

## **Appendix A.14.2**

### **Road Safety Audit Stage 1**

## A.14.2

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Transport Infrastructure Ireland  
**Galway City Transport Plan**  
Road Safety Audit – Stage 1

REP/001

Issue 1 | 14 August 2017

This report takes into account the particular instructions and requirements of our client.

It is not intended for and should not be relied upon by any third party and no responsibility is undertaken to any third party.

Job number 233985

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**ARUP**

# Document Verification

# ARUP

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# 1 Introduction

Arup Dublin has been appointed to conduct a Stage 1 Road Safety Audit on the preferred route of the proposed N6 Galway City Transport Plan. A plan showing the location of the proposed scheme in the context of the surrounding road network is presented in Figure 1.

Figure 1: Galway City Transport Plan – Proposed Route



The audit report was completed on the November 11 in the Arup Dublin office following a desktop review and site visit on November 7, 2016.

The weather during the site visit was dry and sunny and the road surface was dry.

The audit team members were as follows:

- Shane Fitzgerald (Team Leader)
- Thomas Connell (Team Member)

An Audit Team Statement and feedback form is included at the end of the report.

This Stage 1 road safety audit has been carried out in accordance with the relevant sections of GE-STY-01024 – Road Safety Audit. 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 compliance of the design with the relevant standards or any other criteria. The audit team were not made aware of any relaxations or departures from standards.

A list of the information provided to assist the Auditors comprised of the drawings and file notes which are included in Appendix A.

The Audit Team approval letter is included in Appendix B.

The designers' response to the audit issues is included in Appendix C.

## 2 Stage F Part 2 RSA Assessment

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Having reviewed the Stage F Part 2 RSA report, the Auditors are satisfied that the issues identified have been appropriately addressed by the Designer. As a result none of the issues identified at that stage have been brought forward into this report.

## 3 Items raised during this audit

### 3.1 Issue: Earthworks design

**Location:** Throughout the scheme

**Problem:** The earthworks design at various locations throughout the scheme appears to overlap (see figures 2 and 3). This could lead to an inability to construct the scheme as currently presented which could potentially result in a scheme which may be unsafe in parts for all users.

Figure 2: Earthworks overlap – Bearna West Roundabout

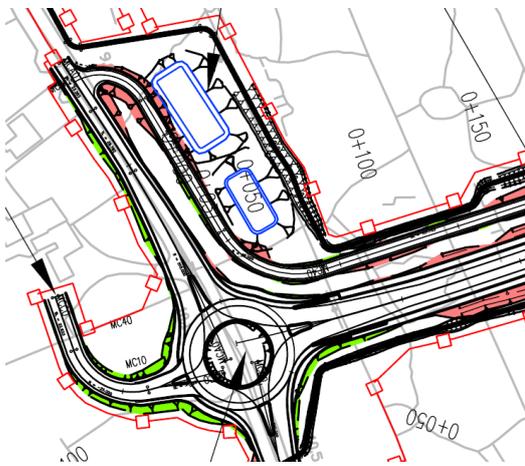
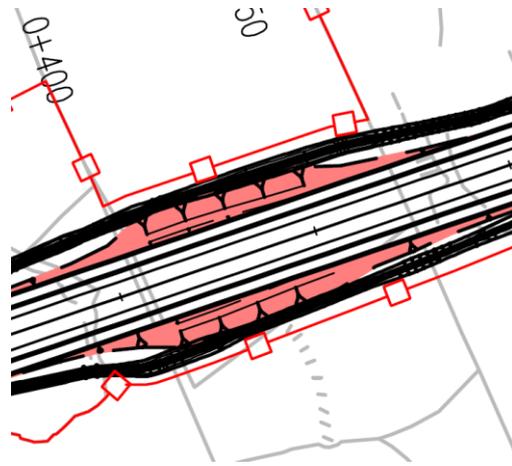


