Volume 5 Section 2
Part 2
NRA HD 19/01

NATIONAL ROADS AUTHORITY
An tÚdarás um Bóithre Náisiúnta

Road Safety Audits

Incorporating NRA HA 42/01 Road Safety Audit Guidelines

June 2001

Headquarters St. Martin's Hse., Waterloo Road, Dublin 4. Tel: 01 660 2511 Fax: 01 668 0009

Summary :

This Standard covers the requirements for Road Safety Audits on national road schemes. It describes the stages at which the audits shall be carried out, the procedures to be followed and the monitoring of schemes after opening.

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2001

VOLUME 5 ASSESSMENT AND PREPARATION OF ROAD SCHEMES

SECTION 2 PREPARATION AND IMPLEMENTATION

PART 2

NRA HD 19/01

ROAD SAFETY AUDITS

Contents

Chapter

1. INTRODUCTION

General

1.1 The objective of this Standard is to ensure that the road safety implications of all schemes are fully considered for all users of the road and others affected by the scheme.

1.2 This Standard supersedes NRA HD 19/00, Road Safety Audits, dated December 2000. Revisions have been made to Paragraphs 2.19 to 2.23 and to Figure 1.

Definitions

1.3 *Road Safety Audit:* The evaluation of road schemes during design and construction to identify potential safety hazards which may affect any type of road user, before the scheme is opened to traffic, and to suggest measures to eliminate or mitigate those problems.

1.4 *Road Schemes:* All works that involve permanent change to the existing road layout.

1.5 *Design Office:* The organisation managing the various phases of scheme preparation and supervision of construction.

1.6 *Design Team:* The group undertaking the various phases of scheme preparation and supervision of construction on behalf of the Design Office. This may be a team within the Design Office or a separate consultant.

1.7 *Audit Team:* A team of a minimum of two persons, independent of the Design Team and approved by the Overseeing Organisation. The Audit Team shall comprise staff with appropriate levels of training and experience in road safety engineering, accident investigation and safety audit, as set out in memoranda produced from time to time by the Overseeing Organisation. Each member of the Audit Team shall consider the scheme design at specific stages to identify road safety problems. In the case of Design and Build schemes, the Audit Team shall be from a completely separate organisation to the Design Team.

1.8 *Audit Team Leader (ATL):* The person nominated and approved as Audit Team Leader in accordance with the memorandum discussed in Paragraph 1.7 above.

1.9 *Director:* The Head of Project Management and Engineering in the Overseeing Organisation. In Ireland, the Overseeing Organisation for national roads is the National Roads Authority.

1.10 *Design Office Project Manager (DOPM):* The person within the Design Office responsible for ensuring the progression of a scheme in accordance with policy and procedures.

1.11 *Design Team Leader (DTL):* The person within the Design Team responsible for managing the scheme design.

1.12 *Exception Report: A* report prepared by the Design Office PM following discussion with the Director on each recommendation in the Audit Report which the Design Office PM proposes should not be implemented. The report shall give reasons and, where necessary, propose alternative means of addressing the underlying safety problem identified by the Audit.

1.13 During the course of scheme preparation and construction the Design Organisation may change, as may the personnel within the Design Team and Audit Team. It is recommended that, where possible, the same Audit Team be used throughout the scheme delivery to ensure a consistent approach.

Scope

1.14 This Standard sets out the procedures required to implement Road Safety Audits on national road schemes. It defines the relevant schemes and stages in the design and construction at which audits shall be undertaken and sets out the requirements for post-implementation accident monitoring.

1.15 The Standard is commended to other Roads Authorities for use in the preparation of their own road schemes on non-national roads.

Implementation

1.16 This Standard shall be used for schemes currently being prepared (unless granted specific exemption – see Paragraph 2.4 below) provided that, in the opinion of the Overseeing Organisation, this would not result in unacceptable additional preparation cost or unduly delay progress. Schemes for which planning is initiated after December 2000 shall be subject to this Standard unless exempted under Paragraph 2.4.

2. ROAD SAFETY AUDIT

Schemes to be Audited

2.1 Except as noted at Paragraph 2.4 this Standard shall apply to all road schemes on national roads including motorways. This includes work carried out under agreement with the Overseeing Organisation resulting from developments alongside or affecting the national roads.

Application to Major Temporary Traffic Management Schemes

2.2 Application of this Standard to major temporary traffic management schemes is at the discretion of the Design Office PM in consultation with the Overseeing Organisation.

Application to Design and Build Contracts

2.3 Except as noted at Paragraph 2.4, this Standard shall apply to Design and Build contracts.

Exemption

2.4 Schemes may be given exemption from auditing requirements by the Director where their effect on the network is minimal or where specialist consideration has already been given to safety issues and a formal audit would merely duplicate that work.

Scope of the Audit

2.5 The Road Safety Audit shall only consider matters that have an adverse bearing on road safety. It shall consider safety under all operating conditions.

2.6 The primary purpose of a Road Safety Audit is to identify potential safety hazards within the scheme design as they could affect road users. The audit shall not be concerned with structural safety.

2.7 Formulation of recommendations for dealing with the identified hazards should make allowance for the fact that strategic decisions on matters such as route choice, junction type, standard of provision and Departures from Standards should already reflect the best balance of a number of factors, including safety.

Stages of Audit

2.8 Audits and subsequent action shall be completed at four specific stages in the preparation of the scheme, except as detailed in Paragraph 2.9 below. These stages are:

Stage F: Route selection stage, prior to route choice.

Stage 1: Completion of preliminary design prior to land acquisition procedures.

Stage 2: Completion of detailed design, prior to tender of construction contract. In the case of Design and Build contracts, a Stage 2 audit shall be carried out in accordance with the requirements of the contract.

Stage 3: Completion of construction (prior to opening of the scheme to traffic wherever possible).

2.9 In general larger schemes, except as noted at Paragraph 2.4, shall be audited at Stages F, 1, 2 and 3. In the case of smaller schemes, Stages F, 1 and 2 may be combined. For temporary traffic management schemes, only Stage 2 and 3 audits shall be required.

2.10 Where no previous stage audit has been undertaken then those factors that would normally be considered at an earlier stage shall be included as necessary.

2.11 On conventional admeasurement contracts, tenders shall not be invited until the Stage 2 Audit has been completed and the appropriate amendments incorporated into the design.

Audit Team – Proposal and Approval

2.12 The Design Office PM shall examine the curriculum vitae of each team member of available Safety Audit Teams in conjunction with a designated Safety Audit Officer of the Overseeing Organisation. Having satisfied him/herself and the Overseeing Organisation as to the qualifications of available Audit Teams, the Design Office PM shall appoint an Audit Team. The Audit Team shall have had no previous connection with the design of the scheme.

2.13 In the case of Design and Build contracts the procedure for appointment of the Audit Team may be included in the Employer's Requirements.

Project Management

2.14 The Design Office PM shall provide the link between the Audit and Design Teams for dealing with queries or requests for additional information.

2.15 The Design Office PM shall liaise with the Design Team and initiate the Audit process at the appropriate stages, ensuring that sufficient programme time is available to complete the full audit procedure. This should include an allowance for the incorporation of design changes.

2.16 The Design Office PM shall ensure that the Audit Team is given due notice of when the scheme will be ready for audit and the date by which the report shall be required.

2.17 The Design Office PM is responsible for ensuring that representatives of An Garda Siochana and those responsible for network management are invited to take part in the Stage 3 Audit.

Audit Brief

2.18 The Design Office PM is responsible for preparing the audit brief.

The Report and Subsequent Actions

2.19 The Design Office PM shall convene a meeting between the Audit Team, the Design Team and the Overseeing Organisation to resolve as many of the audit issues as possible.

2.20 At each stage, the Audit Team shall prepare a written report, which shall be forwarded directly to the Design Office PM, with a copy to the Design Team Leader and the Overseeing Organisation. The report must clearly identify the scheme, the audit Stage and the Audit Team membership, including the names of others contributing at Stage 3 site visits. The body of the report should be kept brief and shall contain descriptions of the specific road safety problems that the Audit Team believes would be created. It should include background reasoning in support of the findings together with the Audit Team's recommendations to eliminate or mitigate the hazards identified. The report should indicate the relative importance of each problem.

2.21 The reports shall contain a signed statement by each Audit Team member confirming team membership and independence from the Design Team.

2.22 The Design Team Leader shall consider the Audit Report and prepare a Design Team response to each of the recommendations, stating clearly whether the recommendations are accepted, rejected, or whether an alternative recommendation is proposed. Copies of the Design Team response shall be sent to the Design Office PM and the Audit Team.

2.23 The Design Office PM shall consider the Audit Report and the Design Team Response. Where unresolved issues remain, the Design Office PM shall prepare an Exception Report, following discussions with the Overseeing Organisation. The final decision shall rest with the Director of the Overseeing Organisation.

2.24 The Design Office PM shall instruct the Design Team in respect of any changes required during the preparation, design and construction of the scheme resulting from audit.

2.25 The Design Office PM shall send copies of all reports and decisions to the Overseeing Organisation, the Design Team Leader and the Audit Team Leader.

