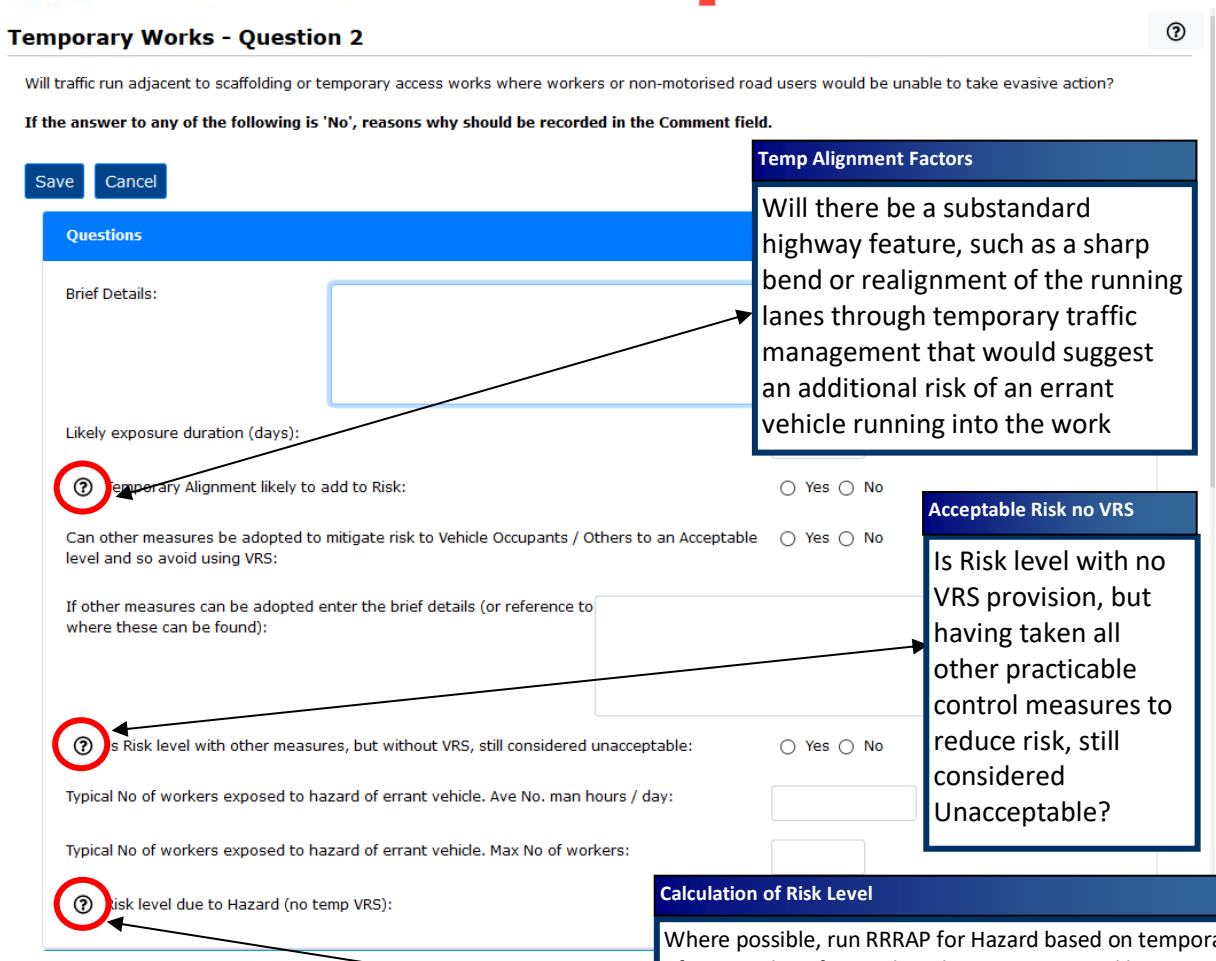


Figure 13-5 Temporary Works details (2)

Figure 13-6 Temporary Works details (2)