Figure 3: Earthworks overlap – Mainline approach to Bearna West Roundabout



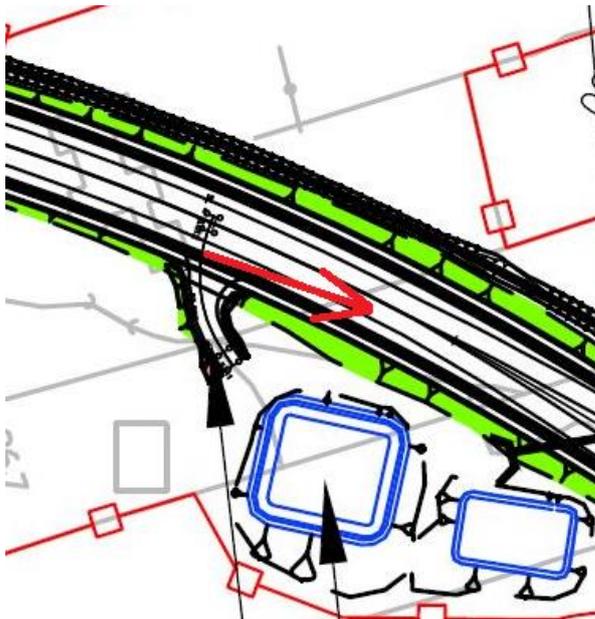
**Recommendation:** The Designer should reassess the earthworks design to ensure that the scheme can be constructed within the proposed scheme footprint without any adverse impact of all user's safety.

## 3.2 Issue: Visibility to oncoming traffic

**Location:** Throughout the scheme

**Problem:** The Audit Team is concerned that there may be issues with appropriate sightlines at junctions being achieved as a result of proposed adjacent infrastructure. It is also noted that the level of detail provided to the Audit Team at this stage does not allow for an analysis of verge widening to ensure that visibility is achieved. Substandard visibility at junctions could increase the potential for collisions at these locations.

Figure 4: Visibility to oncoming traffic



**Recommendation:** The Designer should ensure that they have allowed sufficient land take to provide the required visibility at all road junctions. The Designer should also demonstrate that sufficient visibility is provided by the preparation of the appropriate drawings.

### 3.3 Issue: Possible headlight glare

**Location:** Throughout the scheme

**Problem:** A number of parallel access roads are proposed in close proximity to the mainline. The Auditors are concerned that there could be a headlight glare issue between road users travelling in opposite directions on these roads. This could cause temporary blindness or dazzle and road user confusion ultimately leading to sudden braking which could result in rear end shunt type collisions.

Figure 5: Possible headlight glare location



**Recommendation:** The Designer should assess the potential for headlight glare between opposing road users on the parallel access roads and the mainline. If it is found that headlight glare could be an issue appropriate mitigation measures should be introduced.

### 3.4 Issue: Access to attenuation ponds

**Location:** Throughout the scheme

**Problem:** A number of attenuation ponds do not appear to have been provided with access roads or links to the adjacent road network (see figures 5 and 6). This could have an impact on the overall scheme design if the lands made available for the scheme are not extensive enough to cater for all design elements.