Accident Monitoring

2.26 Staff in the Overseeing Organisation who are responsible for network management shall arrange for accident monitoring of audited schemes to be undertaken.

2.27 A record of all the accidents that have occurred on the scheme since opening shall be obtained at 1 year and 3 years after opening in order to monitor the effectiveness of road safety audits. This shall supplement routine monitoring.

2.28 The accident records shall be analysed in detail to identify such factors as:

a) locations at which accidents have occurred;

b) accidents which appear to arise from similar causes or show common factors; and

c) the accident rate and severity ratio after 3 years compared with the average rates for either the type of road or the road before improvement.

Guidance

2.29 This Standard should be read in conjunction with Advice Note NRA HA 42, Road Safety Audit Guidelines (NRA DMRB 5.2.3).

2.30 A flow chart illustrating the Safety Audit process is shown in Figure 1.

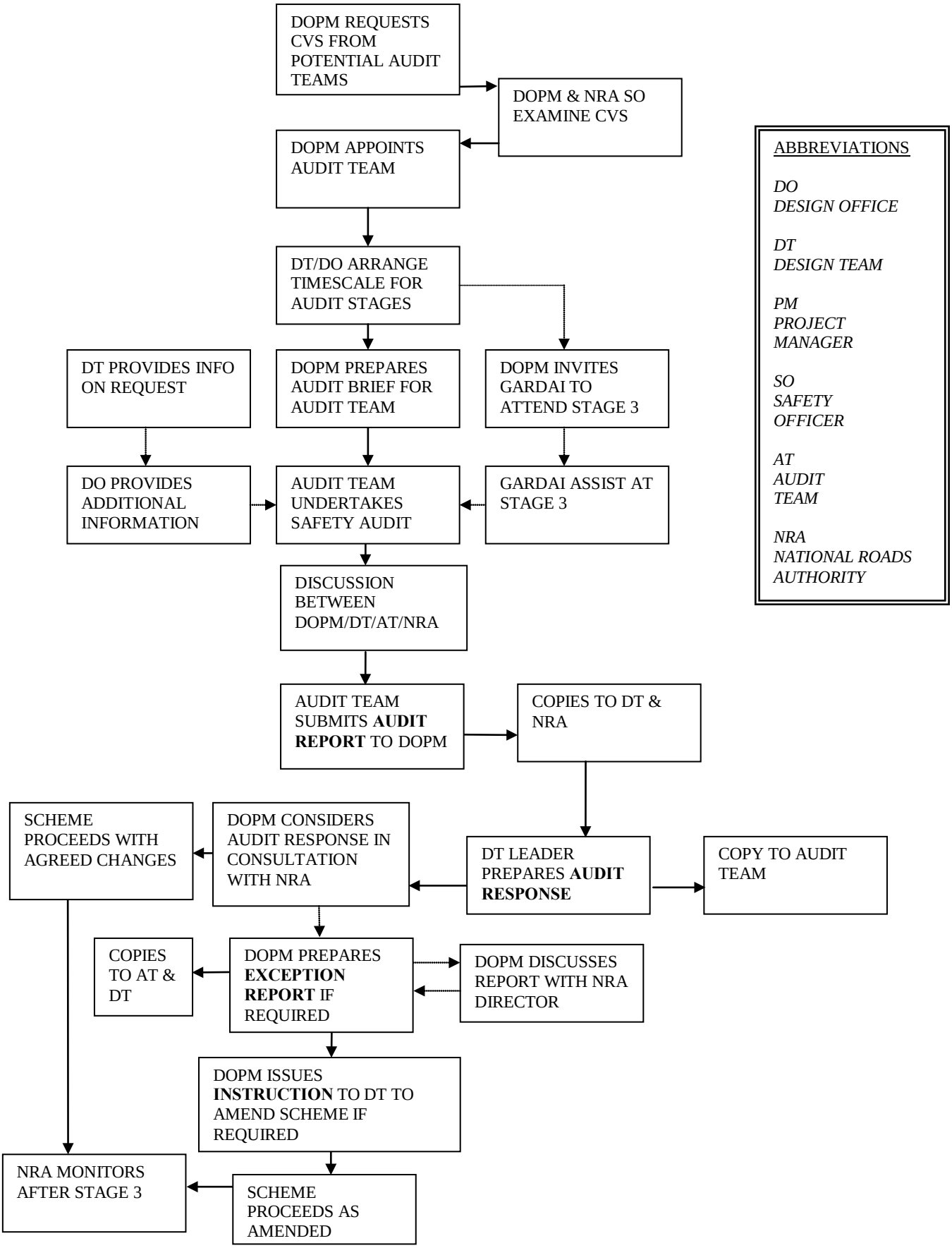

Figure 1 : Safety Audit Flow Chart

3. REFERENCES

3.1 The following document is referred to in this Standard:

NRA Design Manual for Roads and Bridges, Volume 5 – Assessment and Preparation of Road Schemes:

NRA HA 42 Road Safety Audit Guidelines (NRA DMRB 5.2.3).

4. ENQUIRIES

4.1 All technical enquiries or comments on this Standard should be sent in writing to:

Head of Project Management and Engineering
National Roads Authority
St Martin's House
Waterloo Road
Dublin 4

……

E O'CONNOR
Head of Project Management and Engineering

Volume 5 Section 2
Part 3
NRA HA 42/01

NATIONAL ROADS AUTHORITY
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Road Safety Audit Guidelines

June 2001

Headquarters St. Martin's Hse., Waterloo Road, Dublin 4. Tel: 01 660 2511 Fax: 01 668 0009

Summary :

This Advice Note provides guidance on undertaking Road Safety Audits on national road schemes. It is intended to be read in conjunction with the Standard NRA HD19 – Road Safety Audits.

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NRA HA 42/01

ROAD SAFETY AUDIT GUIDELINES

Contents

Chapter

4. INTRODUCTION

1.1 Definitions

These Guidelines should be read in conjunction with the National Roads Authority (NRA) Design Manual for Roads and Bridges Standard NRA HD19, Road Safety Audits (NRA DMRB 5.2.2).

Road Safety Audit: The evaluation of road schemes during design and construction to identify potential safety hazards which may affect any type of road user before the scheme is opened to traffic, and to suggest measures to eliminate or mitigate those problems. This is a formal process involving signed written reports.

Road Safety Check: The informal checking of road schemes during design and construction to identify potential safety hazards, including an informal reporting system.

Road Schemes: All works that involve permanent change to the existing road layout.

Design Office: The organisation managing the various phases of scheme preparation and supervision of construction.

Design Team: The group undertaking the various phases of scheme preparation and supervision of construction on behalf of the Design Office. This may be a team within the Design Office or a separate consultant.

Audit Team: A team of a minimum of two persons, independent of the Design Team and approved by the Overseeing Organisation (NRA). The Audit Team shall comprise staff with appropriate levels of training and experience in road safety engineering, accident investigation, and safety audit, as set out in memorandum produced from time to time by the Overseeing Organisation (NRA). Each member of the Audit Team shall consider the scheme design at specific stages to identify road safety problems. In the case of Design and Build schemes, the Audit Team shall be from a completely separate organisation to the Design Team.

Audit Team Leader (ATL): The person nominated and approved as Audit Team Leader in accordance with the memorandum discussed above.

Director: The Head of Project Management and Engineering in the Overseeing Organisation. The Overseeing Organisation for National Roads in Ireland is the NRA.

Design Office Project Manager (DOPM): The person within the Design Office responsible for ensuring the progression of a scheme in accordance with policy and procedures.

Design Team Leader (DTL): The person within the Design Team responsible for managing the scheme design.

Exception Report: A report prepared by the Design Office Project Manager following discussion with the Director on each recommendation in the Audit Report, which the Design Office Project Manager proposes should not be implemented. The report shall give reasons and where necessary propose alternative means of addressing the underlying safety problem identified by the Audit.

During the course of scheme preparation and construction the Design Office or Design Team may change, as may the personnel within the Design Team and Audit Team. It is recommended that, where possible, the same Audit Team is used throughout the scheme delivery to ensure a consistent approach.

4.2 History and Background

The Road Safety Audit process was initiated when road safety engineers realised that they were carrying out accident remedial schemes on relatively new roads. Adopting the principle of “prevention is better than cure”, they decided to use some of the safety experience they had gained from the remedial work, and design safety into new road schemes. The UK Institution of Highways and Transportation (IHT) Guidelines on Accident Investigation and Prevention produced during this time included a section on "safety checking", suggested as an accident prevention mechanism.

Since then, the important milestones in the development of Safety Audit have been:

1980	some UK local authorities start doing safety audits;
1980-90	safety engineering and safety checks developed in Ireland;
1990	results of safety engineering and safety checking as applied to National Roads reported to local authority Spring Show Conference;
1990/94	Standard and Advice Notes, UK;
1990/96	IHT Guidelines, UK;
1990s	Denmark, Australia, New Zealand introduce procedures;
1996	Safety checking continues in Ireland and is mentioned in the Department of the Environment Road Safety Engineering Manual, 1996, with some recommendations on safety checking;
1999	Dublin Corporation introduces formal safety audit procedures;
2000	Irish Standard introduced as part of NRA DMRB.