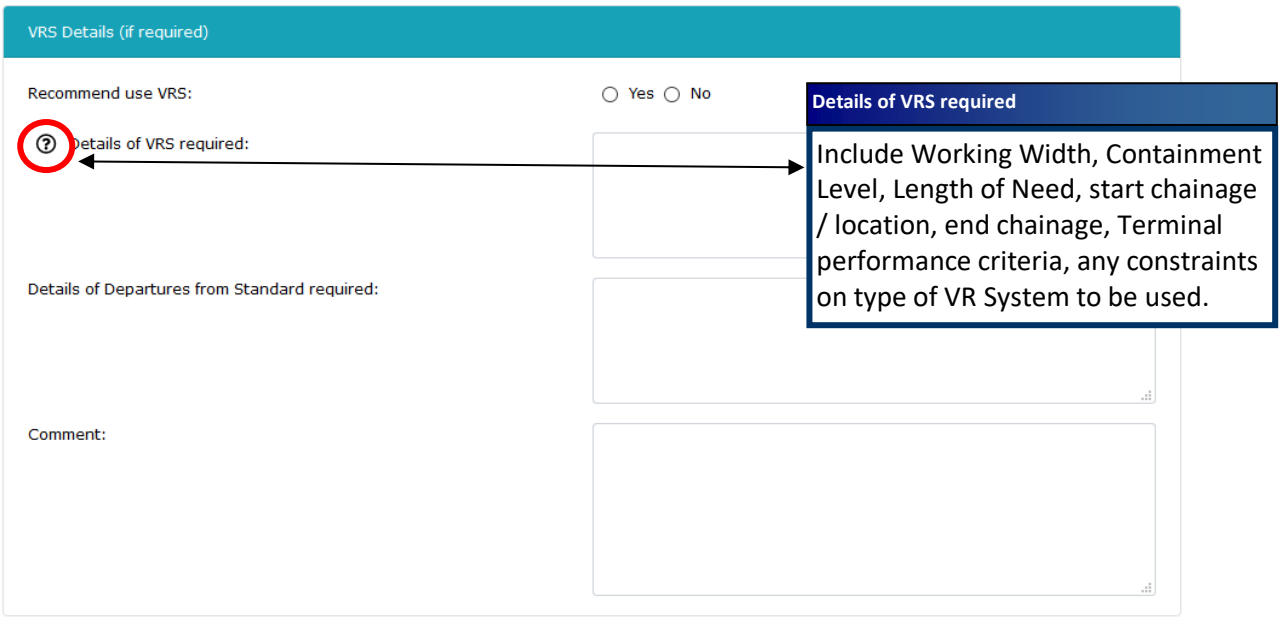


Figure 13-7 Temporary Works details (3)

A record of the temporary works information input into the RRRAP can be exported by using the 'Full Report' option on the under the 'Collation & Reports' page.

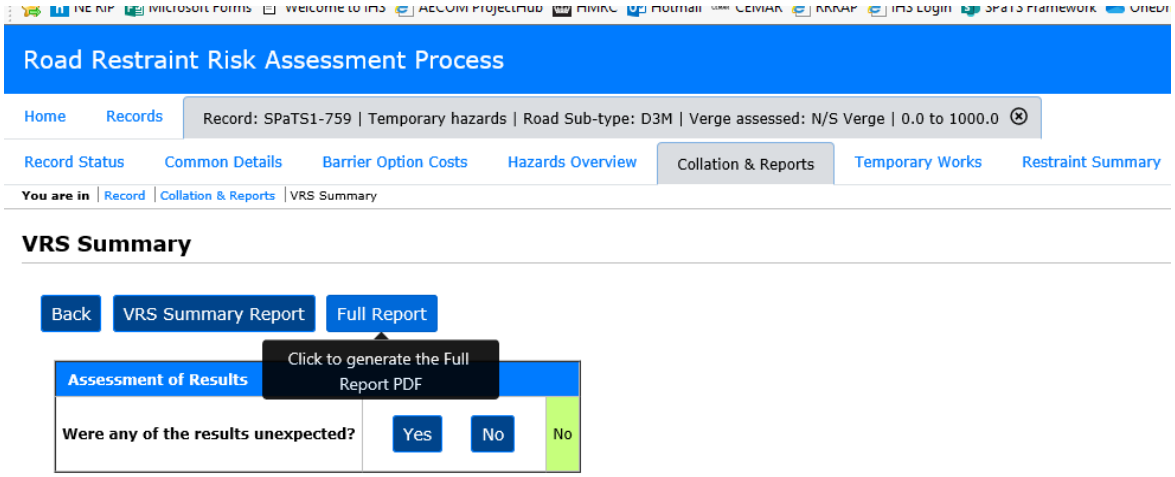


Figure 13-8 Temporary Works report export

14 Saving and retaining a copy of the RRRAP

It is essential, once the RRRAP process has been completed and the Design Organisation has completed all its internal checks and is satisfied with the content and outcome of the RRRAP, that a copy is retained, stored and backed up as appropriate on the Design Organisation's own records systems. This is so that they can be readily viewed, used as the basis for future designs, and be provided as part of the Pre-Construction Information (if required) and Health and Safety File records for the Scheme, Maintenance Area and Highway Authority, as appropriate, and that it is available to the Client and all those who have a legitimate need to make use of it in the future.