Figure 6: Attenuation pond with no access provided

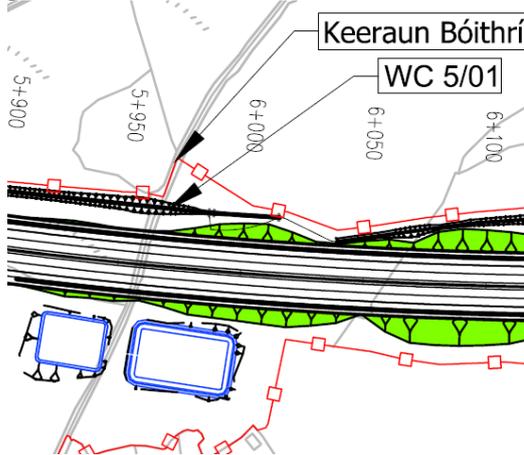
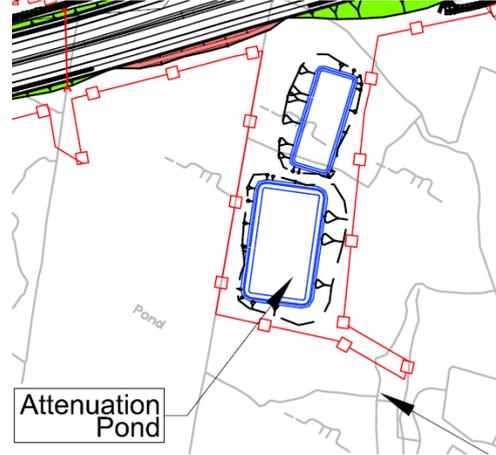


Figure 7: Attenuation pond with no access provided



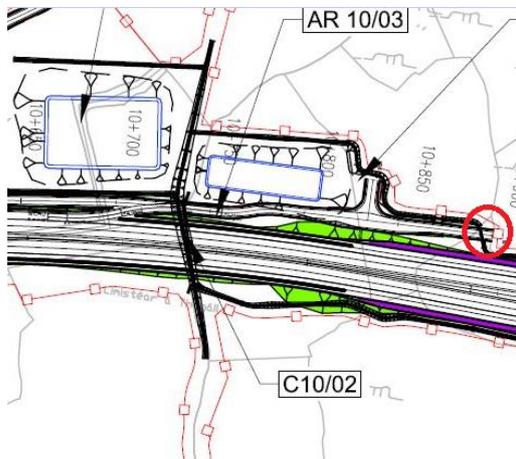
**Recommendation:** The Designer should ensure that all attenuation ponds are provided with an access either from the proposed scheme or the existing adjacent road network.

### 3.5 Issue: Exit roads at tunnels

**Location:** Lackagh Tunnel

**Problem:** It is the Auditors' understanding that the exit roads on the mainline approaches to both tunnels are proposed in order to divert over height vehicles to the local road network to continue their journey. The Auditors are concerned that an over height vehicle that exits the mainline on the eastbound approach to Lackagh Tunnel (see figure 7) may have difficulty joining the local road network as there does not appear to be a turning area to enable the vehicle driver to do so. The Auditors are also concerned that an over height vehicle may need to reverse along the access road in order to join the local road network which could increase the potential for rear end shunt type collisions at this location.

Figure 8: Exit road at Lackagh Tunnel (eastbound)



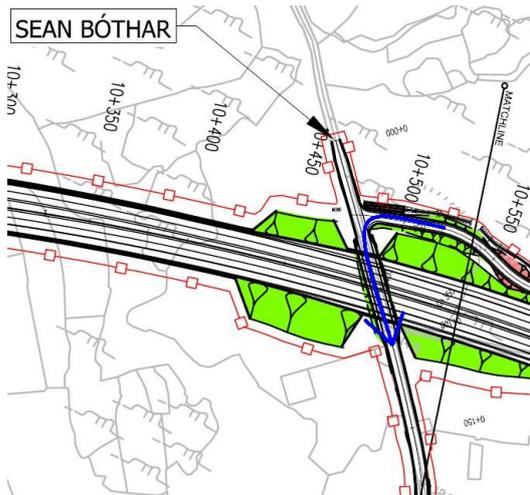
**Recommendation:** The Designer should assess how an over height vehicle will reach the local road network having been directed from the mainline at this location. Measures should be put in place to make the required movements as simple as possible.

### 3.6 Issue: Over height vehicle diversion routes

**Location:** On the approaches to tunnels

**Problem:** Exit roads are provided in advance of both tunnels in order to offer an alternative route to over height vehicles. The Auditors are concerned that some of the local road network may not be suitable for such vehicles (see figure 9) which could lead to blockages potentially resulting in various collision types.