4.3 Stages of Audit

Audits and subsequent actions shall be completed at four specific stages in the preparation of the scheme. These stages are:

Stage F: Route selection stage;

Stage 1: Completion of preliminary design prior to land acquisition procedures;

Stage 2: Completion of detailed design, prior to tender of construction contract. In the case of design and build contracts, a Stage 2 Audit shall be carried out in accordance with the requirements of the contract;

Stage 3: Completion of construction, (prior to opening of the scheme to traffic wherever possible).

In general, larger and more complex schemes shall be audited at Stages F, 1, 2 and 3. In the case of smaller schemes, Stages F, 1 and 2 may be combined. For temporary traffic management schemes, only Stage 2 and 3 Audits shall be required.

Where no previous stage Audit has been undertaken, then those factors that would normally be considered at an earlier stage shall be included as necessary.

An indication of stage of Audit by scheme type is shown in Table 1/1.

Where a choice of routes is available, Stage F Audits should be carried out in two phases. Phase 1 should be a comparative assessment of the routes from a road safety point of view. Once the route has been chosen, Phase 2 of the Audit will be carried out on the chosen route, in the standard problem and recommendation format.

Stage / Scheme type	F	1	2	1/2	3
Major scheme	x	x	x		x
Minor scheme		x	x		x
Traffic scheme				x	x
Local Safety Scheme				x	x
Major development	x	x	x		x
Minor development		x	x		x
Major maintenance		x	x		x
Temporary traffic management	x	x		x	

Table 1/1: Stages of Audit

4.4 Scope of Audit

The Standard sets out the procedures required to implement Road Safety Audits on National Road schemes. It defines the relevant schemes and stages in the design and construction at which Audits shall be undertaken and sets out the requirements for post-implementation accident monitoring.

The Standard is commended to other Roads Authorities for use in the preparation of their own road schemes on non-national roads.

The purpose of a Road Safety Audit is to identify potential road safety hazards within the scheme design. Road Safety Audits should not consider structural safety. They should consider only those matters, which have an adverse effect on road safety. A Road Safety Audit is not a check of compliance with design standards.

Road Safety Audits should consider road safety under all operating conditions.

There is little direct overlap between the task of Road Safety Audit (which relates principally to future operational safety of the scheme) and the Safety Health and Welfare at Work Regulations. However, it will be important to ensure that Stages F, 1 and 2 Road Safety Audits are received by the Project Supervisor for design stage within the Submitting Division prior to invitation to tender, and placed within the Safety File. Stage 3 (post-construction) Road Safety Audits should also be placed within the Safety File.

Recommendations for dealing with identified road safety hazards should make allowance for the fact that strategic decisions on route choice and junction type reflect a balance of factors including safety. Recommendations requiring major changes in these areas are therefore unlikely to be acceptable, particularly after Stage 1 of the Road Safety Audit process.

These guidelines apply to all engineering schemes implemented on roads for which the NRA is the Funding Authority, except where an exemption from the auditing requirement is given by the Director of the NRA.

These guidelines also cover road maintenance or temporary road schemes where a specific requirement to carry out a Road Safety Audit has been placed in the scheme brief or contract.

These guidelines also apply to arrangements between developers and Roads Authorities regarding Road Safety Audits of the road and traffic elements of major planning proposals, and a safety overview of other schemes. Further information on this issue is provided in Section 6.3.

These guidelines apply to all new schemes with effect from March 2001.

4.5 Accident Causation

Work carried out at University College Cork in 1994 found that in Ireland driver/rider factors were the most important contributors to the cause of road accidents followed by road condition factors. This is true for both urban and rural situations and for all casualty types.

The way in which the road itself influences the road user is crucial. Accidents occur because road users fail to cope with their road environment. Although this can often be due to carelessness or impairment, their ability to cope can be influenced for good or ill by basic design factors, and by the signs and markings that provide information and warning.

Safety principles based on research carried out into road traffic accidents are described in more detail in Chapter 2. The Road Safety Auditor's role is to use safety engineering experience to ask the question "how will all road users cope at all times and in all conditions with this road environment?", to identify safety problems, and to suggest measures that will minimise future accident occurrence and severity.

5. SAFETY PRINCIPLES

It is important for Safety Auditors to try to base their comments on sound safety experience, and where possible, to have the means to back up the recommendations from documented sources. NRA HD 19 requires the auditor to be able to produce "background reasoning" for Safety Audits. The source of some the information provided below is the AustRoads Safety Audit Guidelines.

2.1 General Safety Principles

Road Safety Audit is a formal procedure that uses experienced Auditors with extensive safety engineering knowledge to identify safety deficiencies in road schemes. A broad experience in road, traffic and safety engineering will ensure that a Road Safety Auditor has the knowledge and ability to refer back to the basic principles in road safety, and ask a series of pertinent questions:

- does the design layout create confusion or ambiguity for road users that could lead to potential road traffic accidents ?
- is there too much, or too little information for road users ?
- is there too little, or too much visibility, or an obstruction to road users' view ?
- does the layout create hazards or obstacles to road users that could contribute to an increased risk of injuries ?

If there is a "yes" answer to any of these questions, then the safety of the scheme could be compromised and remedial measures may be required to remove this potential or actual deficiency. Drivers and other road users have to perceive and process vast amounts of sensory and visual information to negotiate a road layout. The designer's role is to provide a safe road environment that should:

- provide adequate information for road users of the layout and conditions ahead;
- provide adequate warning of hazards or unusual layouts ahead;
- provide positive control of road users' passage through conflict points or unusual sections;
- provide a road performance that can "forgive" road users' errors or inappropriate behaviour.

Desirable minimum Design Standards should be used wherever possible and advance information and warning should be used to inform road users of the layout ahead. However, driver overload must be avoided as it may cause road users to focus too much on the unimportant data and shed vital information. Conflicting information, an over abundance of road signs or a lack of delineation can cause overload.

Therefore a "safer" road environment can be defined as a layout that:

- provides clear, concise and phased release of road user information;
- provides a consistent standard of road design and traffic control;
- provides adequate warning of hazards.

2.2 Designing for the Road User

It is important that a road improvement caters for all road users. Often the needs of the motorist are incorporated within a scheme whilst the needs of the vulnerable user are ignored. The vulnerable road users that need to be considered are:

- pedestrians – the old, young and those with mobility or sight impairment;
- cyclists – children, commuters and leisure users;
- equestrians;
- motorcyclists.

Each vulnerable road user has different needs from the road network and it is important that designers and Auditors are aware of their specific requirements. In the urban environment the pedestrian is likely to be the principal user and designs must incorporate safe crossing locations, adequate visibility to and from the crossings and appropriate lighting.

In addition to the needs of vulnerable road users, particular attention should be paid to the needs of lorries, buses or other specialist vehicles.

To assist in the determination and needs for all road users, it is essential that traffic data and local user surveys are used to shape the design process and tailor a 'safer' environment.

2.3 Roadway Elements and Safety

2.3.1 Design Context

Safe road design varies from the urban to the rural road network; and a number of external factors can create a situation in which a safe road in one location becomes unsafe due to external factors beyond the designer's control. These factors can include traffic volumes, population density, noise, or road user familiarity.

The function of a road should be clear to all road users, and a well planned and defined road hierarchy can assist in providing a safe road network. The design speed can also be an important factor in influencing the safety of a road and should be appropriate to the location, local road users and level of private access control.

2.3.2 Junctions

The most important point to consider with respect to the safety of junctions is that both the layout and control method should be simple and clear, with defined priorities for all road users.

The assumption that 'straight on' traffic has priority is widely accepted and it needs to be remembered that alterations to this, despite reinforcement with signs and lines can still be confusing if visual clues such as fences, kerbing or lighting remain unchanged.

It is important to attempt to make any minor approach perpendicular to the main road, and junctions with acute angles should be avoided. These angled junctions pose a particular problem for the elderly or those with restricted neck movements, and forward and side visibility is often restricted. Similarly, it is advisable to avoid intersections on the inside of bends as foliage often encroaches into sight lines after several years.

Roundabouts used as a form of junction control have their own rules and design requirements. It is important that a roundabout looks like a roundabout from all approaches, and for all users, in order to prevent potential conflict. One of the primary requirements in good roundabout design is that the radius is tighter on the entry than the exit, this ensures a slow entry and lower circulating speed.
Visibility is a key requirement for all junction types, all road users need to see and be seen by others. Care should be taken with siting street furniture and vegetation within visibility splays. Vulnerable road users often experience difficulties crossing junctions. It is important that their needs are provided for and that safe crossing places are implemented where required.

2.3.3 Links

Links that are well designed with few private access points traditionally have a good safety record. However, within the urban environment strict access control is more difficult.

