Route Selection Report

Galway City Transport Project

Volume 1A

Report - Part 1

March 2016

An Roinn Iompair Turasóireachta agus Spóirt

Bonneagar Iompair Éireann Transport Infrastructure Ireland

Comhairle Cathrach na Gaillimhe Galway City Council

Comhairle Chontae na Gaillimhe Galway County Council

ARUP

Galway County Council

N6 Galway City Transport Project

Route Selection Report

GCOB-4.04-009

Issue 1 | 16 March 2016

Job number 223985-00

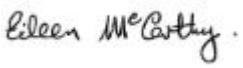
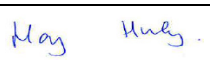
Ove Arup & Partners Ireland Ltd

Arup
Corporate House
City East Business Park
Ballybrit
Galway
Ireland
www.arup.com

ARUP

Document Verification

ARUP

Job title		N6 Galway City Transport Project		**Job number** 223985-00	
Document title		Route Selection Report		**File reference** GCOB-4.04-009	
Document ref		GCOB-4.04-009			
Revision	**Date**	**Filename**	GCOB-4.04-009 (Route Selection Report)_D1.docx		
Draft 1	28 Aug 2015	**Description**	Draft 1		
			Prepared by	Checked by	Approved by
		Name	Mary Hurley	Fiona Patterson	Eileen McCarthy
		Signature			
Issue 1	16 Mar 2016	**Filename**	GCOB-4.04-009 (Route Selection Report)_I1.docx		
		Description	Issue 1		
			Prepared by	Checked by	Approved by
		Name	Mary Hurley	Fiona Patterson	Eileen McCarthy
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
		Filename			
		Description			
			Prepared by	Checked by	Approved by
		Name			
		Signature			
				Issue Document Verification with Document	✓

List of Volumes

Volume 1A – Route Selection Report – Part 1

Volume 1B – Route Selection Report – Part 2

Volume 2 – Figures

Volume 3A – Appendices – Part 1

Volume 3B – Appendices – Part 2

Volume 3A – Appendices – Part 3

Volume 3B – Appendices – Part 4

Volume 1A – Route Selection Report – Part 1 Contents

1 Introduction

1.1 Overview

Galway County Council, Galway City Council, the Transport Infrastructure Ireland (formerly known as National Roads Authority) [1] and the National Transport Authority are collaborating in developing a solution to the existing transportation issues in Galway City and environs. The transportation solution will include a smart mobility component, public transport component and road component.

The N6 Galway City Transport Project (GCTP) is the road component of the transportation solution and is the subject of this route selection report. In parallel, the National Transport Authority is engaged with Galway City Council in developing the smart mobility and public transport components of the overall transportation solution (known as the Galway City Integrated Transport Management Programme (ITMP)). Whilst the N6 GCTP will integrate with the ITMP, the route selection process is a stand-alone process and is not reliant on the other components of the ITMP as studies to date have indicated that a road component is a necessary part of the solution.

This report presents the findings of the Constraints and Route Selection study for the proposed N6 GCTP. This has been prepared in accordance with Phase 2 of the National Roads Authority (NRA) 2010 Project Management Guidelines (PMGs).

The NRA 2010 Project Management Guidelines (PMGs) are a guide on how a scheme should develop and progress. They contain a framework for the phased approach to the development, management and delivery of major national road schemes in Ireland. They are structured so as to ensure consistency in this approach throughout the entire network.

The Guidelines are divided into seven phases namely Phase 1 *Scheme Concept & Feasibility Studies*, Phase 2 *Route Selection*, Phase 3 *Design*, Phase 4 *EIA & The Statutory Processes*, Phase 5 *Advance Works & Construction Documents Preparation, Tender & Award*, Phase 6 *Construction & Implementation*, and Phase 7 *Handover, Review & Closeout*.

We are currently engaged in Phase 2 of the N6 Galway City Transport Project and this report documents the findings of Phase 2 Route Selection.

The Department of Finance established the Capital Works Management Framework (CWMF) in order to deliver the Government's objectives in relation to Public Sector Construction Procurement Reform. As TII-funded schemes constitute Public Sector Procured Construction Projects, they are subject to the requirements of the CWMF. Therefore, elements of the appraisal process required under CWMF are

[1] The Minister for Transport, Tourism and Sport has signed the order for the merger of the National Roads Authority (NRA) with the Railway Procurement Agency (RPA) to establish a single new entity called Transport Infrastructure Ireland (TII). The National Roads Authority is known as Transport Infrastructure Ireland (TII) since 1st of August 2015. All references to guidance documents and standards within this report will retain the *NRA* reference until such time as these documents are updated.

also pertinent to this scheme and there will be interaction with and reference to the CWMF throughout this report

1.2 Purpose of the Route Selection Report

The purpose of Phase 2 as per the NRA PMGs is to identify a suitable Study Area for the examination of alternative routes, to identify key constraints within that Study Area, to develop feasible route options and to carry out a systematic assessment of these options leading to the selection of a Preferred Route Corridor which will form the basis for the detailed design to follow in Phase 3. This phase also outlines the requirements for public consultation associated with the development of routes and alternatives. Collectively an upgrade of the existing infrastructure, the 'on-line' option, and numerous 'green field' options, as well as an initial assessment of improvements to public transport, have been considered during the planning and design of the preferred road component of the transportation solution.

The Route Selection Process is a 3-stage process outlined as follows:

- Stage 1 - Develop a number of feasible route options (typically 6 or more and including 'Do-Nothing' and 'Do-Minimum' alternatives) and carry out a Preliminary Options Assessment using a Framework Matrix (comprising the assessment criteria of Engineering, Environment and Economy);
- Stage 2 - After Stage 1, carry out a Project Appraisal of these routes using the Project Appraisal Matrix (comprising the 5 Common Appraisal Criteria of Economy, Safety, Environment, Accessibility & Social Inclusion and Integration); and
- Stage 3 - After Stage 2, select a Preferred Route Corridor for the Scheme. Following this, prepare a Project Appraisal Balance Sheet (PABS) for the Preferred Route as described in the NRA Project Appraisal Guidelines.

Chapter 2 of this report identifies the need for the N6 GCTP. **Chapter 3** describes the traffic assessment whilst **Chapter 4** outlines the findings of the constraints study and identifies the key constraints within the scheme study area. A public consultation in relation to the constraints study was held in July 2014 and an overview along with the findings of this consultation is also included in **Chapter 4**. **Chapter 5** describes the alternatives that were considered during the process including both feasible and non-feasible alternatives. Six feasible route options were developed and these were included in the Stage 1 assessment as described in **Chapter 6**.

Following this assessment, a second public consultation was held in January/February 2015 to update the public in relation to constraints study and to consult with the public on the six route options. Following this public consultation, modifications were made to the route options and these modified route options were included in the Stage 2 assessment. This consultation, the design modification and Stage 2 assessment are described in **Chapter 7**.

Chapter 8 outlines the results of the Project Appraisal Balance Sheet (PABS) for the Preferred Route Corridor and makes a recommendation for the Preferred Route Corridor which should form the basis of Phases 3 and 4 of the scheme development. Public display of the Emerging Preferred Route Corridor was held in May 2015 and the findings of this consultation are included also in **Chapter 8**.

1.3 Background to the N6 Galway City Transport Project

1.3.1 N6 Galway City Outer Bypass

The N6 Galway City Outer Bypass, an earlier scheme, was previously developed and submitted to An Bord Pleanála (ABP) for approval on 1 December 2006. A brief summary of its history is outlined below.

Consultants were appointed in 1999 to undertake feasibility studies, route selection, design and planning for the N6 Galway City Outer Bypass. The resultant scheme including the Compulsory Purchase Order (CPO) and Environmental Impact Statement (EIS) was submitted to An Bord Pleanála (ABP) on 1 December 2006. This scheme consisted of 21.4km of mainline, 9km of link roads, associated intersections and a major bridge crossing of the River Corrib. This scheme is referenced as the N6 Galway City Outer Bypass (2006) together with the acronym of 2006 GCOB throughout this report.

On 28 November 2008, ABP delivered its decision in respect of the N6 Galway City Outer Bypass (2006). ABP granted approval for part of the scheme, the section from the N59 east to the existing N6, inclusive of both junctions at the N59 and the N6. In their decision, ABP noted their consideration of all data presented and granted approval as it considered that the part of the road development being approved would be an appropriate solution to the identified traffic needs of the city and surrounding area. ABP noted that there would be a localised severe impact on the Lough Corrib candidate Special Area of Conservation but that this did not adversely affect the integrity of this candidate Special Area of Conservation[2].

ABP refused permission for the section of the scheme from the R336 west of Bearna to the N59. ABP considered that the need for an outer bypass of Galway City connecting the N6 on the east to the R336 coast road as an essential part of the strategic transport network of the Galway area had been established. However, ABP was not satisfied with the section of the proposed road development through Tonabrocky Bog which is:

- part of the Moycullen Bogs Natural Heritage Area (NHA);
- an active Blanket bog listed as an priority habitat in Annex I of the EU Habitats Directive; and
- the site of a population of Slender cotton grass which is a legally protected and vulnerable species.

ABP refused the western section of the scheme on the basis that this part of the road development would not be in accordance with the preservation of the Tonabrocky habitat given the potential for significant adverse effects on the environment that less damaging alternatives may be available[2].

An application was made by a third party to the High Court seeking leave to issue judicial review proceedings against the ABP decision which granted approval of the eastern section of the N6 Galway City Outer Bypass (2006). At that point in time, the N6 Galway City Outer Bypass (2006) scheme was assessed on the premise that the loss of a relatively small area of Priority Habitat would not adversely affect

[2] Reference ABP decision 07.ER.2056

the integrity of the cSAC, and the scheme was taken forward on the basis of Article 6(3) of the Habitats Directive. The basis for the request for a review was that ABP erred in its interpretation of Article 6 of the Habitats Directive in arriving at the conclusion that the effect of the road scheme on the Lough Corrib cSAC designated site would not constitute an adverse effect on the integrity of the site.

The High Court undertook a judicial review of the ABP decision. The High Court decision of 9 October 2009 upheld ABPs decision to approve the eastern part of the scheme. On 6 November 2009, the third party was granted leave to appeal to the Supreme Court against the High Court decision of 9 October 2009. The Supreme Court sought the opinion of the Court of Justice of the European Union (CJEU) on an interpretation of the Habitats Directive.

The judgment of the CJEU was delivered on the 11 April 2013. The judgement concluded on two significant points:

1. The N6 Galway City Outer Bypass (2006) did have a significant adverse impact on the integrity of the Lough Corrib cSAC due to the removal of 1.5ha of Limestone pavement; and
2. Given that the N6 Galway City Outer Bypass (2006) had a significant adverse impact on the integrity of the cSAC, the correct planning process should be under Article 6(4) as opposed to Article 6(3).

The EU Judgement (i.e. Case C-258/11) established that the loss of a relatively small area of Priority Annex I habitat could adversely affect the integrity of the Lough Corrib cSAC and that where there is the potential to adversely affect Priority Annex I habitat, Article 6(4) applies. If it is determined that Article 6(4) applies, there is a need to identify the least damaging alternatives.

Following receipt of the CJEU opinion, the Supreme Court quashed the earlier ABP decision. Therefore, the process of developing a transportation solution for Galway City and environs recommenced starting again at Phase 1, feasibility and concept stage.

Further detail is provided on the legal proceedings in relation to the N6 Galway City Outer Bypass (2006) in **Chapter 5** and a full assessment of the scheme is included in **Appendix A.5.4**.

1.3.2 Development of the Project

Arup were appointed to provide multi-disciplinary engineering consultancy services for delivery of Phases 1, 2, 3 and 4 in compliance with the NRA Project Management Guidelines (NRA PMG) for the N6 GCTP. This appointment includes the examination of studies, documents and court rulings relating to the earlier unsuccessful scheme N6 Galway City Outer Bypass (2006), followed by preparation of feasibility studies, route selection, detailed design and final submission of a planning application for the revised scheme.