Note that the RRRAP site does not have the capacity for long term storage of RRRAP records and it must not be relied upon as providing an indefinite archive. Organisations must manage their record slot allocations on the RRRAP web site through exporting RRRAP records at appropriate stages during the design and development of projects.

The files archived in the Design Organisation's own records system should include:

- An exported copy of the RRRAP record (see section 4.4)
- A full 'Record' report (see section 11.3)
- A 'Restraint Summary' report (see section 12.1)
- Any other relevant files to be used as evidence (individual 'Detailed Result' reports, etc)

Design organisations should discuss and agree with their Client at an early stage how this requirement is to be fulfilled and implemented.

15 RRRAP calculation overview

The following presents an overview description of how the risk calculation works within the Road Restraints Risk Assessment Process (RRRAP) application.

Terminology

These terms are used within the following sections:

- w is the width of the hazard
- v is speed of vehicle at the hazard
- u is the initial vehicle speed
- f is the vehicle deceleration
- m is gradient
- θ is angle at which an errant vehicle might leave the carriageway (RRRAP uses a standard range of angles)
- s is the distance travelled by an errant vehicle
- b is cut-off
- Psb is the point from which setback is measured (refer to CD 127 for definition)

Hazard Risk Calculation

The following steps describe at a high level the process of calculating risk for a hazardous object close to a road at a known offset from Psb.

Road data user input required includes:

- Road type
- AADT flow
- Flow composition (%LGV and %MGV- if unknown, RRRAP assigns standard values for the particular road type)
- Carriageway width Psb to Psb
- Hard shoulder or hardstrip width
- Verge width

Hazard data user input required includes:

- Nature of hazard or feature – the RRRAP assigns to it an 'aggressiveness' value, depending on hazard type (supplied by the RRRAP software)
- For hazards where Others might be involved, (e.g. an adjacent road or railway) information relating to the nature of that hazard, the traffic, its speed and other factors that might influence the Other casualties were the hazard to be reached by an errant vehicle.
- Dimensions of hazard (length and width and, for some hazard types, the height, depth or vertical drop)
- Width and height of slope beyond verge (these factors influence the chance of a hazard within or beyond the slope being reached):
- Hazard offset from Psb.

Barrier data required includes:

- Setback from Psb (the RRRAP defaults to 1.2 m, depending on whether there is a hardshoulder or hardstrip present, otherwise to 0.6 m). These dimensions can be altered by the user as part of the assessment of possible options.

- Barrier containment level and working width (these are defaulted initially to N2 and W2 respectively but can be altered, if required, by the user during the assessment process).

Barrier data preset within the RRRAP (not able to be altered by the user)

- Dimensions of terminal and width of safety barrier and parapet (nominal values are assigned by the RRRAP software)
- Aggressiveness of terminal, safety barrier and parapet (supplied by the RRRAP software)

RRRAP calculation process

1. Check whether object type has special requirements e.g., Police Ramp, Gantry, etc. If so, calculation does not proceed any further; text is displayed pointing user to relevant standards document, e.g., CD 377 and or what further information is required of the user in order that the process can continue.

2. Calculate the effective offset of the hazard. This is based on the actual offset and depends on whether the hazard is on the verge, or on or beyond the side slope (formula from 1996 AASHTO Road Design Guide). The effective offset is equal to the actual offset for an object that is on the verge but is increased if it is up a cutting (harder for an errant vehicle to reach the object) and decreased if it is down an embankment (easier for an errant vehicle to reach the object). Add width of hard shoulder / hard strip to give distance from the running lanes.

3. For each vehicle type in turn i.e. car, medium and large goods vehicles (MGV and LGV):

3.1 Calculate the flow as a proportion of AADT that is vehicles of that type.

3.2 Use formula to calculate the number of single vehicle accidents per year per km (based on road type and calculated flow); from this, deduce the number of run-offs per year per km by using a multiplicative factor.