The principal factors affecting the safety of road links are:

- ***Private access control*** - there is a direct correlation between the number of access points between links and the accident numbers on any given road. This is also true of central reserve gaps in dual carriageways;
- ***Proximity of junctions*** - the majority of accidents take place at junctions, it is essential that junction spacing is maximised and consistent junction types are used;
- ***Horizontal & vertical curves*** - accident frequency increases at crests and dips (vertical curvature) and increasing the degree of horizontal curvature increases accident frequency;
- ***Visibility*** - adequate forward visibility to junctions, crossings and safe stopping distances is crucial to ensure a safe road design;
- ***Design Speed*** - the design speed influences the likely pre-crash impact speed in a road traffic accident. Therefore, it is important that the road environment and design speed selected are appropriate and where possible excess speed is discouraged;
- ***Combinations of elements*** – where two or more sub-standard design elements are combined, it is more likely that a hazard will emerge.

2.3.4 Road Features

The relationship between cross-sectional elements and safety is affected by the type and volume of traffic, and also by the surrounding environment.

Lane widths can be critical in affecting safety, where they are too narrow vehicles may collide on horizontal curves, and there may also be inadequate space for two wheeled vehicles. Where lane widths are too wide the alignment may encourage excess speed.

On high speed links there is a safety benefit to be gained by the provision of a hard shoulder and central reserve gaps should be of adequate width, depending on the size of vehicles turning.

Vehicles parked on the carriageway affect the road environment, layout and consequently safety. Safety problems experienced with parked vehicles are:

- parked vehicles causing physical obstructions which are sideswiped or run into;
- parked vehicles causing sudden braking or nose-to-tail shunts;
- parked vehicles which deflect oncoming vehicles into adjacent vehicle paths;
- parked vehicles blocking visibility for any road user;
- parked vehicles between which pedestrians emerge.

To reduce the risk of parked vehicles contributing to an accident it is important that designs should minimise parking in main traffic lanes.

Trees and foliage can greatly enhance the environmental impact of the street scene. However, left un-maintained, they can also restrict visibility considerably. In addition to this, saplings grow into large trees, which can provide an unforgiving road hazard in the event of a road traffic accident.

2.3.5 Forgiving Roadsides

Studies during the 1960s and 1970s in the USA, followed by work in the 1980's in Europe demonstrated that single vehicle non-pedestrian accidents are a significant problem on motorways, dual carriageways and inter-urban high speed single carriageway roads.

In these collisions a high proportion of vehicles that leave the roadside go on to strike trees, lamp columns, road structures or other items of unprotected street furniture. A hierarchy of treatment has been established to minimise the consequence of this type of accident:

- where possible provide a "clear zone" with all items of rigid street furniture placed at least 2m from the edge of the carriageway;
- where this is not possible protect the street furniture with safety fence;
- where this is not possible use breakable or frangible street furniture.

6. PROCEDURES

3.1 NRA Standard HD19

The requirements for carrying out Road Safety Audits in Ireland are described in the NRA Design Manual for Roads and Bridges Standard NRA HD19 (NRA DMRB 5.2.2) - Road Safety Audits.

The Local Authority is the Roads Authority and as such owns the road, once construction is complete. The NRA is the Roads Funding and Standards Authority, and as such pays for the design and construction and sets out Standards for construction.

3.2 Other Guidelines

In Ireland, Dublin Corporation has produced a series of Road Safety Audit Procedures and Guidelines. International Standards can be found (amongst others) in the UK, Australia, New Zealand and Denmark. In the UK the IHT has produced Guidelines on Road Safety Audit.

3.3 Roles and Responsibilities

A brief resume of the roles is provided below:

Commission the Audit:
Design Office Project Manager/ NRA.
Provide a brief, plans and other information:
Design Office Project Manager.
Carry out the Audit:
Audit Team.
Respond to the Audit:
Design Team.
Finalise action:
Design Office Project Manager/ NRA.

Appendix A, based on the flowchart in NRA HD 19 (NRA DMRB 5.2.2.), shows the Road Safety Audit process which is described in more detail in Chapter 4.

7. SAFETY AUDIT PROCESS

4.1 Audit Team Make-up

A Safety Audit Team should comprise at least two people who are independent of the Design Team. This independence is vital to ensure that the Design Team does not influence the recommendations of the Safety Audit and therefore compromise safety at the expense of another issue. Team members should have recent relevant experience of undertaking Safety Audits and should also have more general road safety engineering experience.

In most situations the Audit Team will comprise a senior person who will adopt the role of Audit Team Leader. The second person in the team will be the Audit Team Member.

Training of Road Safety Auditors is essential and any Audit Team Member should have attended recognised road safety engineering training and Safety Audit training courses.

The current NRA requirement for Road Safety Audit Teams is as follows. Three categories of person are identified:

<u>Audit Team Leader</u> – Audit Team Leaders should preferably be Road Safety Engineers with at least two years experience of accident investigation and remedial measures, will have taken part in ten Road Safety Audits, and will have attended an accredited three to five day course in Road Safety Audit theory and practice. In some instances, road engineers with at least two years experience in road design will qualify provided they have taken part in ten Road Safety Audits, and have attended a two week accredited Road Safety Engineering Course which includes a three to five day module in Road Safety Audit theory and practice.

<u>Audit Team Member</u> – Audit Team Members will be Road Safety Engineers, road design engineers or road traffic engineers. They will have taken part as trainees in five Road Safety Audits, and will have attended an accredited three to five day course in Road Safety Audit theory and practice.

<u>Trainees</u> – Road engineers who wish to train as Road Safety Audit Team Members may take part in Audits as observers – an additional team member who does not sign the report.

The Design Office Project Manager will request CVs from prospective Road Safety Audit Team Leaders and Team Members, prior to the appointment of an Audit Team. This will be carried out for each individual project. These CVs should be sent to the NRA Safety Officer for approval. Acceptance will be of individuals, rather than of consultancy firms bidding for the work.

4.2 Site Visits Including Stage 3

A site visit should be carried out at least once during the Design Stage Audits (F, 1 and 2). This should be carried out by at least one member of the Audit Team, and take into account the topography, local amenities, tie-ins of the scheme and any other relevant details. Photographs should be collected and stored for future reference.

If a Stage 1 or 2 Audit is being carried out by an Audit Team new to the project, a fresh site visit should be made. Where the same Audit Team is carrying out a Stage 1 or 2 Audit, a fresh site visit should be undertaken if significant changes have occurred since the previous visit.

At Stage 3, a site visit should be made by all members of the Audit Team. This visit should be made during both daylight and darkness conditions. The Design Office Project Manager should invite a representative of the Gardai to attend the Stage 3 visit, along with a representative of the local Roads Authority.

4.3 Checklists

An example of a Road Safety Audit checklist is shown in Appendix B. Road Safety Auditors should use this or other lists when carrying out their work. However, checklists should be used intelligently, and not simply as a “tick box” system. It is recommended that they are used at the end of the process, to ensure that no major potential safety issue has been overlooked.

4.4 Road User Role Play

One of the most important checks carried out involves assessing the safety of the scheme from different potential road users' perspectives. The Safety Auditor should always be asking the question: "What is it about this scheme that will lead road users to fail to cope with the road environment?"

During the design stages the Safety Auditor has to imagine what it would be like to walk, cycle and drive the scheme. "Driving" should include cars, vans, trucks and buses. "Walking" should be considered from the perspective of the elderly, the child, the wheelchair user and those with sight impairment. Cycling includes children, leisure cycling, and utility or commuter cycling. Where appropriate, the needs of the equestrian should be considered.

4.5 Methodology for Design Stage Audits

Safety Audit is carried out at four key stages on National Road schemes, as noted in Section 1.3. The section below describes a working method for carrying out Design Stage (F, 1, and 2) Audits. It is assumed that the Safety Audit Team consists of two members.

- the Safety Audit Team looks through plans to understand the scheme concept;
- consideration should be given to a meeting between the Safety Audit Team, the Design Office Project Manager, and the Design Team, particularly on larger or more complex schemes;
- one Safety Audit Team Member visits the site (taking photographs);
- both Safety Audit Team Members systematically and independently examine all plans and other information provided (including photographs taken during the site visit) and write down any comments;
- the Safety Audit Team Members discuss their individual findings;
- the Safety Audit Team decides which comments are related to safety and discuss possible recommendations. Any comments recorded by team members that do not go forward to the final report should be noted, together with a reason stating why that issue is not to be included;
- the Safety Audit Team produce a draft Audit Report;
- the second Audit Team Member checks the report and edits if necessary;
- the Audit Team Leader attends a meeting with the Design Team, Design Office Project Manager and NRA Inspector to discuss the draft report;
- the Safety Audit Team produces the final report, signs it and sends it to the Design Office Project Manager with copies for the Design Team and NRA Inspector. A copy should be stored centrally by the NRA Safety Officer.

4.6 Methodology for Stage 3 Audits

At Stage 3 it is recommended that the Resident Engineer and the representative of the organisation responsible for future road maintenance should be available for consultation with the Audit Team as required on the day of the audit. The Gardai may have specific local information and knowledge of safety issues. The Garda District Superintendent should be notified in advance of the Stage 3 Audit (by the Design Office Project Manager). The Gardai are thus given the option of sending a representative to meet the Audit Team on the day of the audit.