1.3.2.1 Phase 1

It is essential at the outset to identify the cause of the existing problems and issues within the city in order to develop an appropriate solution to the problem. Prior to the appointment of Arup to the current commission, a multi-modal transport model was developed on behalf of the National Transport Authority (NTA). The model is

called the Galway Interim Model (GIM). The model has become a useful tool in the quantification of the existing transportation issues within the city.

Initial work focused on extensive data collection including travel surveys, traffic analysis and delay assessment on the existing network to clearly establish a set of tangible measurable indicators or key performance indicators (KPI) to define the existing problems and ultimately with which to compare future potential solutions. The outcome of this initial examination of the transportation issues in Galway City and environs have shown that the following are worthy of further study and analysis:

- Congestion of major routes through the city;
- Journey time unreliability due to uncertain quantum of delay;
- Journey time variability throughout the day;
- Peak hour traffic delays;
- By-passable traffic is in conflict with internal traffic;
- Inadequate transport links to access markets within the city;
- Inadequate transport links, including public transport connections from Galway onwards to Connemara; and
- Lack of accessibility to the Western Region as a whole.

In essence the existing network is congested, with substandard provision in terms of capacity both on links and junctions, resulting in unreliable journey times, delay and a lack of access, all of which ultimately impacts on overall safety for users. The provision of a good quality route from the east to the west of Galway will allow Galway to function as a unit to become the gateway of the Western Region.

Phase 1 was completed. The conclusion of Phase 1 was that there is a strong justification for advancing a scheme which includes a combination of both public transport and road based solutions. Smart mobility and public transport measures will be primarily addressed in the Galway City Integrated Transport Management Programme (ITMP) as described in **Section 1.3** below. However, a public transport only solution has also been considered as part of this project but was deemed incapable of delivering a solution in isolation; it is described in **Chapter 5** of this report.

1.3.2.2 Development of Phase 2

For the purpose of Phase 2, a scheme study area has been developed, within which the road component of the transportation solution would be developed.

The scheme study area is bounded by Lough Corrib to the North and Galway Bay to the south and extends from the R336 immediately west of Bearna to the N6 at Coolagh in the east. The scheme study area is divided in two by the River Corrib which flows between Lough Corrib and Galway Bay. Four national roads, namely N6, N17, N84 and N59, are all located within the scheme study area.

The objectives of this phase are firstly to establish all the constraints of a physical, procedural, legal and environmental nature that may affect the development of possible route option corridors and secondly to select the emerging preferred route corridor for the scheme.

Following on from Phase 1, taking cognisance of the judgement on the N6 Galway City Outer Bypass (2006) and the key constraints of the Lough Corrib candidate Special Area of Conservation (cSAC) the options which have been considered in Phase 2 are outlined below:

- "Do-Nothing": This option is the Base Year model with growth factors applied up to the year of opening (2019);
- "Do-Minimum": This option includes road and non-road schemes, including smart mobility measures, which have been committed or are likely to proceed before the year of opening (2019);
- "Do-Something Public Transport": This option was based on measures, options and schemes identified by the existing Galway Public Transport Feasibility Study of 2010 for Galway City Council including smart mobility measures;
- Upgrade Existing Road Alternative (On-line): The first road option developed was the on-line upgrade of the existing road and utilises the existing N6 and the R338; and
- Build New Road Alternative (Off-line): This option included off-line route options connecting the R336 in the west to the M6 in the east.

Details of all work undertaken in Phase 2 Route Selection are contained in this report.

1.4 Galway City Integrated Transport Management Programme

As required by national policy, the design team has incorporated the principles of smart mobility into the design process since commencement of the project. In particular this has meant that smarter travel and public transport measures have always been included as measures that are being considered as part of the available alternatives to solve the transportation problem in Galway City and its environs'.

The Galway Transportation and Planning Study (GTPS) was formulated over a number of years between 1999 and 2002 jointly by Galway City and County Councils and adopted by both Galway City and County Councils in 2003. The current Galway County Council Development Plan (2015-2021) contains an objective to continue to support the careful management of growth in the commuter zone of Galway City as defined in the GTPS. However, through consultation with key stakeholders including TII, NTA, Galway County Council and Galway City Council, the need for an updated wider integrated transport strategy for Galway has been identified. This transport strategy will collate existing policies and strategies and identify the level of service requirements for each mode of transport; including walking, cycling, public transport and private vehicle.

It will also include assessment of transport linkages between the city and surrounding settlements, thereby addressing the public transport demand and other modal demand of those living in the county areas in proximity to the city. It will identify a series of supporting infrastructure, operational and policy measures to help optimise travel by sustainable modes in order to meet both the current and future travel needs of Galway.

The strategy will be formulated into an Integrated Transport Management Programme which will set out a phased plan of transportation measures for Galway City and environs over a 20 to 30 year horizon.

Whilst the N6 GCTP will integrate with the ITMP, the route selection process is a stand-alone process at this time in order to define the optimum corridor for additional road infrastructure as studies to date have indicated that a road component is required to form part of the solution. A review of the preferred route option will be undertaken in the context of the recommendations of the wider Galway transport strategy at Phase 3 of this project.

1.5 Objectives of the N6 Galway City Transport Project

The overall ambition of the scheme is to achieve a number of specific objectives under a number of multi criteria categories. By considering the objectives under these headings, it is the intention to provide a scheme which is attractive to all, delivers the road component solution (of the overall transport solution), provides benefit to the local and the larger regional population of Galway and the western region and is cognisant of the sensitive environment in which it is interwoven. The multi criteria headings are as follows:

- Economy;
- Safety;
- Environment;
- Accessibility & Social Inclusion; and
- Integration.

The specific objectives under each of the headings are detailed below.

The ***'Economic'*** objectives of the scheme include:

- Encourage local, regional, national and international development;
- Reduce journey times;
- Increase journey time certainty;
- Support the economic performance of the Gateway of Galway as the only large employer in the region;
- Provide benefits to the transport infrastructure;
- Improve connectivity to the Gateway of Galway;
- Improve linkages between the west and east sides of the county; and
- Deliver a cost effective project.

The ***'Safety'*** Objectives of the scheme include:

- Segregation of the interface of through traffic from urban traffic;
- Reduction in road traffic collisions; and

- Provision of safer urban streets.

The ***'Environmental'*** Objectives of the scheme include:

- The proposed scheme will minimise impacts on the integrity of all designated Natura 2000 sites;
- The proposed scheme will seek to avoid impacts to National Monuments;
- The proposed scheme will not be unduly detrimental to the architectural, cultural or linguistic heritage of the area;
- The proposed scheme will take due cognisance of the importance of the existing landscape;
- The proposed scheme will seek to preserve existing well established communities; and
- The proposed scheme will seek to reduce noise and air impacts on sensitive receptors.

The ***'Accessibility and Social Inclusion'*** Objectives of the scheme include:

- Improve accessibility to Galway City;
- Interconnection of the Galway City and environs road network to the national motorway network;
- Improve accessibility of Galway urban area to its main markets;
- Improve accessibility of the Gaeltacht areas to the remainder of the county and country;
- Reduce disadvantage of the Gaeltacht areas;
- Implement sustainable transport policies for shorter commutes;
- Improve urban environment of Galway City centre;
- Support the improvement of the public transport hub linking Galway to other Gateways; and
- Support the current development strategy and settlement strategy.

The ***'Integration'*** Objectives of the scheme include:

- Support the development of critical-mass of regional population centres;
- Integration of Galway City and environs (including western parts of Galway County) into the national economic development agenda;
- Support balanced social and economic development at a national level;
- Support balanced social and economic development at a city-region level;
- Understanding of the development, land-use and transportation pressures in the Galway urban area and their impact on the delivery of a successful city region at Galway;

- To deliver on Galway's potential as Ireland's fourth largest city and an important residential, educational, employment and service centre for a wide regional hinterland, contributing to the national urban hierarchy;
- Recognition of the role of Galway City as a gateway to the west and Connemara, and the consequent socio-economic benefits of enhanced connectivity of Galway City to national markets, enhanced tourism accessibility, and the national transport system; and
- Improvement of the TEN-T network to ensure connectivity of the west of Ireland to the single European market.

1.6 Scheme Operational Goals and Design Strategies

The primary operational goal of the N6 GCTP is to provide the road component solution of the overall transportation solution for Galway and enable the reallocation of existing road space within the city to smart mobility measures. This will be achieved by alleviating congestion within Galway City, facilitating a more efficient public transport system, providing a multi-modal choice of travel and improving safety levels for all public road users. In turn the overall transportation solution for Galway will foster smarter travel initiatives by improving the travel choices available to the population of Galway as outlined by the Department of Transport, Tourism and Sport in "Smarter Travel – A sustainable transport future a new transport policy for Ireland 2009 – 2020".

It is also an operational goal of the N6 GCTP to address the wider social and economic issues affecting the region, such as:

- Lack of accessibility to the gateway city of Galway;
- Restriction on the development of the city in a sustainable manner;
- Quality of life for those living and working in the city of Galway;
- Isolation of the western part of the county of Galway;
- Emigration resulting in the decline of a unique culture, language and heritage in the western part of the county;
- Preservation of the Gaeltacht area;
- Development of the tourism industry and the associated revenue generated from it; and
- Development of a strategic economic corridor as outlined in the Galway County Development Plan.

Taking into account the scheme objectives, the performance targets and aspirations for the overall N6 GCTP are set out below:

- Achieve high capacity connectivity to existing national and regional roads and congestion relief on major through route;
- Removal of peak hour traffic delays and minimise fuel wastage and emissions;
- Improve accessibility of the Galway urban area to its main markets;
- Improve connectivity to the Gateway of Galway;
- Improve transport connections from Galway onwards to Connemara and the Western Region;

- Improve journey time reliability to facilitate just-in time deliveries, mobility of people and goods throughout the day;
- Reduction in journey times;
- Improve the interconnection of the Galway City and environs road network to the national motorway network;
- Support sustainable transport policies and smarter travel choices for shorter commutes;
- Protection of existing residential communities; and
- Minimise environmental impacts.

The design strategy is based around the various options presented in **Section 1.2.2.2** above. To assess the most viable option, the design team have assessed the natural and physical constraints as well as all external parameters affecting the scheme.

Arup is providing multi-disciplinary engineering consultancy services for delivery of Phases 1, 2, 3 and 4 in compliance with the NRA Project Management Guidelines (NRA PMG) for the N6 GCTP. The environmental assessment of the project has been carried out by Arup with assistance from the following specialist environmental sub-consultants:

- Ecology (Scott Cawley Ltd);
- Hydrology (Hydro Environmental Ltd);
- Landscape and Visual (Brady Shipman Martin);
- Planning (Brady Shipman Martin);
- Archaeology, Cultural and Architectural Heritage (Irish Archaeological Consultancy (IAC));
- Material Assets - Agriculture (Curtin Agricultural Consultants Ltd);
- Noise and Vibration (AWN Consulting Ltd);
- Human Beings (Optimize Consultants Ltd);
- Traffic (Systra); and
- Valuation (Lisney).

2 Identification of Need

2.1 Introduction

The existing N6 is a National Primary route which connects the M6 on the east side of Galway at Ardaun to the N59 and the R338 on the north-west side of Galway at Newcastle. The existing N6 passes though the environs of Galway City, namely Briarhill, Ballybrit, Ballybane and Terryland on the east side of River Corrib and Newcastle on the west side of River Corrib. The N6 terminates at the R338 at the at-grade roundabout junction, Browne Roundabout, with the N59/N6. The R338 continues in a westerly direction to the Coast Road, the R336. Whilst the N6 bypasses Galway City centre, a large portion of the traffic on the N6/R338 is not fully bypassing Galway City environs, rather it is using the N6 to move in an east/west direction across the city, refer **Figure 4.10.1**.