3.3 The calculation is undertaken for a set of runoff angles, each of which has an associated speed and proportion of errant vehicles leaving the road at this angle with this speed. Most errant vehicles will run off the road at small angles and relatively high speed, having drifted off due to inattention or impairment. Higher angles might be attained if the vehicle has skidded or if it hits something else first, for example the central barrier before leaving the road on the nearside. In this case, speed is likely to have reduced before the vehicle runs off the road, so higher angles have lower speeds associated with them. Use the speed / angle matrix for the current vehicle type; the speed / angle matrix for LGVs is different from that for MGVs and cars.

3.4 Also select the appropriate speed / accident matrix for the current vehicle type. This is used to determine the number of injuries resulting from the errant vehicle hitting the object, depending on the speed of the vehicle at impact and the aggressiveness of the object (speed / accident matrices are currently the same for all vehicle types, but strictly should differ).

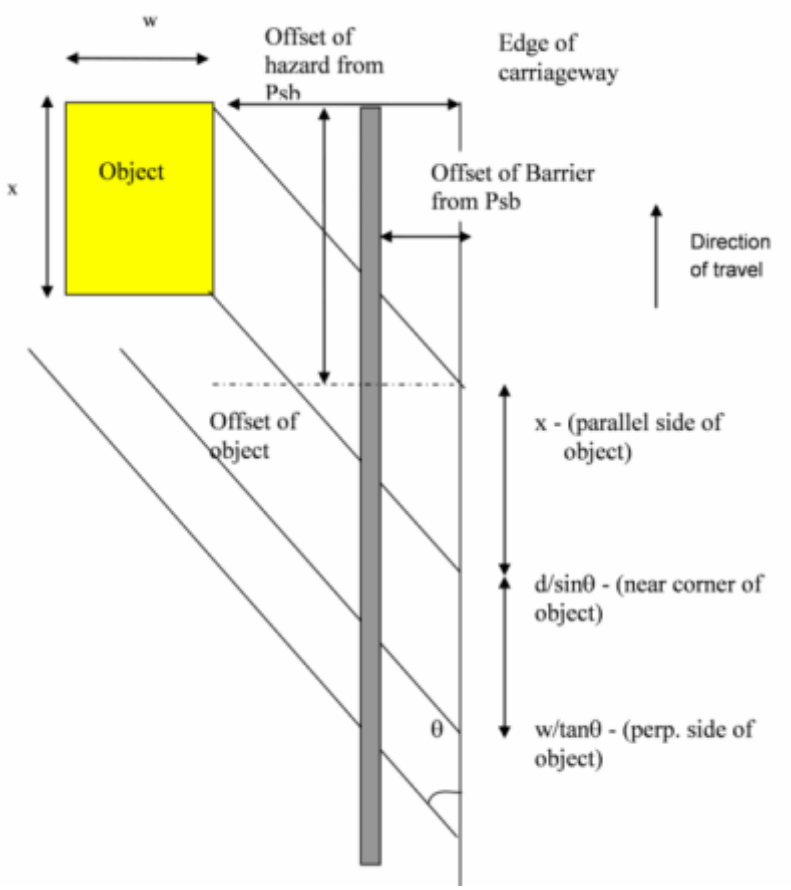
The steps below are then worked through for the terminal, the barrier, and finally the object.

3.5 For each of terminal, barrier, and object:

3.5.1 For each speed v / angle θ combination in the speed / angle matrix:

3.5.1.1 Calculate the effective length of the object or terminal as $w/\tan\theta+2/\sin\theta$ (omitting the actual length of the object and assuming that the width of the object is w, the errant vehicle is 2m wide and the runoff angle is θ) - see diagram below; barriers are assumed to have an effective length of 1000m, independent of angle, since errant vehicles all reach the barrier if they are travelling at a high enough speed.

(Note that the maximum width of objects in the RRRAP software is limited to 1.5m, to avoid the very large values of effective length that occur at small angles).



3.5.1.2 Calculate the number of run-offs per year over the effective length.

3.5.1.3 Include any modifying factors for runoffs due to poor road alignment, etc.

3.5.1.4 Calculate the distance 's' travelled to reach the object; s = (offset / sinθ).

3.5.1.5 Use the proportion of vehicles which leave the road at each angle (supplied by the RRRAP software depending on road type) to determine the number reaching the object.