The Safety Audit Team observers can sign the Audit Report, but they are not obliged to sign it. A suggested working method for undertaking Stage 3 Road Safety Audits is as follows:

- the Safety Audit Team visits the site during daylight;
- the Safety Audit Team walks, drives and, where appropriate, cycles, along and across the scheme;
- one Team Member takes notes of all the possible safety points;
- the other Team Member takes photographs of all the possible safety points;
- before leaving the site a team meeting is held to ensure that the note-taker has covered all safety points;
- the Safety Audit Team visits the site during darkness (this can be carried out by one team member);
- one Team Member produces a draft Audit Report and circulates it to all present at the site visit;

- the report is edited following comments from the other Team Members and observers;
- the Audit Team Leader attends a meeting with the Design Team, Design Office Project Manager and NRA Inspector, to discuss the draft report;
- the Safety Audit Team produces the final report, signs it and sends it to the Design Office Project Manager with copies for the Design Team and NRA Inspector. A copy should be stored centrally by the NRA Safety Officer.

There is often pressure to open new road schemes as soon as they are completed. This makes it difficult to carry out the process described above, and provide an immediate report to the client. On these occasions it is recommended to undertake a "pre-Stage 3" Audit shortly before completion. If the recommendations from the pre-Stage 3 Audit are acted upon, the final Stage 3 Audit will be less onerous. It may also be possible to provide the Resident Engineer with a copy of the hand-written notes taken during the Stage 3 visit, or with a typed up version shortly afterwards. The Resident Engineer can then start to act upon these notes prior to receiving the formal Stage 3 Audit Report.

4.7 Audit Brief

The list below describes the items that should be provided for Road Safety Audit. It is the responsibility of the Design Office Project Manager to ensure that the Road Safety Audit Team receives the necessary information.

- Design Brief;
- Design checklist (if relevant);
- Departures from Standard;
- scheme plans (list separately if possible);
- other scheme details (list separately if possible) eg signs schedules;
- accident printout for existing roads affected by the scheme;
- traffic surveys;
- previous Road Safety Audit reports;
- previous Exception Reports;
- start date for construction;
- any other information (list separately).

4.8 Audit Report

Having carried out a Road Safety Audit by looking through scheme plans or examining the completed scheme on site a formal report is written.

The following items should be included within the Audit Report:

- a brief description of the scheme being audited, and the Audit Stage;
- the dates when the Safety Audit was carried out (and the date of the site visit);
- a list of the Safety Audit Team members and any other personnel attending the site visit;
- a series of road safety problems and recommendations for action - it may be useful to include a plan showing the location of the problems;
- a statement signed by the Safety Audit Team members to certify that they have examined the scheme;
- for Feasibility, Stage 1 and 2 Audits, a list of all plans and other information examined.

The main element of the report is the section on problems and recommendations and the following points should be borne in mind when writing this section:

- all problems identified in a Safety Audit Report must relate to road safety problems. Non-safety items identified can be itemised in a separate report or letter to the client;
- all safety problems highlighted should be stated as clearly as possible. A clear identification of a problem will help the Design Office or Design Team to consider not only the recommendation in the report but also to consider alternative ways to overcome the safety problem.

NRA HD 19 states that the Road Safety Audit Report should indicate the relative importance of each problem. Road Safety Audit Teams should consider methods for this. Options used by Audit Teams in other situations have included:

- using a “star system” to indicate the relative importance of the problem;
- using language such as “must”, “should”, or “consideration should be given to” within the

recommendations to indicate the relative importance of the problem;

- using background reasoning describing accident "control data" from published sources within the definition of problem to indicate the relative importance of the problem;
- using a form of risk assessment as illustrated in Section 6.2 to indicate the relative importance of the problem.

However, Road Safety Audit Teams should exercise caution in documenting large differences in the potential severity of problems – the legal implications of Road Safety Audit are discussed in Chapter 5. Audit Teams can use the meeting with the Design Office Project Manager, Design Team and NRA Inspector to discuss the relative importance of issues raised within the draft report. This is the preferred method.

Recommendations should be as practical as possible and be relative to the overall scheme cost. There is little value in putting forward a recommendation that will add more than a small percentage increase to the cost of a scheme. Costs and benefits are discussed in more detail in Section 6.1.

Safety problems that remain un-addressed throughout the Audit process should be repeated at subsequent Audit Stages. Recommendations may change as appropriate to the stage the design has reached. For example, a Stage 1 Audit on a new high-speed road that crosses an existing footpath would identify the problem of potential accidents as pedestrians cross from one path to another. The recommendation may be to build a footbridge. At Stage 2, the Safety Auditors note that the designer has rejected the idea of a footbridge. The problem should be restated, however the recommendation may be that the footpath be re-directed to the nearest over-bridge.

A sample Road Safety Audit Report is shown in Appendix C.

4.9 Design Team Response and Exception Report

The recipient of a Road Safety Audit Report will be the Design Office Project Manager, who will have to decide whether or not to act on the recommendations contained within the report.

The draft report should be discussed at a meeting between the Road Safety Audit Team, Design Team, Design Office Project Manager and NRA Inspector (in consultation with the NRA Safety Officer if required). For Stage 1 and 2 Audits this meeting may take place some days after the report has been completed. Due to time pressures for Stage 3 Audits it is suggested that the meeting takes place immediately after the Stage 3 site visit. The purpose of the meeting is to clarify issues raised within the Audit Report. The Auditors should be prepared to indicate the importance of issues raised within the report, and to justify why the problems are genuine safety issues. They should not be under external pressure to change their report. However, once issues have been clarified, the Auditors may feel that they can amend sections of the report, for example a recommendation within their report may be amended in the light of new information that demonstrates that their original ideas could not be implemented. As long as the Auditors accept that the new recommendation will have a genuine safety benefit, they can change their draft report, and produce a final version.

Having received the final Audit Report, the Design Office Project Manager should pass a copy to the Design Team, who prepare an Audit Response. The Design Office Project Manager considers this response. In most cases the Design Office Project Manager will instruct the Design Team to make changes in response to the Road Safety Audit Report. Where these are major changes it may be necessary to carry out a re-audit of that part of the scheme.

For those cases where the recommendations in the Road Safety Audit are not accepted, the Design Office Project Manager will prepare an Exception Report. The Exception Report should address all items in the Audit Report that will not be acted upon. When writing an Exception Report it should be noted that both the Safety Audit and Exception Reports could be used in future litigation. The legal implications of Safety Audit are examined in Chapter 5.

There are two possible types of comments within an Exception Report. It may be that the Design Office accepts an identified problem, but that the recommendation cannot be implemented for various reasons. In this case, the Exception Report should describe the alternative measure to be

implemented. The discussion between the Road Safety Audit Team, Design Team, NRA Inspector and Design Office Project Manager should have helped to come up with suitable alternatives.

The other scenario is where the Design Office does not accept that the identified problem exists. In this case, the Exception Report should produce some evidence as to why the problem is not valid. It may be that the Audit Team did not have all information available, or that the scheme design has changed since the plans used in the audit were prepared.

It is important that a copy of the Exception Report is returned to the Road Safety Audit Team. Without some form of feedback, Safety Auditors are working in a vacuum and will find it difficult to improve their Audits over time. A copy of the Exception Report should be sent to the NRA Inspector and a further copy stored centrally by the NRA Safety Officer.

4.10 Arbitration

There will inevitably be some conflict between safety and other issues within the Audit process. Some examples are given below:

- large conspicuous road signs are generally a good idea from a safety point of view, while they can have an adverse affect on visual intrusion;
- street lighting generally improves road safety but has implications for light pollution;
- multi-lane approaches to roundabouts can have a poor safety record but will reduce traffic delays.

While the Safety Auditor concentrates on road safety issues, the Design Office will have to weigh up the various consequences of implementing the recommendations within the Safety Audit Report. Generally, the Design Office Project Manager will prepare an Exception Report explaining why recommendations have been rejected. However, occasionally there will be situations where decisions are very difficult and in these cases it may be necessary to introduce a system of arbitration.

The arbitrator will be the Director (or at least a senior officer) in the NRA who has some knowledge of road safety work and who has not been directly involved in the scheme design or the Safety Audit.

4.11 Accident Monitoring

When a scheme has been completed, it is important to monitor its performance in terms of the number and severity of road accidents and casualties.

NRA HD 19 has a requirement for the NRA Safety Officer to monitor schemes one year and three years after completion. The Standard requires that accident locations and common accident types are identified and that accident rates and severity ratios are compared with average rates.

Although this monitoring is necessary, it is of limited use unless it is related back to the original Safety Audit Reports. A suggested working method for monitoring is outlined below:

- identify accident locations;
- identify accident types;
- identify which items highlighted in the Safety Audit Report were amended on site;
- look at the Safety Audit Reports and compare the recorded accidents against the problems highlighted in the report. A comparison of those problems not addressed by the client with accident occurrence will be of particular interest;
- prepare a monitoring report for the client (with a copy to the original Audit Team).
- it may also be useful to examine maintenance records as these could highlight where damage-only accidents have occurred.