The existing N6 is a four lane carriageway between the M6 and the N59, with a varying median width, and a number of at-grade junctions comprising at-grade roundabouts and signalised junctions. There are various forms of at-grade junctions including roundabouts, signals and priority junctions on the R338 from its junction with the N59 to the R336.

The need for the N6 Galway City Transport Project (GCTP) to replace the role of the existing N6/R338 road network is supported in terms of policy from national to local level which is outlined in **Section 2.2** and **Section 2.3**. The specific project need is defined in terms of its potential to solve existing transport issues in Galway City and environs, all of which is detailed in **Section 2.3** below.

2.2 Strategic Fit and Priority within the National Road Programme

The National Roads Authority (NRA) was formally established as an independent statutory body under the Roads Act, 1993 with effect from 1 January, 1994. The Minister for Transport, Tourism and Sport signed the order for the merger of the National Roads Authority (NRA) with the Railway Procurement Agency (RPA) to establish a single new entity called Transport Infrastructure Ireland (TII). The National Roads Authority is known as Transport Infrastructure Ireland (TII) since 1st August 2015. The Authority's primary function, under the Roads Act 1993, is to secure the provision of a safe and efficient network of national roads. For this purpose, it has overall responsibility for the planning, supervision of construction, road network management and maintenance on national roads.

The objective of the National Roads Authority capital expenditure programme (in place in advance of the formation of TII) is to improve the safety and efficiency of the national road network to make it fit for freight, business and social travel. Developing, maintaining and operating the national road network in a safe, cost effective and sustainable manner generates an improved quality of life and national economic competitiveness.

The three strategic priorities for TII are summarised as follows:

"Priority 1 – Asset Management, Network Rehabilitation and Network Operations;

Priority 2 – National Secondary Roads Improvements, Bottleneck Improvement Projects, Safety Projects and Traffic Management Projects; and

Priority 3 – Network Improvement Projects."

The N6 GCTP links four national routes around Galway City, namely N59, N84, N17 and N6. It also links a number of regional routes including the R336, which accesses south Connemara, refer **Figure 4.10.1**. The project is the mechanism to convey traffic east to west from the north and south and effectively encompasses all three of TII priorities whereby the existing primary road network is rehabilitated and improved, providing safety benefits and congestion/bottleneck improvements.

Investment in the N6 GCTP adds value to the overall strategic national roads network for the country.

2.3 Road Development Policy

The N6 GCTP is congruent with current transport policy and planning policy as set out in the various policy documents over the past number of years. Specific details for each of the policies and how the N6 GCTP complies with these, and more local and regional policies, are outlined below.

2.3.1 European Context

As of January 2014, the European Union has a new transport infrastructure policy that connects the continent between East and West, North and South. This policy aims to close the gaps between Member States' transport networks and to remove bottlenecks that still hamper the smooth functioning of the internal market. It is recognised that integrated transport networks are essential to a single market.

The aim of the European Union's land transport policy is to promote a mobility that is efficient, safe, secure and environmentally friendly. Congestion is not just a nuisance for road users; it also results in an enormous waste of fuel and productivity. Many manufacturing processes depend on just-in-time deliveries and free flow transport for efficient production. Congestion costs the EU economy more than 1% of GDP – in other words, more than the EU budget. To reduce this, the EU needs more efficient transport and logistics, better infrastructure and the ability to optimise capacity use.

The EU Commission also recognises that Europe needs transport which is cleaner and less dependent on oil. Moving towards low-carbon and more energy efficient transport, as well as developing more efficient urban and intermodal transport solutions as alternatives are essential to developing a more environmentally friendly transport policy.

The European transport infrastructure (TEN-T) includes the core transport routes in all EU Member States for all transport modes: air, rail, road, maritime and inland waterways. The N6 around Galway forms part of the TEN-T comprehensive network in Ireland.

The objectives of the N6 GCTP align with the European Union's land transport policies as included among its objectives are the following targets:

- Congestion relief on major through routes;
- Journey time reliability to facilitate just-in time deliveries;
- Removal of peak hour traffic delays to minimise fuel wastage and emissions;
- Improved transport links to access markets within the city; and
- Improved transport connections from Galway onwards to Connemara and the Western Region.

2.3.2 Infrastructure and Capital Investment 2012 - 2016

The *Infrastructure and Capital Investment 2012-2016 – Medium Term Exchequer Framework* presents the findings of a Government-wide review of infrastructure and capital investment. Within the context of tight fiscal constraints, the Government is committed to ensuring that the country's stock of infrastructure is capable of facilitating economic growth. The review assesses the existing capacity of Ireland's infrastructure and identifies remaining gaps which must be addressed to aid economic recovery, social cohesion and environmental sustainability.

Among the main priorities identified are:

- Ensuring adequate maintenance of the National Road Network in order to protect the value of previous investments;
- Targeting the improvement of specific road segments where there is a clear economic justification, including advancing two key PPP roads projects; and
- Continued investment to enhance Ireland's tourism product offering.

The N6 GCTP is consistent with these priorities in so far as it seeks to connect the west of County Galway to the remaining national road network. This connectivity is essential to ensure the viability of the western parts of the county which have a very high quality tourist offering which is dependent on connectivity to achieve its potential.

County Galway has a thriving tourism industry which contributes to the national tourism industry. There were almost one million overseas visitors to Galway in 2012 alone, generating an estimated €253M in revenue. Approximately, two thirds of the tourists visit the area in the period from May to September, with one of the main attractions being Connemara with its scenic landscapes and unpolluted environment. Tourism traffic, together with local recreation traffic accessing the beaches at the west of the city, add to the traffic volumes on this linear transport corridor in this summer period. Galway is also located on the Wild Atlantic Way which is a new initiative by Fáilte Ireland to encourage tourism into the west and is likely to generate additional traffic into the area.

Tourism is a vital industry to ensure the viability and survival of the South Connemara region, which is linked to overall improved social provision, quality of life and environmental sustainability.

2.3.3 Smarter Travel, A Sustainable Transport Future, 2009

"Smarter Travel – A Sustainable Transport Future" a policy framework approved by the Government in 2009 sets out measures so that by 2020 we can have thousands more people walking, cycling, using public transport and leaving their cars at home. With this action plan, the Government aims to change the transport mix in Ireland so that by 2020 car share of total commutes drops from the current 65% to 45%.

This involves new ways of approaching many aspects of policy making in Ireland. It affects how we plan our schools and school curricula, influences where we develop residential areas and centres of employment in the future, opens up social and employment opportunities for people who experience reduced mobility and returns urban spaces to people rather than cars.

Galway City and Galway County Council developed the *Galway Metropolitan Smarter Travel Area Action Plan 2010-2015* which is in line with the Smarter Travel national policy and sets out to develop a world-class area for sustainable travel in the area of Galway City and hinterland. This document assumes that the N6 Galway City Outer Bypass (2006) is in place.

The N6 GCTP supports these objectives fully as it includes among its objectives the delivery of an overall holistic transport solution for Galway. It is essential that the project relieves congestion, thus freeing road space which must be reallocated for other modes such as public transport, cycling and walking. A multi-modal model for Galway City and its surrounds was developed for the purpose of assessing the relative transport merits of various transport options, and for subsequent appraisal of the economic and environmental benefits of the preferred set of recommendations. This multi-modal traffic model is capable of accurately testing alternatives which comprise a combination of public transport options with road based options. This facilitates the provision of a solution which provides relief to the congestion in the city without jeopardising the public transport component of the overall solution.

The delivery of an overall solution which alleviates the current congestion will in turn improve the streetscapes to enable workers/school children to commute by walking and cycling, thereby reducing the very high percentage of short commutes by providing a safe environment for such a change in behaviour. Reallocation of the existing road space which will be created once traffic moves to the new road space is necessary to deliver this high quality safe environment within which vulnerable road users can move safely.

The recent *Galway City and Environs Walking and Cycling Strategy (AECOM Mitchell & Associates, 2010),* and *Ireland's National Cycle Policy Framework, 2009 to 2020* set out to create a strong cycling culture in Ireland with a target level of 10% of all trips to be made by bike by 2020. Currently, Galway City Council and Galway County Council have projects in design stage to deliver a Greenway from the city centre to Bearna and from the city centre to Oughterard. The Bearna Greenway will enable school children to cycle from the western suburbs of Galway City and Bearna to the secondary schools in the Salthill area. Galway City Council have recently completed construction of the Threadneedle Road cycle lane which is a significant improvement, designed again to promote cycling as a mode of transport to the secondary schools which are located on and adjacent to Threadneedle Road. The key to achieving the Government target of 10%

commuting by bike by 2020 is threefold; firstly, planning at all levels needs to consider cyclist needs, secondly, transport infrastructure must provide cycle friendly safe direct routes, and finally, education and communication is necessary to foster a cycling culture from a young age.

A key objective of the N6 GCTP which aligns with this national cycling policy is removal of congestion within Galway City to enable reallocation of further road space for cyclists. This can be achieved by reducing the number of short commuter journeys by car by facilitating journeys by bicycle which are faster, cheaper, and sustainable and generate health benefits. This is achieved by improving the transport infrastructure for cyclists by junction upgrades including installation of traffic signals, speed reduction measures and installation of additional nodes on the existing network to improve connectivity. In turn, all of these measures will also discourage city centre through traffic and force such journeys that may be necessary by car on to the new road space.

Smarter Travel seeks to improve public transport service. This is facilitated by the N6 GCTP which seeks to remove congestion, guarantee journey times, and encourages modal shift to public transport. Improvements to the bus network have been identified as necessary to better cater for existing and future travel patterns in Galway City in the most recent public transport study in Galway (*Galway Public Transport Feasibility Study, MVA 2010*). Significant improvements have been made to the bus network in Galway City in recent years with the addition of dedicated bus lanes along Seamus Quirke Road on the west side and the Dublin Road on the east side, addition of sheltered waiting facilities, provision of Real Time Service Information at existing bus stops and provision of increased frequencies on busy routes. However, the overall journey from origin to destination, both in terms of time, reliability, and cost, must be more attractive via public transport in order to encourage the mode shift from the private vehicle. Therefore, whilst the public transport schemes delivered to date are significant in Galway, the bus lanes installed to date terminate in advance of the city centre and the bus returns to the congested streets with the associated lack of certainty on journey times.

As outlined above, a key objective of the N6 GCTP is removal of congestion within Galway City which will facilitate the delivery of an improved bus network by further reallocation of road space for public transport. This can be achieved by reducing the number of short commuter journeys by car by facilitating journeys by bus which are faster, reliable, comfortable and stress-free to destinations within the city centre. This is achieved by improving bus journey times through bus priority at traffic signals, additional dedicated bus lanes, and delivery of bus routes through to the city centre terminus. In turn, all of these measures will also discourage city centre through traffic and force such journeys that may be necessary by car on to the new road space.

Achieving the targets as set out in Smarter Travel policies will deliver a more attractive, vibrant and economic Galway City with associated health and environmental benefits, all of which are necessary for sustainable travel into the future. The N6 GCTP aligns with these policies and this project is necessary to firstly resolve the congestion issues which are currently restricting maximum implementation of the Smarter Travel policies by supporting sustainable transport policies for shorter commutes.

2.3.4 Forfás Regional Competitiveness Agendas

Forfás is Ireland's national policy advisory body for enterprise and science. Forfás was established in 1994 as an agency of the Department of Enterprise, Trade and Employment. Forfás' policy functions include the provision of independent and rigorous research, advice and support in the areas of enterprise and science policy. This work informs the Department of Enterprise, Trade and Employment and wider Government in its responses to the fast-changing needs of the global business environment.