3.5.1.6 For vehicles that do not breach the barrier (all light vehicles, most medium and some large goods vehicles) calculate the average speed of an errant vehicle at the object using the formula $v2=u2-2fs$. A more complicated approach is used for wider objects, in order to allow for the extra distance required to reach the far side of the object compared with the nearside. This assumes that the probability of the vehicle hitting the object at a position across the object's width decreases exponentially with distance from the running lanes; estimate an average speed by dividing the face of the object into strips and calculating the speed at each strip.

3.5.1.7 For those vehicles that breach the barrier, calculate the speed of the errant vehicle at the barrier, assume this speed is reduced by 20m/sec following impact with the barrier then, if the speed is still greater than zero, find the speed at the object by re-applying $v^2=u^2-2fs$ starting from the barrier.

3.5.1.8 Use the speed / accident matrix to determine the resulting number of fatal, serious, and slight accidents depending on the speed of the errant vehicle at the object. If v < 0, the vehicle never reaches the object; If v >= 0 calculate fatal, serious, and slight accidents depending on aggressiveness of object. Note: if the object is a rail or road feature, the consequences to the errant vehicle are independent of the speed at which it reaches the object (since vehicles reaching e.g., a railway track are at high risk even if their speed is zero).

3.5.1.9 Determine accidents involving Others (3rd parties), if any. Accidents involving a rail or road hazard are again independent of vehicle speed, since the risk arises from the presence of the errant vehicle rather than its speed; accidents involving Others if a vehicle hits a building, or a chemical / fuel depot are speed dependent and numbers of people likely to be present and duration of presence. Accidents involving Others are also influenced by, for instance, the adjacent railway/road type (number of tracks/lanes, train/traffic speed, etc).

3.5.1.10 To ensure that objects with a large offset are not easily reached, multiply the number of vehicles reaching the object by exp(-0.1 * (Offset - 6.5)) if the offset from the Psb exceeds 6.5m (value reached by trial and error during development of RRRAP software).

3.5.1.11 Convert accidents to fatal, serious, and slight casualties.

3.5.1.12 Convert casualties to equivalent fatalities (where 100 slight casualties = 10 serious casualties = 1 fatality).

3.5.2 End of speed / angle calculation loop.

3.5.3 Sum equivalent fatalities over all speed / angle combinations in matrix.

3.5.4 Add results for this vehicle type to totals.

3.6 End of object, barrier, and terminal loop.

4. End of vehicle type loop.

Now determine Benefit Cost Ratio and length of barrier needed.

For each angle θ:

5. Calculate length of need of barrier measured along the road required to prevent errant vehicles reaching object as:
length of need = effective length of object + offset of object / tan θ.

6. Use proportional triangles to deduce actual length of need at the barrier setback (shorter than the length of need along the road because the barrier is nearer the object).

7. Calculate fatal, serious, and slight casualties per year with barrier corresponding to the length of need; for medium and large goods vehicles, need to allow for breach.

8. Deduce equivalent fatalities per year for object, barrier, and terminal combined.

9. With a barrier corresponding to the length of need at the smallest angle, there are assumed to be no errant vehicles hitting the object. With a barrier of length of need corresponding to a larger angle, there will still be hits from errant vehicles leaving the road at smaller angles.

10. Calculate casualties per year from errant vehicle hitting the object if there is a barrier equal to the length of need - these will be casualties from smaller angles (which are not prevented by the barrier).

11. Calculate casualties per year with a barrier of length of need and a terminal.

12. Calculate the reduction in fatal, serious, and slight casualties per year if use a barrier of length equal to the length of need as:
Reduction = Total casualties per year with barrier over all angles minus casualties per year if there is a barrier of length of need corresponding to angle θ minus those with barrier and terminal.