4.12 Note for the Resident Engineer

Resident Engineers (RE) can take a constructive role within the Road Safety Audit process. The key stages for involvement are:

- prior to construction, copies of Stage F, 1 & 2 Road Safety Audits should be despatched to the RE;
- during the construction process any on-site re-design or alterations should be referenced back to the Design Team. A safety assessment or Audit may be required;
- prior to the scheme opening, the RE and future maintenance representative should have

an opportunity to consult with the Stage 3 Road Safety Audit Team. The RE will be in a position to give advice to the Safety Audit Team, but should not attempt to influence their task. Once the Stage 3 site visit is complete the RE may be in a position to immediately address some of the findings, without having to wait for the formal Safety Audit Report.

8. LEGAL IMPLICATION

5.1 Background

There are no formal legal requirements to carry out Road Safety Audits in Ireland. Safety checking processes are referred to in Chapter 9 of "A Guide to Road Safety Engineering in Ireland", published by the Department of the Environment in 1996.

Statutory duties that are relevant in the general area of Road Safety are contained in the 1961 Road Traffic Act. This Act has provisions for both Roads Authorities and the Minister of the Environment to promote road safety.

The 1993 Roads Act places a duty on people using public roads to take reasonable care for their own safety and for other people using the road. The 1993 Act also places a duty on Road Authorities to construct and maintain roads. In carrying out these duties the Roads Authority has a responsibility to consider the needs of all road users, and can provide for the safety of road users.

The 1994 Road Traffic Act makes provision for the Roads Authority to carry out traffic calming measures in the interest of safety.

With no experience (up to the end of 1998) of claims having been made against Roads Authorities in Ireland, in respect of deficient Road Safety Audit, the guidance on how to deal with possible litigation can only be speculative. There is increasing evidence, however, of claims being made against Roads Authorities in cases of road traffic accidents. There are many reasons given for this, but it appears that there is an increasing awareness on the part of both claimants' solicitors and the judiciary of the possibility of contributory negligence awards against Roads Authorities.

Following the occurrence of a road accident, it may be possible that a claimant would argue that the Roads Authority is in breach of a statutory duty, and/or is negligent. Legal proceedings are more likely to ensue in those cases where there is evidence to suggest that a road factor is dominant in accident causation. This might be at a site with a history of similar types of accidents relating to a road problem, for example poor alignment or road lighting. Or it may be a situation where it can be shown that certain aspects of the drainage or signing were both substandard and contributory to accident occurrence. Or it may be where it can be shown that certain procedures, such as Road Safety Audit, were not carried out in accordance with existing recommended good practice.

In order to succeed, a claimant must show that the Roads Authority failed to take such care as in all the circumstances was reasonably required to ensure that the road was not dangerous to traffic. In this respect authorities could be judged, inter alia, on the basis of the consistency and objectivity of their internal procedures (including Road Safety Audit), and their compliance with any published advice on Road Safety Audit.

The issue of non-feasance and mis-feasance is important in understanding the position of Roads Authorities when faced with potential litigation in road accident cases. If it can be shown that an authority did not know about a problem and did nothing about it (for example in connection with a pothole that appears in the road), then non-feasance may apply and the authority will not be found liable. On the other hand, if the authority did know about a potential problem and did nothing (for example not following through a recommendation in a Road Safety Audit Report) then mis-feasance can apply and the authority may well be liable.

5.2 Areas of Concern

The NRA is therefore concerned about the legal implications of both general safety engineering work, and the requirement for effective Road Safety Audit procedures.

A number of potential issues arise, once an accident has occurred on a new road scheme or a road improvement. In devising Road Safety Audit guidelines, the NRA has addressed the following issues:

What are the legal implications on a road where an accident occurs and litigation ensues if:

- *no effective, consistent Road Safety Audit procedures exist?*
  It is considered that until there is a statutory obligation to carry out Road Safety Audit in Ireland, a Roads Authority is not obliged to do this work;

- *despite publishing a set of specific procedures, a Road Safety Audit has not been carried out on one of the NRA's roads?*
  Although this would be seen as contrary to the written procedures, it is considered likely that this would be viewed as a mistake, rather than as a breach of statutory duty or negligence;

- *a Road Safety Audit has been carried out, but the recommendations have not been acted upon?*
  Mis-feasance could apply here. The importance of acting on Road Safety Audit reports, and having a well documented Exception Report process is strongly emphasised;

- *a Road Safety Audit has been carried out, but has failed to identify a relevant problem?*
  The Road Safety Auditor is considered likely to be judged on the basis of whether he or she could reasonably have been expected to identify that particular problem.

It is important that a clear procedure for managing and organising Road Safety Audit is established, and that the practice of undertaking and reporting Road Safety Audit is clearly specified, and that the actions are fully and consistently documented.

In undertaking Road Safety Audits for the NRA, parties involved should:

- ensure that the terms of reference for each Road Safety Audit are clear;
- establish exactly what information has been received by the Road Safety Audit Team and subsequently used as information to assist with the Road Safety Audit;
- in writing Road Safety Audit reports at Stages 2 & 3, ensure that safety issues raised at earlier stages, which have not been addressed, are re-examined where appropriate. In some circumstances it may be appropriate to suggest alternative solutions at subsequent stages;
- note that the Stage 3 Road Safety Audit is the final opportunity to examine the scheme from a road safety point of view before it is opened to traffic;
- ensure that Road Safety Audit Team Members are aware of their responsibilities in undertaking a Road Safety Audit;
- ensure that Design Office and Design Team staff are aware of their responsibilities in responding to a Road Safety Audit;
- maintain the documentation of a formal set of Road Safety Audit procedures;
- maintain a record of the full documentation for each Road Safety Audit undertaken;
- ensure that Road Safety Audit ties in with responsibilities under the Safety Health and Welfare at Work (Construction) Regulations;
- monitor the safety performance of road schemes after they are open;
- give consideration to specific indemnification for Road Safety Audit work carried out by staff working in this area.

Consultants carrying out Road Safety Audit work on behalf of the NRA will be expected to provide adequate professional indemnity cover for this type of work.

9. SAFETY AUDIT ISSUES

6.1 Costs and Benefits

The average cost of each stage of a Safety Audit in the UK is estimated at between £500 and £1,000 (although this could be considerably more for a few complex schemes, such as a new section of motorway or a complex set of linked urban traffic signals). This gives a total audit cost on a scheme for Stages 1 to 3 of between £1,500 and £3,000. This figure should be compared with the average cost of an injury accident in Ireland of some £70,000.

There are a number of costs that can be attributed to a Safety Audit. Firstly there is the cost of the audit itself. The cost of a Safety Audit is related to the time spent to complete it, rather than the cost of the scheme itself. It takes less time to audit a scheme involving a new link road with a simple junction at each end that in does to audit a complex traffic signal junction in an urban area. Research carried out by the IHT found that the average time taken to complete an audit was 25 hours.

The second element of cost relates to the implementation of the recommendations contained within the Audit Report. In general, these costs are not significantly high and items identified at Feasibility Stage and Stages 1 and 2 may have no cost implications at all (although they may require some re-design time). There are, however, some instances where audit recommendations, particularly at Stage 3, will add to the cost of a scheme. For example, a recommendation for applying anti-skid surfacing on the approach to a set of traffic signals.

The implementation cost of Audit recommendations will obviously vary greatly between schemes, but an average figure of £5,000 per scheme would seem to be a reasonable assumption. The IHT research referred to earlier indicated that about half of Safety Audits involve redesign and that increases in design costs were in the order of 1% of overall scheme costs.

Adding these costs together (assuming an Audit is carried out at three stages) would give costs in the order of £10,000 per scheme, although a Safety Audit should be seen as part of the scheme design process and cost, rather than additional.

It is difficult to identify the benefits of carrying out a Safety Audit on a scheme in a quantitative way. When an Audit has been carried out, the scenarios are that either the recommendations are implemented or they are not; and although the subsequent accident record can be examined, only one of the scenarios can be evaluated. It is not possible to compare how an individual scheme that has been audited could have performed had the Audit not been carried out.

The only monitoring of Safety Audited schemes seems to have been carried out by Surrey County Council in the UK. The County Council was introducing Safety Audit at the time and they checked the safety performance of 20 minor improvement schemes that had been audited and modified accordingly, against 20 similar schemes that had not been audited. Their findings were that the audited schemes had, on average, about one casualty per year less than the non-audited schemes.

Whilst it may be possible to look at schemes in a wider national context and check the performance of audited schemes versus those that have not been audited, it would be inadvisable to not carry out Safety Audits as part of an experiment, due to potential legal liabilities.

One way of estimating whether Safety Audit could save accidents is to carry out an audit on a road that has been open for say five years, and then compare the Safety Audit comments with the accident record. A recent Audit of an existing road in Ireland showed that 30% of identified Audit problems materialised as injury accidents. The implication is that some of these accidents could have been saved if the Safety Audit had been carried out at the design stages.