In their suite of seven Regional Competitiveness Agendas (RCAs): *Overview, Findings & Actions of December 2009*, Forfás assesses how each region can strengthen its competitive environment in support of enterprise. The RCAs propose specific actions to address barriers to development and focus efforts on realising the potential of each region. The N6 Galway City Outer Bypass (2006) is listed under Priority Actions for Physical Infrastructure in the West.

The additional Forfás publication of 2012, entitled *Overview of Main Infrastructure Issues for Enterprise*, which was published post the publication of the Infrastructure and Capital Investment 2012-2016 (November 2011) acknowledged that we had reached the conclusion of a major phase of Exchequer funded capital investment. It also noted that in the context of significantly reduced budgets, we need to develop smarter solutions to leverage the significant investments already made and improve our competitiveness and Galway Ring Road is listed as a priority:

"Given the limited capital resources available in the short to medium term, it is critical that we prioritise investment that will support economic recovery and sustainable growth. These include the completion of the Cork and Galway ring roads and two short sections of the Atlantic Corridor (Galway - Limerick-Cork) which will improve the mobility of people and goods in and between Ireland's main regional cities. Improving public transport in the main cities is critical to enhance mobility for all urban transport users."

The N6 GCTP is identified as a project at a national level which is necessary to support economic recovery and sustainable growth because of its ability to improve mobility of people and goods into and out of Galway. This is vital to the economic recovery of the Western Region as a whole which is of overriding public interest at a national level as the country moves towards sustainable growth and recovery. The objectives of the N6 GCTP include but are not limited to the following, all of which are targeted at economic recovery of the Western Region:

- Congestion relief on major through routes;
- Journey time reliability to facilitate mobility of people and goods;
- Support sustainable transport policies for shorter commutes;
- Improved transport links to access markets within the city; and
- Improved transport connections from Galway onwards to Connemara and the Western Region.

2.3.5 West Regional Authority: Regional Planning Guidelines

The *Regional Planning Guidelines (RPGs) for the West Region 2010 – 2022* were made by the Members of the West Regional Authority on 19 October 2010.

The RPGs recognise that the West Region has a significant and valuable resource in its natural heritage environment with a wide variety of species and habitats of local, national and international importance, the extent of which enhances the quality of life but also represents a real challenge in achieving sustainable development.

The RPGs acknowledge that the West Region has experienced difficulties in the past due to its peripheral location along the Atlantic seaboard and on the periphery of the European Union. For the West Region to achieve critical mass and growth and ultimately offer an alternative development corridor to the east coast corridor, strong communication links are required to achieve this through well-developed road, rail and air links as they are key stimuli for 'corridor' growth.

Section 3.5.2 of the RPGs, sets out specifically the need for a reduction in transport costs by improving the road networks particularly the M6 and potential Galway Outer Bypass as part of the economic development of the region. Section 5.2.1 of the RPGs outlines the necessary road priorities for the Region, including the Galway City Outer Bypass.

As outlined above, the N6 GCTP is necessary to support economic recovery and sustainable growth of the Western Region as a whole which is of overriding public interest at a national level as the country moves towards sustainable growth and recovery.

2.3.6 Galway County Development Plan, 2015 – 2021

The Galway County Development Plan 2015 – 2021 was adopted in January 2015, and is effective from 23 February 2015. It retains the objectives of the previous County Plan to provide a solution to congestion, to provide better connection from all parts of the County to the trans-national network, and to improve safety levels on all public roads. "*The integration of land use and transportation shall continue to be the overarching strategic aim of the Galway County Development plan 2015-2021*". (Refer Section 5.1).

The Plan further states that "*the timely provision of high quality transportation infrastructure within County Galway is critical to the County's socio-economic development and in the promotion of social and economic well-being*". (Refer Section 5.1)

The Development Plan transportation objectives (section 5.1.1) include the following strategic aims among others:

- "To provide a safe and efficient network of transport to serve the needs of the people and the movement of goods and services to and within County Galway;
- Provide access for all in an integrated manner with an enhanced choice of transport options including the Rural Transport Programme;
- To promote and encourage the use of alternative sustainable modes of transport and to promote the use of transport energy from renewable resources; and
- To safeguard the strategic transport function and carrying capacity of the motorway and national road network and associated junctions in order to provide for the safe and efficient movement of inter-urban and inter-regional traffic".

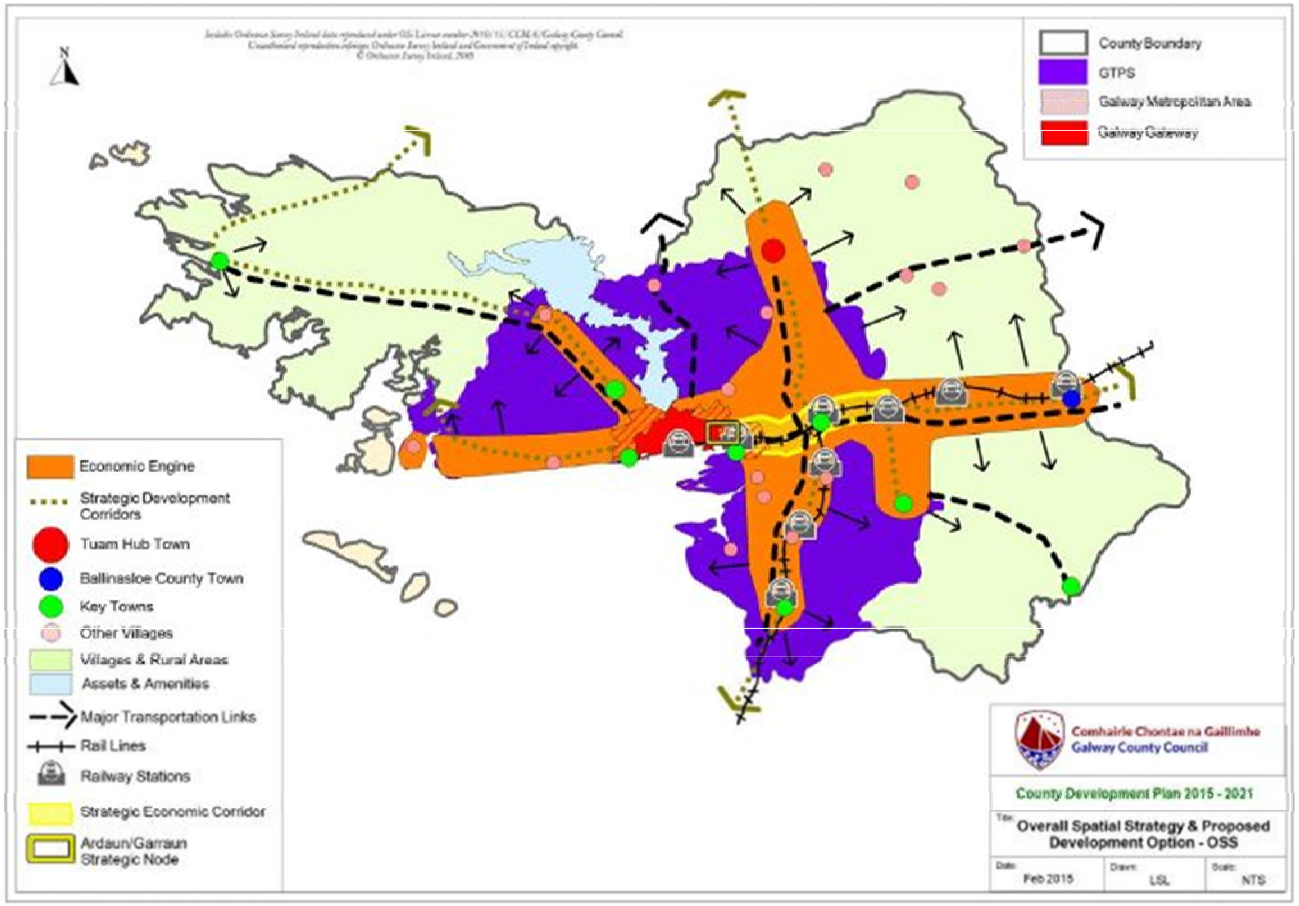
The Development Plan Strategy objectives (section 2.3) recognises the area defined by the original Galway Transportation and Planning Study (GTPS) and seeks to carry out a review of the transport strategy in this study during the lifetime of this plan – see extract from County Development Plan in **Figure 2.1** below.

The Development Plan also contains a specific objective setting out the role of Galway County Council to deliver the necessary transportation infrastructure. Objective TI 15 states that Galway County Council "*will work with all other relevant bodies to deliver the necessary improvement to transportation infrastructure, including new infrastructure if necessary, to help secure the medium and long term economic and social development of Galway Gateway and the west of the County. Any such investment or project shall be carried out with due regard to the necessity to protect the environment and in full compliance with the provision of relevant legislation, including the Habitats Directive.*"

Furthermore, the County Development Plan contains a specific objective setting out the need for public transport to be a part of the transportation objectives. Objective TI 18 states that Galway County Council "*shall prepare a Public Transport Plan in consultation and co-operation with the National Transport Authority, the Galway Transportation Co-Ordination Unit (TCU) and other relevant agencies.*"

This is strengthened in the County Development Plan in stated policy, Policy TI 8, which states that "*Galway County Council to work with Galway City Council and all relevant statutory bodies to develop an appropriate infrastructural response to the transportation needs of the Galway Gateway, its environs and the west of the County, with a view to relieving congestion, improving travel times, increased safety of all road users and enhancing connectivity and access within the region and enhanced accessibility of the western region in a national and international context. Any such solution shall have due regard to the necessity to protect the environment and will comply fully with the requirements of the Habitats Directive.*"

Figure 2.1 Overall Spatial Strategy & Proposed Development Option



The **Vision for Galway County**, as per the *Galway County Development Plan 2015-2022, is to 'Enhance the quality of life of the people of Galway and maintain the County as a uniquely attractive place in which to live, work, invest and visit, harnessing the potential of the County's competitive advantages in a sustainable and environmentally sensitive manner'*. Strategic aims of the Plan centre on the following:

- Promote Regional Development;
- Environmental Protection;
- Living Landscapes;
- Balanced Urban and Rural Areas;
- Inclusive Communities;
- Integrated Development;
- Sustainable Transportation;
- An Ghaeltacht;
- Infrastructural Projects;
- Heritage; and
- Climate Change Adaptation.

The performance targets of the N6 GCTP align with the strategic aims of the County Development Plan as they include the following targets:

- Reduction of journey times which will promote regional development through improved connectivity to markets and journey time reliability;
- Improve connectivity to the Gateway of Galway by providing high capacity linkages connecting east and west sides of the county;
- Support sustainable transport policies for shorter commutes which will enable delivery of improved living landscapes; and
- Protection of existing residential communities and minimise environmental impacts which could make Galway a uniquely attractive place in which to live, work, invest and visit, in a sustainable and environmentally sensitive manner.

2.3.7 Galway City Development Plan, 2011 – 2017

The Galway City Development Plan 2011-17 was adopted on 25 January 2011. It sets out a strategy for the city for a period of six years. The preparation of the subsequent plan commenced in January 2015 and is ongoing; however, the current plan is the statutory plan in force for the period up to January 2017.

The strategic goals of the City Development Plan 2011-2017 are as follows:

- Promote balanced and sustainable economic development that will enable Galway City to fulfil its role as a National Gateway and a Regional Centre, providing sufficient employment opportunities and appropriate services;
- Use the role of the Gateway to harness the strengths and maximise the economic development of the region;

- Provide for a built and natural environment that is of high quality and that contributes to providing a good quality of life for residents and visitors and affords sustainable transportation opportunities;
- Promote social inclusion in accordance with the National Anti-Poverty Strategy 2007 and the National Action Plan for Social Inclusion 2007-2016 and aim to reduce and ultimately eliminate poverty levels in accordance with national targets;
- Facilitate the achievement of the goals contained in the Galway City Development Board (GCDB) Strategy Gaillimh Beo agus Briomhar (GCDB) 2002-2012; and
- Promote the reduction of greenhouse gas emissions through proactive measures in line with EU commitments to tackle climate change.