Figure 9: Sean Bothar diversion route



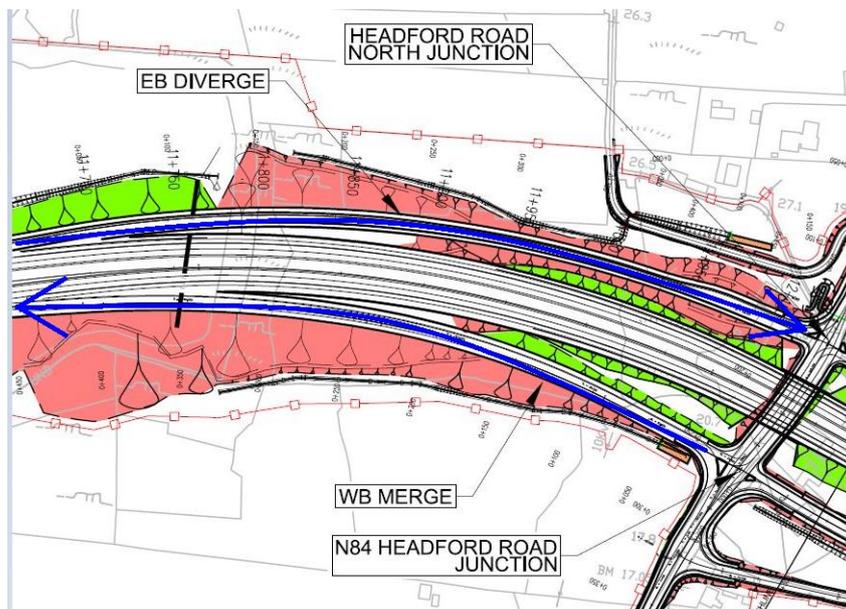
**Recommendation:** Diversion routes should be developed from each exit road at the tunnels. These routes should indicate the maximum height available to such vehicles in order to minimise disruption to other road users.

### 3.7 Issue: Lack of verge widening

**Location:** Headford Road and Tuam Road Junctions

**Problem:** The Auditors are concerned that forward visibility on the eastbound diverges and westbound merges for these junctions may be insufficient as there does not appear to be verge widening proposed at this stage. Sub-standard forward visibility could lead to road users being unaware of a hazard within the carriageway ahead. This could lead to late braking or erratic manoeuvres potentially increasing the risk of collision at these locations.

Figure 10: Lack of verge widening (Headford Road Junction)



**Recommendation:** The Designer should make an assessment of the requirements for verge widening and alter the design if necessary.

### 3.8 Issue: Successive merges and diverges

**Location:** N17 Tuam Road and Parkmore Junctions

**Problem:** The design presented for audit includes successive eastbound merges at chainages 13+580 and 13+850 and successive westbound diverges at chainages 13+550 and 13+350. The Auditors are concerned that road users may become confused or distracted by these layouts which could result in sudden braking, weaving or erratic manoeuvres which could increase the risk of injury to all users. This issue could also be complicated by the proposed N84 Headford Road junction which will be situated ~1,100m west of the N17 Tuam Road junction, including auxiliary lanes between both.

Figure 11: Successive merges and diverges



**Recommendation:** The Designers should assess whether the diverge for the N17 and merge for the mainline from Parkmore Link Road are required as there appears to be an alternative route within the proposed design for each of these movements. If a merge and diverge was removed from the design these issues would not arise. Please also refer to comment 3.5.