Some work carried out in New Zealand suggests that the benefit to cost ratio for Safety Audits is in the order of twenty to one. In Denmark, the first year rate of return for Safety Audits has been estimated as over 149%. This figure was based on estimates for accident savings that might be made by introducing Safety Audit recommendations.

There are also cost savings to be made by making changes to a scheme during its design rather than after construction (and possibly after accidents had occurred). The Transport Research Laboratory studied 22 schemes and estimated that if design changes were made at Stage 1 or Stage 2 rather than after completion, a saving of £11,000 per audit would be achieved.

A further qualitative benefit is the extent to which design engineers receive improved safety awareness through the Safety Audit process. Local authorities in the UK who have carried out this work over a decade or more have noticed a reduction in the number of comments being made by Safety Auditors.

Using current accident costs, Safety Audit costs identified in this chapter, and assuming the safety benefits identified by Surrey County Council, a First Year Rate of Return of around 600% can be estimated for this type of work.

6.2 Risk Assessment

The Road Safety Auditor can make comments on safety issues and make recommendations, but has no direct ownership of the scheme. There are two concerns resulting from this:

- Safety Auditors with limited safety experience make recommendations that change schemes without any safety benefits to be gained;
- Safety Auditors make recommendations where the cost of implementation far outweighs any safety benefit to be gained.

It has therefore been suggested that Safety Auditors carry out a formal risk assessment of their work, ranking both the audit problems and recommendations using a matrix like that shown in Table 6/1.

The Audit Team would go through the report and give each problem a risk score – effectively their assessment of risk if nothing is done. The team would then go back through their recommendations, and, making the assumption that the recommendation will be carried out, re-assess the risk.

An Audit Report could then contain a risk assessment table in the summary, such as the example in Table 6/2.

The information would be used by the client to help decide whether or not to implement the recommendations. The client could instruct the designer to cost the recommendations and then judge whether the reduction in risk was worth the cost of improvement. At present it is sometimes too easy for a client or designer to turn down a Safety Audit recommendation on the basis of cost - this is not always reasonable.

Probability Of Outcome / **Severity of Outcome**	More than once per year ***(probable score 4)***	Once every 1-3 years ***(possible score 3)***	Once every 3-7 years ***(remote score 2)***	Once every 7-20 years ***(improbable score 1)***
Multiple fatal ***(extreme score 4)***	**16**	**12**	**8**	**4**
Fatal/ serious ***(severe score 3)***	**12**	**9**	**6**	**3**
Minor injury ***(minor score 2)***	**8**	**6**	**4**	**2**
Damage only ***(negligible score 1)***	**4**	**3**	**2**	**1**

Note: A risk score of 1 - 3 is "low" risk, 4 - 9 is "medium" risk, and 12 - 16 is "high" risk.

Table 6/1:Risk Assessment Matrix

Audit pa ragraph number	Risk a ssessment of problem	Risk assessment if recommendation implemented
2.1	16 (high)	9 (medium)
2.2	8 (medium)	1 (low)
2.3	6 (medium)	1 (low)
2.4	3 (low)	1 (low)
2.5	2 (low)	1 (low)

Table 6/2: Example Risk Assessment

Many national roads authorities are looking at risk assessment within Safety Audit, and it is likely to be introduced by some in the near future. At this stage it is suggested that Safety Auditors in Ireland familiarise themselves with the principles of risk assessment for future reference.

6.3 Auditing Development Schemes

The auditing of development-led road schemes within the planning process is another area that needs clarification.

At present many Roads Authorities require a Safety Audit too late in the process to address fundamental safety issues. Once planning approval has been given it is difficult to require developers to make significant changes to schemes, especially if they are costly or reduce the amount of land available for development.

If the developer submits a Stage F Safety Audit with their planning application, the Safety Audit and response could be considered before planning permission is granted. In a few cases, the findings of the Safety Audit could lead to the refusal of the planning application. It is more likely that the developer would be given planning permission, but that the scheme proceeds subject to specific requirements resulting from the Stage F Safety Audit.

Subsequent Safety Audits at Stages 1, 2 and 3 could be enforced through agreements between the Roads Authority and the developer.

In order to facilitate such a process, it would be necessary for senior roads and planning colleagues to review their in-house planning application processes, so that the inclusion of a Stage F Safety Audit becomes a requirement of the planning application.

10. REFERENCES

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HD 19/94, Road Safety Audits, 1994.

HD 42/94, Road Safety Audits, 1994.

Institution of Highways and Transportation, Guidelines for the Safety Audit of Highways, 1990, 1996.

National Roads Authority, NRA Design Manual for Roads and Bridges, Volume 5:

NRA HD 19, Road Safety Audits, 2001.

Roads Act, 1993.

Road Traffic Act, 1961.

Road Traffic Act, 1994.

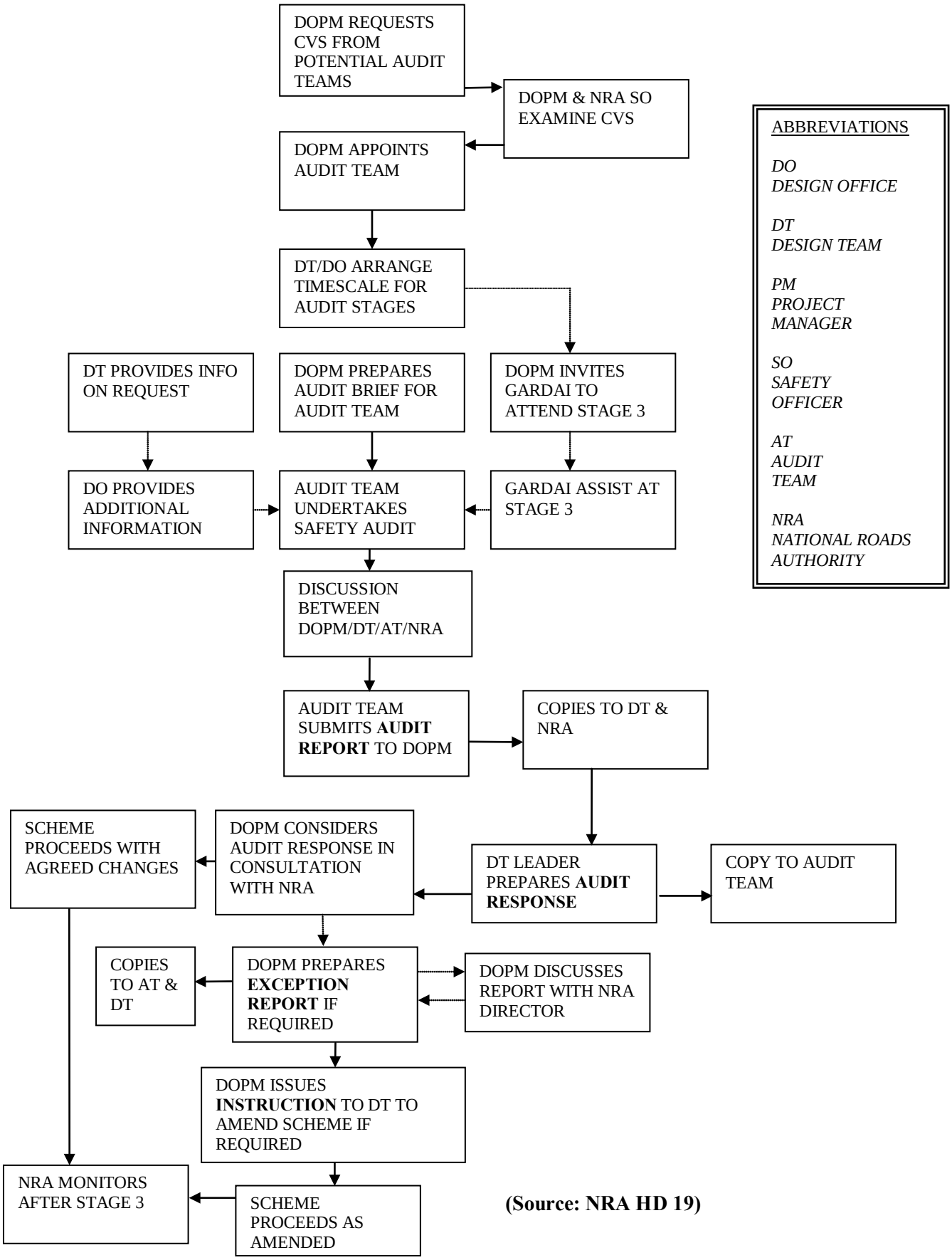
11. ENQUIRIES

12.1 All technical enquiries or comments on these guidelines should be sent in writing to:

Head of Project Management and Engineering
National Roads Authority
St Martin's House
Waterloo Road
Dublin 4

……..
E O'CONNOR
Head of Project Management and Engineering

APPENDIX A: SAFETY AUDIT FLOW CHART



(Source: NRA HD 19)

APPENDIX B: ROAD SAFETY AUDITORS' CHECKLIST – MAJOR ISSUES TO BE CONSIDERED

(Source: IHT Road Safety Audit Guidelines)