13. Determine cost benefit of using barrier:

13.1 Benefit is cost of casualties over (discounted) lifetime of barrier.

13.2 Cost is initial cost of barrier plus annual cost of maintenance over lifetime of barrier.

13.3 B/C is ratio of benefit to cost.

14. Deduce equivalent fatalities per year with the object if there is a barrier equal to the length of need.

15. Deduce equivalent fatalities per year with a barrier of length of need and a terminal.

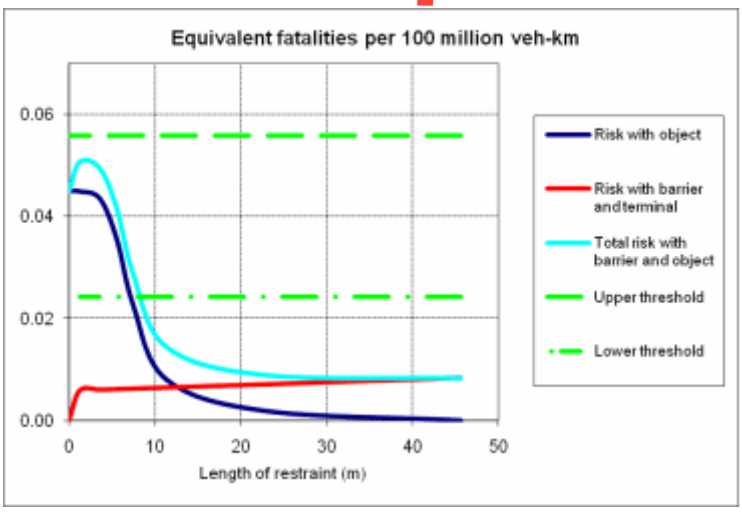
16. Deduce equivalent fatalities per year with object, barrier and terminal combined.

17. Repeat steps 14 to 16 with equivalent fatalities per year replaced by the RRRAP definition of "risk" (i.e., equivalent fatalities per 100 million veh-km, assuming a 100m length to reflect the zone of influence of the object, rather than the actual length of the object). This also includes calculating the risk with no barrier.

End of angle calculation loop

At this point in the calculation, we have now determined risk with the object and barrier combined and the Benefit Cost Ratio of the barrier as a function of barrier length at a set of irregular intervals (corresponding to the length of need at each angle).

Thresholds are used to determine whether risk is acceptable, tolerable, or intolerable. The upper threshold is the boundary between tolerable and intolerable and the lower threshold is the boundary between tolerable and acceptable. They were set to ensure that an aggressive object close to the road generally requires a barrier (risk is intolerable) even if small and that risk for a larger aggressive object is generally acceptable with an N2 barrier.

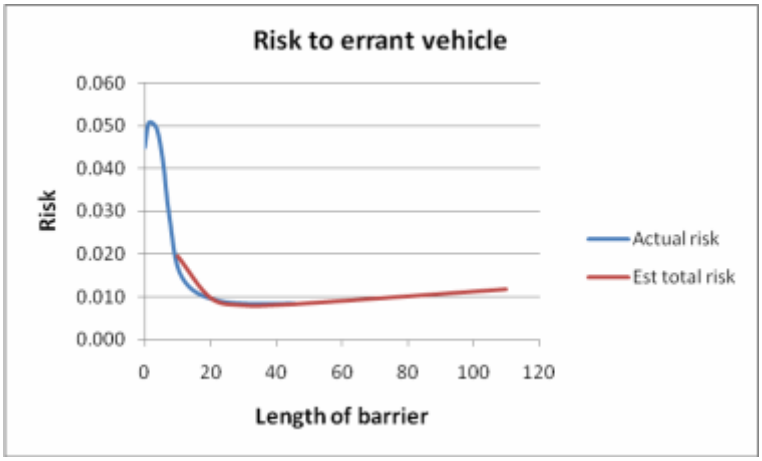


18. Deduce risk at pre-defined regular intervals, e.g., 10m, 20m, 30m etc by fitting a suitable curve:

18.1 Use exponential regression to fit the risk curve (without barrier). This gives a best fit curve following the form y = bm^x.

18.2 Use linear regression to estimate the barrier risk. This gives a best fit line following the form y=mx+b (straight line fit from first principles).

18.3 Total risk is sum of these (generating risk without barrier and also risk with barrier).

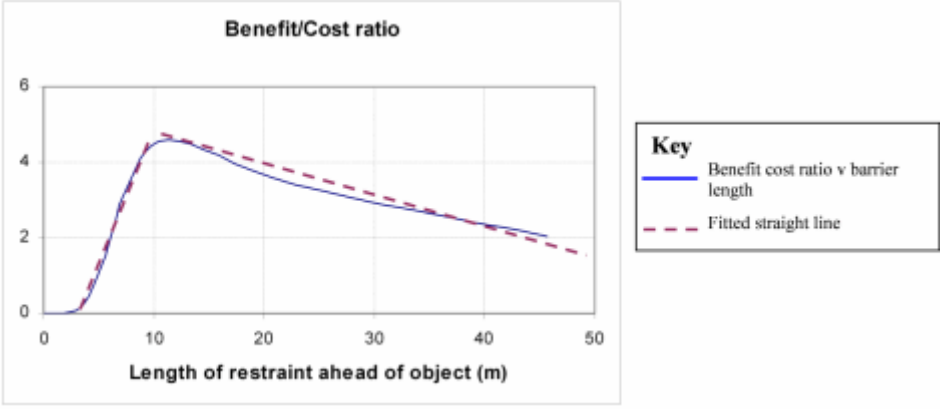


19. If applicable, also calculate Risk to Others (equivalent fatalities per 100 million vehicle-km to Others on adjacent road, railway, building or chemical / fuel depot)