### 3.9 Issue: Junction proximity to tunnel

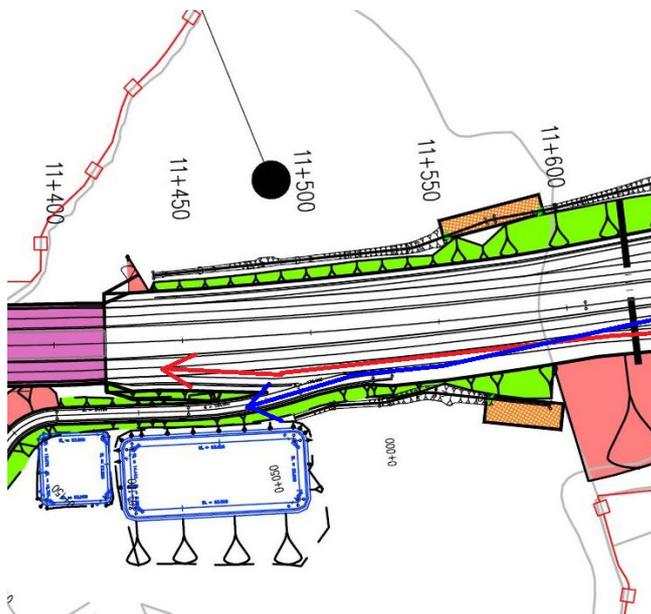
**Location:** Headford Road Junction and Lackagh Tunnel

**Problem:** The Auditors are concerned about the proximity of this tunnel to the junction to the east. The diverge for the N84 begins almost immediately east of the tunnel and the merge from the N84 to the N6 terminates just east of the tunnel entrance.

Travelling eastbound there is little or no opportunity for the provision of the required advanced directional signage and the diverge commences immediately upon egress from the tunnel. This may lead to driver confusion potentially resulting in stopping or reversing on the mainline.

Travelling westbound the merge lane terminates at the tunnel entrance, where there is no hard shoulder. This could lead to slow moving vehicles attempting to merge into fast moving traffic which could potentially result in side swipe or rear end type collisions as well as increasing the risk of hard braking or skidding. The crossover between the over-height vehicle escape lane with the westbound merge lane exacerbates this situation by placing merging vehicles in direct conflict with egressing over-height vehicles. This additional conflict may result in additional issues for merging vehicles, particularly considering the potential restricted visibility afforded due to over-height vehicles exiting the carriageway.

Figure 12: Lackagh Tunnel / N84 Headford Junction



**Recommendation:** The Designer should investigate widening the tunnel to include a hardshoulder or to extend the merge/diverge lanes through it. This would simplify the provision of signage on the eastbound direction and will reduce the potential for the collision types outlined.

Alternatively, the interchange could be relocated further east or the merge / diverge lane configurations adjusted to relocate their interaction points further east and away from the tunnel entrance / exit.

In relation to the emergency over height vehicle egress, egressing vehicles should not be in direct conflict with merging vehicles. The Designer should take this into account in the redesign of the egress for these vehicles.

### 3.10 Issue: Lane designation

**Location:** N6 tie in and Coolagh Junction

**Problem:** The westbound road layout on the approach to Coolagh Junction is complex and includes a mainline diverge for city bound road users which in turn splits to create a diverge for Oranmore bound road users, all over a distance of ~ 700m. This could prove confusing for approaching road users and could lead to sudden braking thereby increasing the potential risk of collisions.

**Recommendation:** The ITS, traffic signal, signage and public lighting strategies should be developed taking account of the potential approach speeds of road users arriving at these locations. All of the above should form part of the Stage 2 RSA assessment of the scheme.

### 3.11 Issue: Safety barrier design

**Location:** Throughout the scheme

**Problem:** The Auditors note that there appears to be an excessive amount of safety barrier installations proposed for the scheme. It should be noted that safety barriers are also considered hazards and should only be installed when all other mitigating factors have been exhausted.

**Recommendation:** The Designers should take heed of the requirements of GE-TBU-01019 (NRA TD 19 and Forging Roadsides) and DN-REQ-03034 (Safety Barriers) prior to developing the safety barrier design and the land boundary for the scheme. The clear zone requirements of DN-REQ-03034 should, insofar as is reasonably practicable, be provided.