The transport aim of the City Development Plan is to integrate sustainable land use with an integrated transportation system that is based on smarter travel principles. The transportation strategy for the city of Galway has evolved from the Galway Transportation and Planning Study, 2002 (GTPS). The GTPS set out a strategy for transportation and settlement within the scheme study area which included the city and a hinterland area of approximately 30km radius. The original GTPS included the city plus the surrounding area and the project was run jointly by the City and the County Councils. The strategy supported significant improved public transportation systems including development of the bus network, park and ride facilities, commuter rail services and improvement to cycling and walking networks in conjunction with the development of the Galway City Outer Bypass. The Galway Transportation Unit (GTU) within Galway City Council was established in 2008 with a focus on developing such an integrated transport solution for the city, to promote the increased use of non-car based transport services based on smarter travel principles and to overcome existing congestion.

The strategic policy of the GTU is to reduce congestion and provide a greater ease of movement primarily through providing multi-modal choice of travel. The GTU sees "*the importance of the Galway City Outer Bypass in the transport strategy for the city for relieving traffic and to improve the performance of the inner city radial network.*" (Section 3.4) The development of a wider transport strategy as part of the ITMP is in line with these objectives.

In addition, the broad **City Vision** for Galway includes the following:

- Improvement in the city's urban environment is sought through measures such as enhancement of the built and natural environment to foster sustainable development, retaining and enhancing the city's special character, and developing plans for parks in conjunction with local residents (Policy 1.7 Environmental Strategy; Chapter. 4, Policies 4.6, 4.8, 4.10 Specific Objectives 4.10, Section 7.1, 7.4);
- Integration of land use and sustainable transport systems (as prescribed for LAPs to be delivered in Chapter 2 page 17, Policy 3.2), which addresses quality of life, quality of the environment, and economic competitiveness (as per 3.1 Strategy Integrated Sustainable Transportation);
- Social Inclusion and ease of access to the city is sought in the objective to Promote Galway as a Child Friendly City, Healthy City and an Age Friendly City (Chapter 4 pp 38, and Policy 6.2);

- Emphasis on linkages to the city centre and throughout the City including green networks (Chapter 9, Policies 4.2, 4.3);and
- Support for the continued expansion and development of educational institutions in the City (Section 5.2.1).

As per the County Development Plan above, the performance targets of the N6 GCTP also align with the strategic aims of the City Development Plan as they can deliver the following:

- Reduction of journey times and congestion which will promote economic competitiveness;
- Improve connectivity to the Gateway of Galway by providing linkages to the city centre markets;
- Support sustainable transport policies for shorter commutes which will enable delivery of improved living streetscapes in the urban environment as well as enhancing the existing built and natural environment in a sustainable manner; and
- Protection of existing residential communities and minimise environmental impacts which could make Galway an inviting environment for both young and old alike.

A variation to the City Development Plan was adopted on 12 January 2015 to amend and delete where appropriate direct references to the objective for the N6 Galway City Outer Bypass (2006) and to substitute the specific text reference and road line reservations associated with the N6 Galway City Outer Bypass (2006) with text that equally promotes and supports an infrastructural solution to the serious transportation problems currently experienced in Galway City, Galway Gateway and Environs. The variation sets out the need for a solution to address transportation issues which include congestion on the main routes approaching and in the city, unreliable journey times owing to delays, conflict between trough and local traffic and inadequate transport links within the city and westwards to the County area – all of which are having an impact on the wider economic and social life of the city, county and region. Furthermore, the variation outlines the need for the development of a transportation solution which will also include for consideration of opportunities to improve public transportation options and facilities for cyclists and pedestrians.

Therefore, the objectives of this project which include relief of congestion and provision of multi-modal choice of travel align with the objectives of the Galway City Development Plan including the most recent variation to the plan.

2.3.8 National Spatial Strategy, 2002-2020

The need for the development of the gateways as national and regional engines of growth formed part of the Government's stated objectives in the National Spatial Strategy (NSS) of 2002 which set out a twenty year planning framework designed to achieve a better balance of social, economic, physical development and population growth between regions.

The National Spatial Strategy (NSS) identified the main cities and surrounding hinterlands of Cork, Galway, Limerick and Waterford as having the potential, when

combined, of counterbalancing the strong development in the eastern regions around Dublin.

It further states:

"Building on the dynamic role of Galway as a gateway and expanding its influence in promoting economic activity will be at the heart of extending balanced regional development to the West region.

Galway, with its population catchment, quality of life attractions, transport connections and capacity to innovate with the support of its third level institutions, will continue to play the critical role which has been essential in activating the potential of the region."

Specifically, the NSS sets out the need for Ireland to **strengthen** the dynamic, emerging critical mass of the existing gateways in the South East, South and West. It states the following:

"The best prospects for establishing critical mass of the type and scale capable of competing with that of the Greater Dublin Area point to developing Cork, Galway, Limerick/Shannon and Waterford as an increasingly inter-connected and developed network of co-operating and complementary cities."

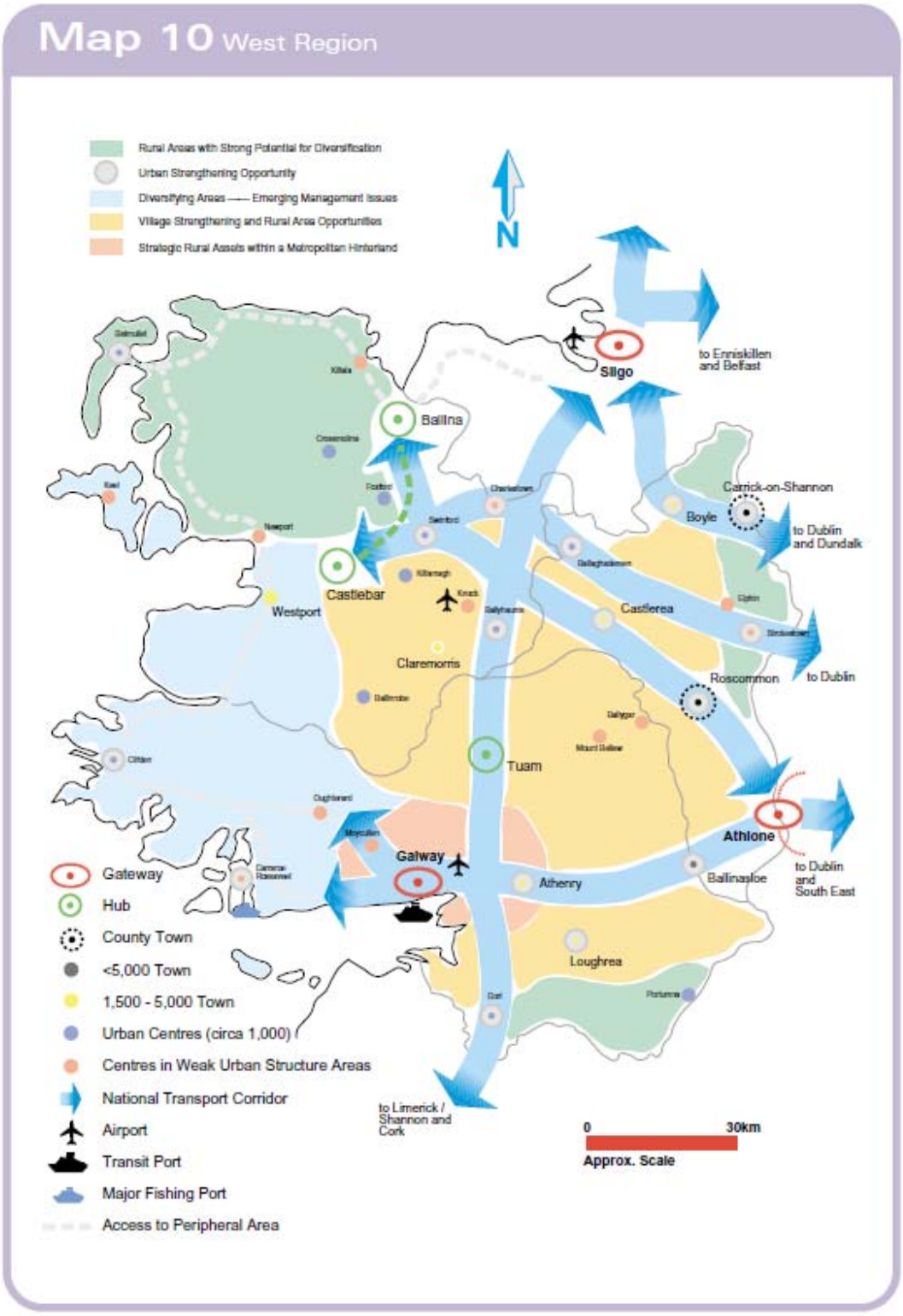
The NSS intended that Gateways should be *"drivers of development in their regions"*.

Figure 2.2 shows an extract from the National Spatial Strategy for the West Region. This shows the national transport corridor extending from the N6 on the east of Galway City across the River Corrib to the west of Galway in order to serve Connemara and Galway County.

The goal in all of this is this spatial restructuring will lead to the following (reference 3.1 of NSS):

- *"a strong and internationally competitive Greater Dublin Area driving both its own economy and national development*
- *strategically placed, national scale urban areas, acting as gateways, which individually and in combination will be key elements for delivering a more spatially balanced Ireland and driving development in their own regions*
- *strategic medium to larger sized towns as hubs linked to the gateways, in turn reaching out to more rural parts*
- *a strengthened county and large to medium sized town structure*
- *diversified and vibrant rural communities, which contribute to and benefit from the development of larger centres such as gateway and hubs."*

Figure 2.2 National Spatial Strategy – Western Region



Whilst the National Spatial Strategy is due for review by the Government, the fundamental concept of balanced development is relevant and necessary at a national level to ensure that there is sufficient infrastructure and services to serve the population needs into the future, to ensure a decent quality of life, to deliver national economic competitiveness and attract high-tech industries which in turn generate employment, trade, industry and investment in regions such as the Western Region.

The concept of achieving spatial balance whereby Galway serves the Western Region is dependent on having the capacity to move people and goods in a cost effective, efficient and timely manner. The existing congestion in Galway totally restricts this capacity which in turn restricts the economic development of the West Region for the following reasons:

- Major routes through the city are congested;
- Journey time unreliability due to uncertain quantum of delay;
- Journey time variability throughout the day;
- Peak hour traffic delays;
- By-passable traffic is in conflict with internal traffic;
- Inadequate transport links to access markets within the city;
- Inadequate transport connections from Galway onwards to Connemara; and
- Lack of accessibility to the Western Region as a whole.

The N6 GCTP seeks to address the transport issues above which are a becoming a barrier to regional accessibility and development.

2.3.9 National Development Plan 2007 – 2013

The general goals set out in the Overview Summary Section 2, the National Development Plan (NDP) again are consistent with the National Spatial Strategy above:

- Decisively tackle structural infrastructure deficits that continue to impact on competitiveness, regional development and general quality of life and to meet the demands of the increasing population; and
- Integrate regional development within the National Spatial Strategy framework of Gateway cities and Hub towns to achieve the goals of economic growth in the regions and provide major investment in the rural economy.

Section 3 of the NDP, sets out the need for balanced regional development so that all regions can achieve their full potential:

- “This Plan aims to promote the development of all regions in Ireland within a co-ordinated, coherent and mutually beneficial framework. Balanced regional development is, accordingly, central to the investment strategy of the Plan. The promotion of regional development will be implemented through:
- A major programme of investment under the Plan in infrastructure with a particular focus on addressing deficits in the various National Spatial Strategy Gateway areas.”