20. For both errant vehicle occupants and Others, if present, test whether the risk without a barrier is acceptable. If so, there is no need for a barrier.

Otherwise, determine the minimum length of barrier for which risk is acceptable, if this exists, using the calculated risk curve (see step 18.1). The length is the minimum for which risk is acceptable for both vehicle occupants and Others (3rd parties), if present. N.B. on the road there will be a minimum operational length of barrier; (see CD 377), but the calculated value is output by the RRRAP software.

21. The Benefit cost ratio as a function of barrier length is approximately an inverted V shape (see diagram below). Fit a straight line to approximate each side of the V. Deduce the benefit cost ratio at the same intervals of barrier length as used for the risk curve (i.e., 10m, 20m, etc).



22. Output the minimum length of barrier that gives acceptable risk and the corresponding Benefit Cost Ratio.

23. Note that for errant vehicles, increasing barrier length increases risk after the minimum value is used, but this is not the case for risk to Others, which is forced to be left at its minimum value once it starts to rise again. The reason for this is that risk to Others does not directly affect Others (though it does affect the occupants of light vehicles).

Parapet Calculation

The model for parapets is much simpler than for other objects.

Currently, the offset of the parapet is not fully taken into account. The parapet is assumed to be close to the Psb with risk increased if there is a substandard hard shoulder on a motorway or no hardstrip on an all-purpose road.

A major difference between parapets and other objects is that risk is assumed to arise from the number of vehicles breaching the parapet rather than hitting it (although the barrier required in advance to stop vehicles hitting its end is calculated in the usual way). There is a possible 3rd party risk depending on what is beneath the parapet.

The following steps describe at a high level the process of calculating risk for a parapet:

For each parapet containment type (starting with N2, then H2, then H4A):

1. For each vehicle type in turn (car, medium and large goods vehicles):

    1.1. Determine average number of vehicles per year breaching the parapet.

        1.1.1. Number of runoffs per year over length of parapet = (Length of parapet / 1000) * Runoff Rate Per km (run off rate calculated as in step 3 for standard hazards)

        1.1.2. Total number of vehicles of this type breaching parapet = No of runoffs per year * proportion of vehicles of this type breaching parapet

1.2. Sum result over vehicle type to get total number of vehicles breaching parapet of this containment level.

2. Modify number of vehicles breaching parapet to allow for substandard hard shoulder width

3. The risk to the vehicle occupant is assumed to arise from breaching the parapet and RRRAP calculates only fatal casualties arising from this

4. Cost of casualties per year to vehicle occupants = Number of vehicles breaching parapet per year * Cost of fatality * Number of fatalities per accident

5. Cost of casualties to Others = Number of vehicles breaching parapet * Cost of fatality * Number of fatalities per accident. Note that the number of fatalities per accident is set to 0.4 (this was adopted as a suitable value for the likelihood in connection with the report on the Selby accident).

6. Convert Number of vehicles breaching parapet to Parapet Risk, i.e., equivalent fatalities per 100 million vehicle km. If present, determine risk to Others.

7. Derive Total cost of casualties per year:

7.1 If N2 is barrier type then
Total cost of casualties per year = Cost of casualties to vehicle occupants + cost of casualties to Others

7.2 Otherwise, calculate
Benefit Cost Ratio of upgrading parapet Benefit per year from upgrade = Total cost of casualties per year with current containment - Total cost of casualties per year with N2 containment
Parapet Benefit / Cost Ratio = (Benefit from upgrade) * Barrier Lifetime / Total cost of upgrading parapet.

8. If the highest risk from either Risk to vehicle occupants or Risk to Others <= lower threshold value then the risk is acceptable, and we have finished determining parapet risk. If not, then loop round with the next parapet containment level (i.e., if parapet containment level is N2, loop back round with H2, otherwise H4A). H4A is assumed to contain all vehicles.