## 4 Comments

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### 4.1 Access road vertical alignment

No vertical alignment information for the access roads labelled “AR” was provided to the Audit Team. As a result a safety assessment of the access roads could not be undertaken.

### 4.2 Sightlines at junctions

The Audit Team is concerned that sightlines at junctions may be obstructed by adjacent infrastructure. Sightlines at junctions could not be assessed considering the level of detail provided at this stage of audit. As a result it is recommended that this element of the design is assessed as part of the stage 2 road safety audit.

### 4.3 Public lighting

No public lighting proposal was provided to the Audit Team. As a result a safety assessment of public lighting proposals could not be undertaken.

### 4.4 Attenuation pond access

Access roads to a number of attenuation ponds were been included in the design submitted for audit. As a result a safety assessment of the access roads could not be undertaken.

### 4.5 Junction rationalisation

The Auditors are concerned about the proximity and complexity of the N17 Tuam Road and Parkmore junctions and feel that a road user could become confused on the mainline approach to either junction. It should also be noted that the traffic sign design has not been completed at this stage and as a result it is unclear whether it will be possible to install overhead gantry signage including the required full forward visibility. The combination of the above factors could lead to road users becoming confused and could lead to sudden braking or erratic manoeuvres which could increase the risk of collisions throughout this section of the scheme.

### 4.6 Traffic signal design

The traffic signal drawings provided to the Audit Team shows signal locations but is indicative only. As a result a safety assessment of the traffic signal design could not be undertaken.

## 4.7 R336 access road vertical alignment

The Auditors note that a gradient of 2.5% is proposed for approximately 50m on the access road approach to the R336 roundabout west of Bearna. This gradient should be reduced to 2% on the immediate approach to a junction.

## **Appendix A**

### **Drawings and Documents**

## A1 Drawings and Documents

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Drawings and documents received for the Stage 1 Road Safety Audit of the proposed Galway City Relief Road are as follows:

GCOB-100-RSA-000 – Mainline Plan\_I1 – Key Plan  
GCOB-100-RSA-100 to 111\_I1 – Mainline Plan & Profile  
GCOB-100-RSA-200\_I1 – Junctions & Side Roads – Key Plan  
GCOB-100-RSA-201 to 221\_I1 – Junctions & Side Roads Plan & Profiles  
GCOB-100-RSA-300 to 304\_I1 – Aquaplaning Assessment Locations – Plan  
GCOB-100-RSA-400 to 414\_I1 – Safety Barriers – Plan  
GCOB-100-RSA-500 to 514\_I1 – Traffic Signs and Road Markings – Plan

GCOB-4.03-2.2-002\_D1 – Aquaplaning Assessment Report  
GCOB-4.03-2.3-000 (Ped Cyc Junct)\_D1 – Pedestrian and Cyclist Provision At Junctions of N6 GCRR  
GCOB-4.04.03.004\_I2 – Phase 3 Junction Strategy

GCOB-100-DP-108\_Plan & Profile\_I2 – Proposed Design Departures and Relaxations Mainline Plan/Profile Ch. 10+550 to 12+200\_Sheet 8 of 11  
GCOB-100-DP-210\_I3 - Proposed Road Development Plan & Profile Menlo Castle Boithrin, Bothar Nua, Sean Bothar\_Sheet 10 of 21  
GCOB-100-DP-217\_I2 - Proposed Road Development Plan & Profile Ballybrit Crescent Junctions\_Sheet 17 of 21

## **Appendix B**

### **Audit Team Approval**

## B1 Audit Team Approval

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*Paul Batty  
Corporate House  
Ballybrit Business Park  
Ballybrit  
Galway*

Date: 03/10/2016

Our Ref: 954439/4287/Stage 1

re: N6 M/N6 Galway City Outer By-Pass

### APPROVAL OF ROAD SAFETY AUDIT TEAM, Stage 1

Dear Paul Batty,

The following members of the proposed road safety audit team are approved to carry out the Stage 1 road safety audit of N6 M/N6 Galway City Outer By-Pass.