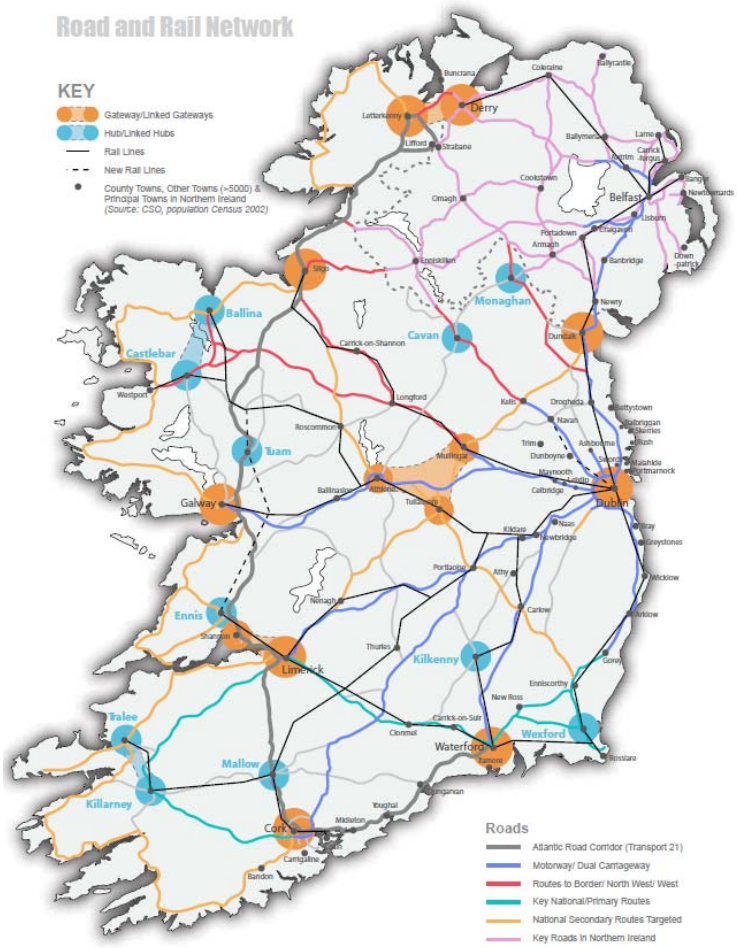
Figure 2.3 below, extracted from the NDP 2007-2013, illustrates the National Road and Rail Network.

Tackling the congestion in Galway is consistent with one of the objectives of the development of the Gateways as part of the policy to strengthen the regions, (refer NDP, Chapter 3: Economic Infrastructure Priority, The Galway Gateway):

"Development challenges include implementing an agreed strategic development strategy for the city and its wider environs to maintain quality of life and competitiveness and tackling traffic congestion, better and more compact urban planning and further renewal of the city centre."

Therefore, the objectives of this project which include relief of congestion in order to improve the economic performance of the western region align with the objectives of the National Development Plan.

Figure 2.3 National Development Plan for Road and Rail Networks



2.3.10 Údarás na Gaeltacht Strategic Development Plan, 2005 – 2010

The main strategic elements of Údarás na Gaeltachta's development strategy 2005-2010 are aimed at increasing the standards of living for the people of the Gaeltacht, revitalising the Irish language as the community language and creating employment in these areas.

The plan identifies the critical importance of upgrading the road infrastructure of the Gaeltacht "so that the Gaeltacht can compete for investment on a level playing field". The plan states that "emphasis will be placed in improving services and infrastructure in areas where industrial estates or business parks are located".

As this project seeks to improve the connectivity to the western region, it aligns with the plan above.

2.3.11 Gaeltacht Local Area Plan, 2008 – 2014

Gaeltacht Na Gaillimhe is the most populous of the Country's Gaeltacht areas. It stretches from Baile Chláir, which is east of the city of Galway to Cloch na Rón in west Connemara, a distance of approximately 100km, and from Oileáin Árainn northwards to the Mayo border. The Gaeltacht Local Area Plan, 2008 – 2014 was prepared and adopted in February 2008.

The purpose of the plan is to put in place controls and guidelines, consistent and compatible with the County Development Plan, to facilitate the provision of infrastructure so that the younger generations will be encouraged to remain in their native area, out of choice, and develop its economy in a way that is both language and culture friendly, thus halting the decline in population. The plan sets out the strategic development principles relating to the roads and transport infrastructure in Section 3.3.2 and identifies the N6 Galway City Outer Bypass (2006) as being of importance to advancing the development of the social and economic advantage of the Gaeltacht and developing an integrated approach to planning.

The aims of the N6 GCTP align with this plan as the N6 GCTP seeks to provide the necessary additional infrastructure to maintain existing rural communities by providing connectivity to them.

2.4 Scheme Specific Need

2.4.1 Overview

Phase 1 *Scheme Concept & Feasibility Studies* of this N6 GCTP concluded that there was a justification for advancing a scheme which includes construction works to provide infrastructure to provide a solution to the transportation issues in Galway which include the following:

- Major routes through the city are congested;
- Journey time unreliability due to uncertain quantum of delay;
- Journey time variability throughout the day;
- Peak hour traffic delays;

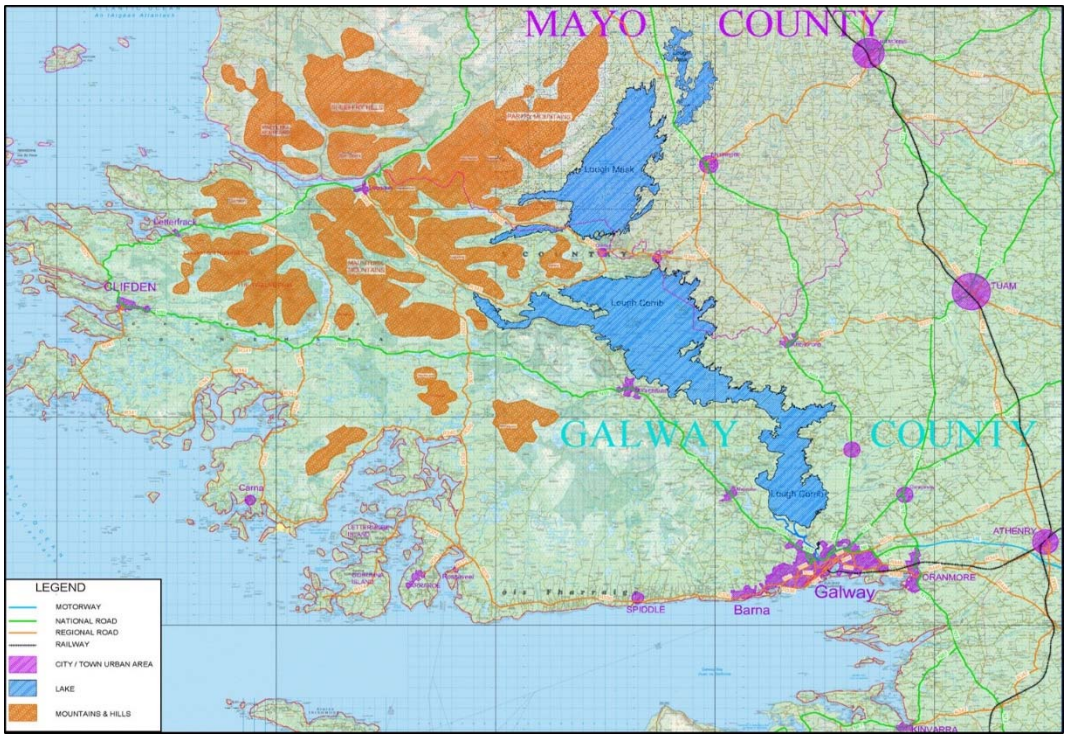
- By-passable traffic is in conflict with internal traffic;
- Inadequate transport links to access markets within the city;
- Inadequate transport connections from Galway onwards to Connemara; and
- Lack of accessibility to the Western Region as a whole.

A copy of the Phase 1 report is contained in **Appendix A.2.1**.

Galway City is physically constrained as it is divided by the River Corrib and a sea inlet known as Lough Atalia and it is bounded along the entire southern boundary by Galway Bay, all of which are natural barriers to free movement and development. There are currently four bridges crossing the river, which cumulatively carry approximately 80,000 vehicles per day. Three of the four bridges are in very close proximity to the city centre, thus drawing traffic into the city for the sole purpose of crossing the river.

Galway County and Connemara as far west as Clifden and onto Letterfrack are equally dependent on this narrow funnel for access as access to this area is restricted by the extents of Lough Corrib heading north, the Twelve Bens mountains, the Maamturk mountains and the many smaller lakes. **Figure 2.4** highlights that access to this area is via the bridges across the River Corrib in Galway City due to the physical natural constraints.

Figure 2.4 Existing Natural Constraints



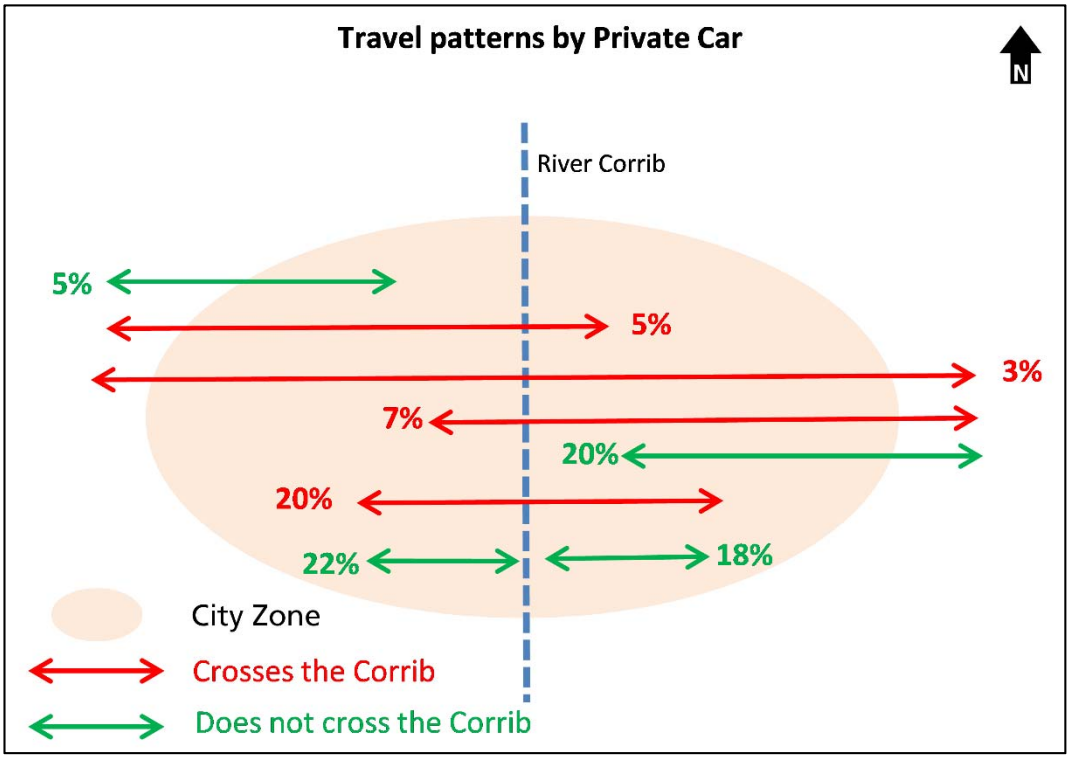
2.4.2 Existing Travel Patterns

Figure 2.5 below is a schematic diagram to illustrate the travel patterns for private car trips to, from or through Galway City in the 2012 Base Year morning peak hour (extracted from the traffic model). Red arrows show movements that cross the River Corrib and green arrows show movements that do not cross the River Corrib.