Checklist for Stage F - Feasibility

General
Consistency of standards with adjacent road network, especially at tie-ins
Secondary effects on surrounding road network
Where a preferred scheme is being chosen, relative safety performance of options

Routes
Impact of standard of route, related to design flows and speed, on safety
Overtaking opportunities
Consistency of junction arrangements, access control
Frequency of junctions (public and private) related to safe access
Horizontal and vertical alignments consistent with visibility requirements, both along the road and at junctions
Facilities for pedestrians, cyclists and equestrians
Provision for unusual aspects of traffic composition (heavy concentrations of particular types of road user), or environment (e.g. sunrise / sunset glare, fog, or wind)

Area Schemes
Designation of functions for different elements of the road hierarchy
Scheme consistent with overall safety plan

Checklist for Stage 1 - Preliminary Design

General
Review any previous Road Safety Audit in order to allow for subsequent design changes
For major schemes, determine need for land take for safety requirements

Alignments and Sight lines
Any elements of horizontal and vertical alignments which may produce hazards due to reduced sight lines, especially where these are combined and / or there are departures from standards
Sight lines obstructed by bridge abutments, parapets, landscaping, structures or street furniture

Junctions
Minimising potential conflict points at junctions (including numbers of private accesses)
Conspicuity of junctions on approach, and sight lines from minor road approaches and private accesses
Control of approach speed, and layout of approach roads
Provision for turning traffic
Location and access of lay-bys

Other
Impact of landscaping on visibility and road user perception
Concept of road marking / signing for road user perception
Provision for safety aids on steep hills
Facilities for pedestrians, cyclists and equestrians
Potential for flooding due to inadequate drainage

Compatibility with adjacent network at tie-ins
Servicing access and maintenance arrangements

Checklist for Stage 2 - Detailed Design

General
Review any previous Road Safety Audit in order to allow for subsequent design changes
Note: Scope for altering alignments or junction design is less extensive at this stage, so the Road Safety Audit will focus mainly on details of signing, marking, lighting, etc, and issues which affect visibility and drivers' perception of the road scene, and provide aids to safety.

Junctions
Appropriateness of corner radii or curvature in relation to approach speed
Road users' perception of road layout

Road signs and markings
Locations of signs and markings to aid, inform, and warn of hazards, without obscuring visibility or misleading drivers
Consistency of signing and marking information

Lighting and signals
Consistency of lighting within the scheme and with the adjacent network
Safe positioning of lighting columns, signals and operational equipment
Confusion or conflict between lighting and traffic signals
Positioning of heads for traffic and pedestrian signals to ensure clarity to appropriate road user, and avoid confusion to others to whom they do not apply
Safe access and servicing arrangements

Facilities for vulnerable road users
Location and type of crossing facilities; visibility
Dedicated cycle or pedestrian facilities
Provision of facilities for people with mobility impairments

Landscaping
Potential obstruction to visibility from landscaping, taking account of future growth
Potential for trees to become collision objects: choice of appropriate species
Ability to maintain planted areas safely

Protective aids
Positioning of safety fences, and guard rails to protect against vehicle conflicts or roadside objects (poles, columns, statutory undertakers' apparatus), without obscuring visibility
Use of arrester beds

Surface characteristics
Appropriate surfacing for high speed roads, or locations (e.g. bends) which are potentially hazardous when wet
Appropriate surfacing for approaches to junctions, and thresholds to villages or residential areas in towns, to encourage lower vehicle speeds

Checklist for Stage 3 - Pre-opening

General

Review any previous Road Safety Audit in order to allow for subsequent design changes.

The main emphasis is to inspect the scheme from the viewpoint of the different road users, considering where appropriate the needs of pedestrians, cyclists, equestrians, public transport operators, and HGVs as well as car drivers.

Inspection at appropriate times of day, in particular in daylight and darkness

Checklist 2 provides an appropriate aide memoire

APPENDIX C: SAMPLE ROAD SAFETY AUDIT REPORT

SOMETOWN BY-PASS

ROAD SAFETY AUDIT STAGE 2

1. INTRODUCTION

1.1 This report describes a Stage 2 Road Safety Audit carried out on a proposed by-pass at Sometown, on behalf of Campbell and Bellamy Partnership. The audit was carried out between 12 and 18 October 2000 in the offices of ABC Consultancy.

1.2 The audit team members were as follows:-

Richard Harris, MSc, MIHT, MCIT; Director, ABC Consultancy;

Wallace Grommit, AMIHIE, Engineer, ABC Consultancy.

1.3 The audit comprised an examination of the drawings relating to the scheme supplied by the design office. Mr Grommit visited the site on 12 October 2000.

1.4 This Stage 2 audit has been carried out in accordance with the relevant sections of NRA HD 19/01. The team has examined only those issues within the design relating to the road safety implications of the scheme, and has therefore not examined or verified the compliance of the design to any other criteria.

1.5 Appendix A describes the drawings examined by the audit team.

1.6 All of the problems described in this report are considered by the audit team to require action in order to improve the safety of the scheme and minimise accident occurrence.

2. ITEMS RESULTING FROM THIS STAGE 2 AUDIT

Accident details have not been supplied with this scheme.

2.1 General problems/ problems at multiple locations

2.1.1 Problem – safety fence end treatments

Vehicles that leave the carriageway can be launched from the leading ramped ends of safety fence.

Recommendation

Leading ramped ends should be tapered away from the approach direction of traffic. Particular attention should be paid to the leading ramped ends of safety fence at:

- M99 northbound entry slip road;
- M99 northbound entry slip road/ N99 eastbound approach to roundabout;
- N99 eastbound entry to roundabout;
- N99 northbound (3 locations);
- N99 southbound.

2.1.2 Problem – protection of various hazards

A number of drainage ditches/head walls/balancing ponds/pylons appear to be unprotected. Vehicle occupants could be injured if vehicles overturn in ditches or strike head walls or pylons. Vehicle occupants could drown in balancing ponds.

Recommendation

The need for safety fence should be considered at the following locations:

- The north side of the N99/M99 northbound link (drainage ditch and culvert 4);
- The inside of the M99 exit slip road loop (balancing pond and pylons);
- The south side of the N99 northbound east of Marsh Lane track (brook running alongside road);

2.1.3 Problem – Temporary Warning Signs

Drivers need to be aware of the new arrangements.

Recommendation

New Road Layout Ahead and/or New Roundabout Signs should be provided on all approaches except the M99 exit slip road.

2.2 Problems at specific locations

2.2.1 Problem – M99 northbound entry slip road

The slip road has a section at a radius that is 3 steps below standard: the merge length, taper length and hard shoulder width are all sub-standard. Departures from Standard in isolation may have no road safety consequences. Wholesale departures could combine to create a dangerous situation. It is not understood why there needs to be 4 different radii on the slip road. The 255m radius is not listed as a Departure.

Recommendation

Whilst at this stage, with earthworks underway, it may not be possible to amend the design, consideration should be given to the provision of a constant radius over a greater length. Consideration should be given to the need for an advisory speed limit.

2.2.2 Problem – Marsh Lane roundabout

The N99 eastbound and the M99 exit slip road approach to the roundabout will be relatively high speed in low flow conditions. The straight approaches could lead to a situation in which drivers lose control and overrun the central island.

Recommendation

Consideration should be given to block paved chevrons on the central island to increase roundabout conspicuity. Central island chevrons should be mounted on breakable posts, or erected as in Diagram 515.1A. Consideration should be given to yellow borders to the signs. Consideration should be given to the angle of the sign facing the N99 eastbound entry, to the length, height and position of the sign facing Warren Road, and to the position of the sign facing the M99 entry slip road, in order to ensure optimum sign face conspicuity for approach traffic. Antiskid surfacing should be provided on the approaches.

2.2.3 Problem – Marsh Lane track/Pipers Lane

Drivers on Marsh Lane track need to be aware that they are approaching a junction.

Recommendation

The warning centre line should be extended to 5 marks. A give way sign and triangle should be provided at Marsh Lane track/ Pipers Lane junction.

2.2.4 Problem – N99 at Marsh Lane

A gully is located near to the footway crossing on the south side of Marsh Lane. This could be a trip hazard for pedestrians.

Recommendation

The gully should be sited away from the footway crossing.

2.2.5 Problem – N99 at Marsh Lane

Pedestrians and cyclists cross Marsh Lane south of the speed limit de-restriction. Drivers might accelerate away from the junction through the crossing having seen the signs.

Recommendation

The speed limit boundary should be sited south of the crossing point.

3. AUDIT TEAM STATEMENT

We certify that we have examined the drawings and other information listed in Appendix 1. This examination has been carried out with the sole purpose of identifying any features of the design that could be removed or modified to improve the safety of the scheme. The problems that we have identified have been noted in the report, together with suggestions for improvement which we recommend should be studied for implementation.

signed.....Richard Harris, ABC Consultancy

date.....

signed.....Wallace Grommit, ABC Consultancy

date.....

APPENDIX 1:

LIST OF DRAWINGS EXAMINED

01300/D11 Rev A

01300/D12 Rev B

01300/D13 Rev C