1. Shane FitzGerald - Arup - Leader
2. Thomas Connell - Arup - Member

A copy of all audit reports, design team response and exception reports must be uploaded through RSAAS. Successful upload of these reports and completion of the audit approval process is necessary for any further audit approval on this scheme.

Yours sincerely,

Lucy Curtis

*Regional Road Safety Engineer*  
[roadsafetyaudits@nra.ie](mailto:roadsafetyaudits@nra.ie)

## Appendix C

### Designer Response Form

# C1 Designer Response Form

<b>Scheme:</b> Galway City Relief Road	<b>Route Nos.:</b> N6, N17, N59, N84, R336, Local Road realignments
<b>Audit Stage:</b> Stage 1	<b>Date Audit Completed:</b> June 2017

Problem / Comment	To be completed by the Designer				Describe Alternative Measure	To be completed by Audit Team Leader	
	Problem / Comment Accepted		Recommended Measure Accepted			Alternative Measures Accepted	
	Yes	No	Yes	No		Yes	No
3.1	✓		✓		Areas of earthworks overlap have been re-examined to ensure that the scheme can be constructed. The scheme footprint takes account of construction requirements.	✓	
3.2	✓		✓		Forward visibility has been provided in accordance with TII Publications. All junctions have been assessed to ensure visibility in accordance with TII Publications is provided.	✓	
3.3	✓		✓		The scheme has been assessed from the perspective of headlight glare. Where the potential arises, appropriate timber screening fencing and landscaping (bunds, shrubs) is provided within the scheme footprint.	✓	
3.4	✓		✓		Access to all attenuation ponds has been designed within the lands made available for the scheme.	✓	
3.5	✓		✓		The clearance of Lackagh Tunnel and the Galway Racecourse tunnel have been increased to accord with TII Publications. Consequently, the exits now serve as	✓	

		To be completed by the Designer				To be completed by Audit Team Leader	
Problem / Comment	Problem / Comment Accepted		Recommended Measure Accepted		Describe Alternative Measure	Alternative Measures Accepted	
	Yes	No	Yes	No		Yes	No
					<p>emergency exit routes. These emergency exit routes accommodate egress from the mainline during tunnel incidents. The operation of these emergency exits will be controlled by an intelligent transportation system.</p> <p>The emergency routes via which redirected vehicles will join the local road networks has been examined and simplified by eliminating the need to complete a turnaround.</p>		
3.6	✓		✓		<p>The clearance of Lackagh Tunnel and the Galway Racecourse tunnel have been increased to accord with TII Publications. Consequently, the exits now serve as emergency exit routes. These emergency exit routes accommodate egress from the mainline during tunnel incidents. The operation of these emergency exits will be controlled by an intelligent transportation system.</p> <p>The need for exiting vehicles to perform u-turn movements have been removed.</p> <p>The routes that overheight vehicles will utilise following departure from the mainline has been examined and where required are proposed for upgrade as part of the scheme so as to enhance safety and operational performance. Refer to drawings GCOB-100-DP-210 and GCOB-100-DP-217.</p>	✓	
3.7	✓		✓		<p>Visibility for the Headford Road and N17 junction have been re-assessed. Visibility in accordance with TII Publications has been provided.</p>	✓	