In total 35% of total car trips into and around Galway City cross the River Corrib. Of this total number of cross-river trips, approximately 9% are by-passable traffic (i.e. 3% of 35%). Approximately 20% of all trips are to/from the west side of Galway City to/from the east side of Galway City, cross-river trips, within the city zone. Some 40% of all trips remain on the same side of the city as where they started.

This analysis implies that the N6 GCTP must cater for movements from one side of the city to the other in addition to by-passable traffic, rather than a conventional bypass which would mainly cater for wholly by-passable traffic. This analysis also demonstrates the importance of an integrated solution which supports modal shift for shorter commutes.

Figure 2.5 Travel Patterns 2012 Base Year Morning Peak Hour



Note: arrows include traffic in both directions, inclusive of trips both into the zone and out of the zone

2.4.3 Journey Time Reliability

Analysis of travel surveys, journey times and delays on the existing network was carried out to establish a set of measurable key performance indicators (KPI) to define the existing problems and ultimately with which to compare future potential solutions.

An analysis of observed journey times on three key routes around Galway and environs as shown on **Figure 2.6** below was carried out to show the variance in journey times between the peak and off-peak periods in the Base Year. The difference between the peak and off-peak journey times is a measure of the level of congestion during the peak, and increasing congestion results in worsening journey time reliability.

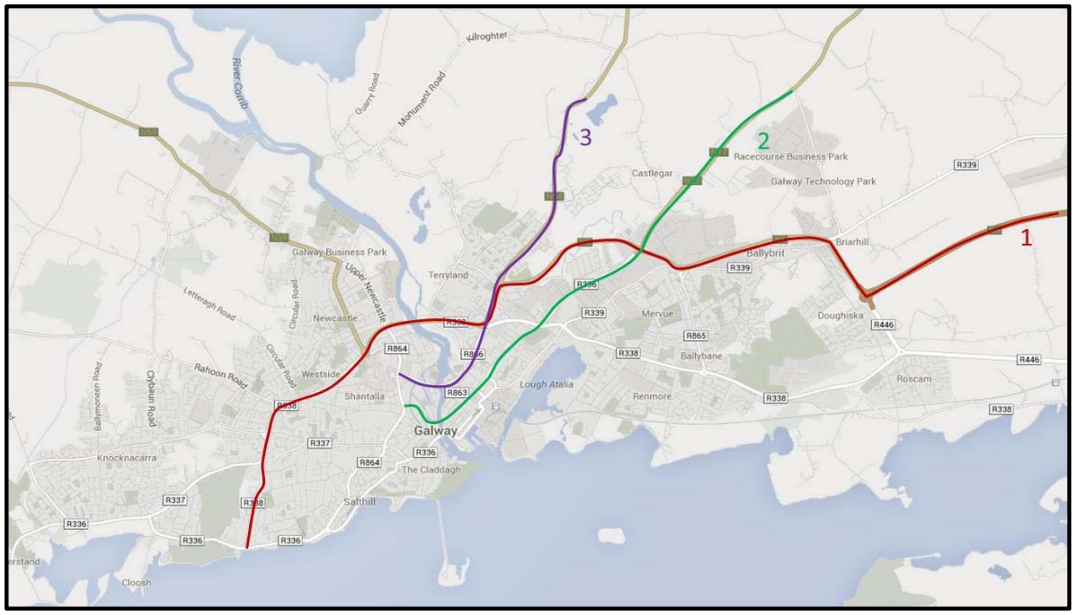
Observed travel times in 2012 Base Year on each of the routes in the inbound direction in the morning peak period versus the off-peak period are tabulated in **Table 2.1** below.

This assessment of journey time shows that the travel times on these three key routes in the morning peak hour are on average more than double the off-peak travel times.

Table 2.1 Journey Time Reliability

		2012 Observed Journey Times (minutes)			
		Off-peak average hour	Morning peak hour	Difference	%Difference
Inbound	Route 1 IN	14	28	14	100%
	Roue 2 IN	14	25	11	79%
	Route 3 IN	8	19	11	138%
	Average	**12**	**24**	**12**	**105%**

Figure 2.6 Journey Time Reliability Routes



Journey time unreliability is a significant detractor to incoming businesses seeking to locate in the area, to tourism due to difficulties of scheduling timetables and also to indigenous industries attempting to get goods out to national markets. The N6 GCTP seeks to address this issue by relief of the traffic congestion by removal of traffic both through modal shift, provision of additional road space and separation of bypass traffic.

2.4.4 Junction Capacity Assessment

An assessment of the volume/capacity (V/C) ratio was undertaken at signalised junctions and roundabouts, plus other key junctions where main roads intersect as shown on **Figure 2.7**. Max turn V/Cs show the maximum volume-to-capacity ratio

for the turns at each junction. This indicator is useful for highlighting the problem junctions, compared to the average V/C or average delay, which can be dominated by the high-volume low-delay movements. The volume to capacity ratios are then related to level of delay and congestion at the junctions.

Figure 2.7 Volume / Capacity Ratios at Junctions (2012)

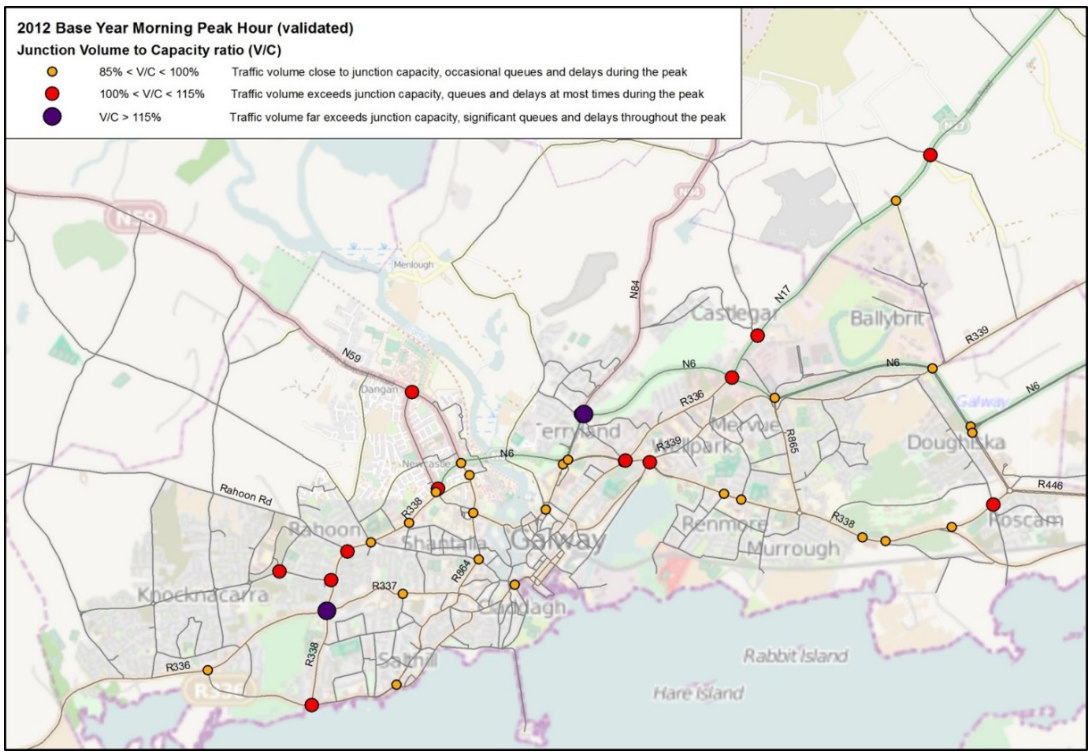


Figure 2.7 shows the number of junctions with a max turn V/C within standard ranges of 0.85-1.00, 1.00-1.15 and >1.15. Junctions with a V/C ratio greater than 1 are over capacity. Ideally junctions should operate at a V/C ratio of < 0.85, which would allow 15% spare capacity in the junction to cope with an unexpected event or natural growth.

This analysis demonstrates that the existing network is restricted by junction capacity. The junctions on the critical corridors accessing the city, namely the junctions of the N84, N17 and N59 Junctions with the N6, are all currently over capacity at peak hour as shown on **Figure 2.7** above. These junctions are operating at greater than 100% of their capacity, which in turn leads to the significant delays at these junctions. As these junctions are the main arteries into the city and the main junctions on the circumferential route around the city, this is a significant issue for the Gateway of Galway.

In addition, approximately 40% of all junctions on the key access routes across the scheme study area are operating above 85% capacity. This demonstrates that the network is finely balanced with minimal spare capacity to allow for any unforeseen event or natural growth. This is significant as grid-lock on a city wide scale is evident in the event of an unforeseen occurrence such as an accident, significant weather event, temporary traffic management associated with regular maintenance works on existing road network, seasonal events and particular match day events.

The N6 GCTP is essential to resolve this constant lingering problem of over-capacity of the existing N6 route and existing network which frequently results in grid-lock in the city.

2.4.5 Scheme Specific Need

As a Gateway to the Connemara and the western region, connectivity and accessibility to and through Galway City is essential in aiding the region to revitalise, improve and develop into the future. Accessibility and connectivity for areas within the county is of significant public interest and a key driver for this scheme; however, given that any corridor seeking to link either side of the county will traverse areas of the city, then accessibility to and from the city is inextricably linked to this scheme.

Providing well developed transport links via roads, rail and air to the western region, enables enterprises and the local economy of the west to grow and develop as a viable alternative to the east coast corridor which is of significant public interest at a national level.

Providing improved road infrastructure generates significant safety benefits to the network at two levels, firstly via the transfer of high volumes of traffic to the safer roads and secondly via a reduction in distances travelled on less safe existing road. Modern technology and information systems which form part of new road infrastructure also gives greater security to road users. Opportunities for further safety benefits present through the provision for vulnerable road users through reallocation of road space on the existing network. Safety and security on our road network is of national interest and a key part of government policy over the past decades.

Provision of reliable transport infrastructure facilitates improved access to employment, education, vital services such as hospitals and amenities for all users. Reallocation of existing road space within the urban network will facilitate better provision of public transport which improves accessibility to all of the above services, in particular for lower income groups, vulnerable road users and the elderly. This in turn generates a healthier environment within the urban network where the population density is higher.

More sustainable and reliable infrastructure links to and from the Gaeltacht areas of the western region, enables Irish language speakers to remain in their native areas out of choice, and develop its economy in a way that is both language and culture friendly, halting the recent decline in population. This is of public interest as it is of national interest to preserve our heritage including our native language.

As part of the N6 GCTP, various options will be considered to facilitate the improvement of the existing public transport network within the city. This may include consideration of Bus Rapid Transport (BRT), park and ride facilities, and or complementary traffic measures such as bus priority at junctions, and the reallocation of road space to facilitate public transport. Options will be developed to form part of the overall integrated solution for Galway.

In tackling the city's congestion issues, the scheme will provide a better quality of life for the city's inhabitants and provide a much safer environment in which to live. By reducing the number of cars on the roads within the city centre, improving streetscapes, workers and school children are facilitated to commute using multi

modal transport means. This includes travelling on foot, by bicycle and on the public transport system. As a result more sustainable travel is supported and encouraged. This is of overriding public interest at a local level in Galway itself, but more importantly for the entire western region as Galway is at the core of the region and needs to be able to function efficiently to serve the region.

The potential long term impacts on the social and economic fabric of Galway if this project is not developed are significant.

Macro-economic impacts which may arise if the project is not developed could include any or all of the following:

- Disincentive for Foreign Direct Investment (FDI) to invest in Galway City due to congestion costs in terms of both goods and labour;
- Decline in the quality of the urban environment due to increased congestion and pollution may lead to reduced attractiveness of Galway City for labour force location;
- Decline in the quality of the urban environment could exacerbate the already existing trend to live outside the city limits and commute to Galway for work, increasing congestion and reducing the potential for any investment in public transport or alternative means of travel, to make an impact;
- May lead to further relocating of other activities away from the city core e.g. retail, business, employment, leisure, reducing the strength of Galway as a Gateway City;
- Impact on the economic development of the wider western region as access is compromised (labour, goods, tourism);
- Suppressed travel movements either side of the River Corrib, resulting in isolation of areas of the city and county; and
- Overall, can lead to the decline of Galway City to act as a Gateway on the western corridor, and act as a regional counter balance to the east.