		To be completed by the Designer				To be completed by Audit Team Leader	
Problem / Comment	Problem / Comment Accepted		Recommended Measure Accepted		Describe Alternative Measure	Alternative Measures Accepted	
	Yes	No	Yes	No		Yes	No
3.8	✓		✓		The layout of the N17 junction has been examined. Following further traffic analysis and junction optioneering the eastbound diverge to the Parkmore Link Road has been removed and the westbound merge from the Parkmore Link Road has been removed.	✓	
3.9	✓			✓	<p>The interaction of the N84 and Lackagh Tunnel portal has been examined and the following measures are proposed to enhance safety and operational performance.</p> <p>Travelling eastbound the length of the auxiliary lane of the parallel diverge has been reduced to 100m to provide a travel distance between the Lackagh portal and the start of the diverge taper thereby allowing diverging traffic to identify the diverge. Hourly diverging traffic flows for the 2039 design year, with high growth, are low (169) thereby minimising the interaction between diverging and mainline traffic. A departure from standard has been obtained from TII for the reduced auxiliary lane length. The area will be lit to enhance the safety of the scheme and ensure the layout is clearly visible to road users. The diverge will be appropriately sign posted via fixed signage (posts and gantries) allowing motorists to anticipate the diverge.</p> <p>Travelling westbound the hourly merging traffic flows for the 2039 design year, with high growth, are low (242) thereby minimising the interaction between merging and mainline traffic. The area will be lit to enhance the safety of the scheme</p>	✓	

		To be completed by the Designer				To be completed by Audit Team Leader	
Problem / Comment	Problem / Comment Accepted		Recommended Measure Accepted		Describe Alternative Measure	Alternative Measures Accepted	
	Yes	No	Yes	No		Yes	No
					<p>and ensure the layout is clearly visible to road users. The merge will be appropriately sign posted via fixed signage (posts and gantries) allowing motorists to anticipate the diverge.</p> <p>Regarding the emergency route which is in proximity to the Lackagh tunnel portal and the N84 westbound diverge. The clearance of Lackagh Tunnel and the Galway Racecourse tunnel have been increased to accord with TII Publications. Consequently, the exits now serve as emergency exit routes. These emergency exit routes accommodate egress from the mainline during tunnel incidents. The operation of these emergency exits will be controlled by an intelligent transportation system. Thus vehicular traffic interactions at this location will be limited to tunnel incidents and not everyday usage.</p> <p>Refer to drawing GCOB-100-DP-108.</p>		
3.10	✓		✓		During design development the westbound road layout on the approach to Coolagh Junction and the further diverge to the R446 was examined. The layout was amended to provide sequential diverging movements.	✓	
3.11	✓		✓		The requirements of GE-TBU-01019 and DN-REQ-03034 have been considered. These requirements have contributed to the development of the scheme footprint. The layout and need for safety barriers have been determined in accordance with the standards noted, and show a reduced length from the initial scheme design proposal.	✓	

		To be completed by the Designer				To be completed by Audit Team Leader	
Problem / Comment	Problem / Comment Accepted		Recommended Measure Accepted		Describe Alternative Measure	Alternative Measures Accepted	
	Yes	No	Yes	No		Yes	No
4.1	✓		✓		All access roads have been designed in accordance with TII DN-GEO-03031 and vehicular tracking has been undertaken. This element of the design will be assessed as part of the stage 2 road safety audit.	✓	
4.2	✓		✓		All junctions and accesses have been designed in accordance with TII DN-GEO-03031 and DN-GEO-03060. This element of the design will be assessed as part of the stage 2 road safety audit.	✓	
4.3	✓		✓		Road lighting has been designed in accordance with I.S. EN 13201-2.	✓	
4.4	✓		✓		All junctions and accesses have been designed in accordance with TII DN-GEO-03031 and DN-GEO-03060. This element of the design will be assessed as part of the stage 2 road safety audit.	✓	
4.5	✓		✓		The layout of the junctions between the N84 and the N17 has been rationalised and simplified.	✓	
4.6	✓		✓		All signalised junctions have undergone extensive traffic modelling to ensure safe and efficient operation. This element of the design will be assessed as part of the stage 2 road safety audit.	✓	
4.7	✓		✓		The southern arm serves as a residential and agricultural access. This is a low speed access road.	✓	

Signed *Eileen McCarthy*

Designer

Date *11/8/17*

Signed *[Signature]*

Audit Team Leader

Date *14.08.2017*

Signed *Fintan O'Meara*

Employer

Date *18/9/17*