Social impacts resulting from the above could include:

- Create a challenging environment in accessibility terms for some sectors of society, particularly those most dependent on non-private car travel, as investment in public transport will be harder to justify over a more dispersed city fabric;
- Potential reduction in range of employment options available which could impact the profile of residents in the city and corresponding impacts on communities; and
- Reduction in quality of life indicators.

2.5 References

National Roads Authority. *Network Improvements Overview* http://www.nra.ie/public-private-partnership/a-decade-of-progress/

Department of Transport, Tourism and Sport. (2009) *Smarter Travel, A Sustainable Transport Future, A New Transport Policy for Ireland 2009-2020*

MVA Consulting. (2010) *Galway Public Transport Feasibility Study*

AECOM Mitchell & Associates. (2010) *Draft Galway City and Environs Walking and Cycling Strategy*

The West Regional Authority. (2010) *The Regional Planning Guidelines for the West Region 2010 – 2022*

Environmental Protection Agency. (2002) *Guidelines on the information to be contained in Environmental Impact Statement.* Environmental Protection Agency. Wexford.

Forfás. (2012) *Overview of Main Infrastructure Issues for Enterprise*

Forfás. (2010) *Regional Competitiveness Agendas, Overview, findings and actions*

Galway County Council. (2015) *Galway County Development Plan 2015-2021*

Galway City Council. *Galway City Development Plan 2011 to 2017*

Údarás na Gaeltacht. (2005) *Strategic Development Plan 2005-2010*

Galway County Council. (2008) *Gaeltacht Local Area Plan 2008-2018*

Department of Environment, Heritage and Local Government *National Spatial Strategy for Ireland 2002-2020*

Irish Government *National Development Plan, 2007 – 2013,*

European Commissoin: *Infrastructure - TEN-T - Connecting Europe*

3 Traffic Assessment and Route Cross-section

3.1 Introduction

This section of the report provides a summary of the Traffic Modelling Report in **Section 3.2**, an overview of the initial selection of the road type and cross-section in **Section 3.3** and the preliminary Junction Strategy in **Section 3.4**. The full Traffic Modelling report is included in **Appendix A.3.1**. Traffic analysis of Do-Something options is included in **Section 7.2.8**.

3.2 Summary of Traffic Modelling Report

3.2.1 Introduction

This section provides a summary of the Traffic Modelling Report (TMR).

The purpose of the TMR is to describe the traffic forecasting that has been undertaken. It outlines the development of the Base Year transport model, the methodology for forecasting future year travel demands and the testing of scheme options.

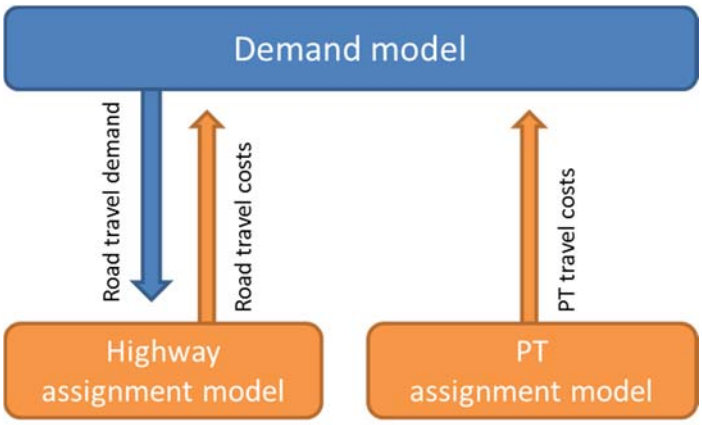
3.2.2 Modelling Overview

For the appraisal of the N6 Galway City Transport Project (GCTP) a new multi-modal transport model was developed by consultants SYSTRA and Jacobs on behalf of the National Transport Authority (NTA) during 2013. The model is called the Galway Interim Model (GIM) and was developed specifically for the GCTP in advance of the planned development of the NTA's Regional Models of Ireland.

The GIM is capable of providing future year forecasts of travel demand, traffic flows and journey times for road and public transport schemes, and is a robust tool for assessing the traffic impacts and economic benefits of the GCTP Options.

The GIM comprises three main parts, a highway assignment model in SATURN software, a public transport assignment model in CUBE Voyager software, and a demand model in DIADEM software. These three parts work together as a modelling system to produce forecasts of travel demand and travel costs, as illustrated below.

Figure 3.2.1 GIM Model System



The modelling system works as follows. The travel costs from the assignment models are read into the demand model. The demand model then adjusts the travel demand according to changes between forecast travel costs (e.g. with scheme) and reference travel costs (e.g. without scheme). The adjusted demand is read back into the highway assignment model and the highway travel costs are re-calculated to take account of the impact of the changes to the travel demand. The demand model and highway assignment model are run iteratively until a solution is reached whereby the travel costs and travel demand are in equilibrium.

The assignment models were calibrated and validated against observed data for a 2012 Base Year for the morning peak hour (AM: 0800-0900) and average inter-peak hour (IP: average hour 1000-1600). The AM peak hour of 0800-0900 was selected following an analysis of traffic survey data. A selection of key ATC survey sites in the urban area were used to produce a traffic profile graph over a typical weekday in November 2012 in Galway. The resultant graph confirms the AM peak hour of 0800-0900.

At this stage the assessment of Options relative to each other has been undertaken for the AM only as it is a comparative assessment across the Options. However, full analysis using AM, IP and PM models will be utilised at Phase 3 *Design.*

The GIM model system is considered to be a robust tool for the purposes of appraising the highway component and public transport alternatives for the GCTP at Phase 2 *Route Selection*.

3.2.3 Data Collection

3.2.3.1 Traffic Surveys

Traffic counts were undertaken during November 2012. In total 58 number 12-hour manually classified Junction Turning Counts (JTCs) were undertaken across the city and 58 temporary Automatic Traffic Counters (ATCs) were installed to collect data over a seven day period.

3.2.3.2 Traffic Signal Data

Galway City Council provided traffic signal staging and green times for all signalised junctions within the city.

Journey time data was purchased from TomTom providing observed flow weighted travel time of vehicles traversing each link in the city over the period September 2012 to May 2013. TomTom survey data is obtained from satellite information gathered from real journeys and data on journey times over a time period, over a range of time periods and over a certain section of road is available. This data is used to compliment the data from the 2011 Census, POWSCAR and the 2012 National Household Travel Survey (NHTS) and in order to undertake comparative analysis of journey times. TomTom data for the primary cross city routes and the approaching national and regional routes was sourced.

3.2.4 Model Development

3.2.4.1 Road Network Development

The basic road network structure was created from HERE mapping and converted into SATURN node and link format, the nodes being the junctions and the links being the lengths of road that connect them. The SATURN network is divided into three areas of decreasing detail: simulation, buffer and external, as shown below. The Galway Model Extent (GME) comprises the simulation and buffer areas: this is the area within which the proposed schemes are likely to affect travel patterns.

Figure 3.2.2 Galway Model Extent

Simulation Area

The simulation area covers Galway City and is coded in full simulation detail, where all junctions' details are coded and the delays are calculated by SATURN based on the interaction of traffic at each junction.

Buffer Area

The buffer area extends into a large portion of Galway County and parts of north County Clare. In the buffer area junction details are not coded, instead delays on the road network are calculated by SATURN based on flow-delay curves coded on every link.

External Area

Within the rest of Connaught (County Mayo, Sligo, Leitrim and Roscommon) and County Clare, a reasonable level of network detail has been retained to maintain consistency with the planned development of the West Regional Model and to allow sufficient route choice to and from the GME. Outside this area the network is very sparse and includes just a 'stub' that represents where trips to/from the rest of Ireland will load onto the model network. The stubs are coded with representative distances and speeds, which is particularly important within the public transport assignment sub-mode choice (i.e. the choice between bus and rail). The external stubs include the N15/N16 north and east of Sligo, the N63/N5 east of Roscommon, the M6 and N55 east of Athlone, and the N20/N21 and N24 south of Limerick.

Within the external area delays on the road network are not included in the model.

3.2.4.2 Public Transport Network Development

The public transport (PT) network was created from the highway network, which ensures that the highway and PT network structures are identical. This approach enables the PT link speeds to be updated from congested highway link speeds.

Additional links to represent rail lines were then added and railway stations were added and connected to the road network for access to and from zones.

All bus and rail services to, from, through and within the Galway Model Extent (GME) were coded using data from the National Journey Planner in April 2013.

3.2.4.3 Model Zone System

The model zones have been defined by aggregating Small Areas (SAs) such that the activity levels of each zone fall within a certain range, where activity levels are measured from the 2011 POWSCAR[3].

Other criteria taken into account in determining the zone size and shapes include:

- Electoral District (ED) boundaries;
- Large individual attractors;
- Physical barriers and connectivity to the network; and
- Land use.

[3] POWSCAR (Place of Work, School or College – Census Anonymised Records) is produced by the Central Statistics Office based on the 2011 Census and contains geo-coded data on the place of work or education for all workers and students in Ireland.

In some cases it was necessary to split a SA into one or more zones in order to respect the above criteria, in particular to ensure accurate loading of trips from the zones onto the road network.

The GIM comprises 298 model zones. There are:

- 170 simulation zones;
- 97 buffer zones;
- 21 external zones; and
- 10 dummy zones.

The same model zone system is used for the road, PT and demand model.

3.2.4.4 Matrix Development

Travel demand matrices are an essential part of the modelling system. They represent the demand for travel between every pair of model zones and therefore represent the trips that people make by car and public transport.

The process of building the travel demand matrices for the 2012 Base Year can be summarised as follows:

- Calculate 24 hour Production Attraction (PA) trip ends by purpose at the model zone level using a version of the National Trip End Model (NTEM) that has been developed specifically for the GIM (the NTEM has been calibrated against data in the 2012 National Household Travel Survey (NHTS) and 2011 POWSCAR);
- Split the trip ends by travel mode and car availability, based on data from POWSCAR and NHTS;
- For home based commute and education, create PA travel demand matrices from POWSCAR and control to the trip ends calculated from the NTEM using a row and column balancing procedure;
- For the other purposes, create matrices as follows:
  - using a gravity model for trips within the Galway Model Extent;
  - using distributions extracted from POWSCAR for trips to or from Galway with one end at an external zone; and
- Apply daily time profiles, return home probabilities and occupancy rates derived from NHTS to convert from 24-hour PA person trip matrices to peak hour Origin Destination (OD) vehicle trip matrices.

POWSCAR (Place of Work, School or College – Census Anonymised Records) is produced by the Central Statistics Office based on the 2011 Census and contains geo-coded data on the place of work or education for all workers and students in Ireland. The level of data from POWSCAR is very significant and useful. It is supplemented then with the 2012 National Household Travel Survey which was commissioned by the National Transport Authority (NTA) to obtain information on all-day travel patterns to get information on travel behaviour at off-peak times of the day when trips for purposes other than work or education become more significant, for example shopping trips, trips on personal business and trips for leisure or sporting purposes. This survey also supplied information to better understand travel behaviour when linked to people's general use of transport modes

and their perception of these modes. This information combined to give a very robust picture of travel demand in and around Galway and the wider region, for which the National Transport Authority have developed the traffic model.

3.2.4.5 Demand Model Form

For the GIM it was decided to adopt an off-the-shelf demand model system that has been tried and tested on various schemes and would therefore be a reliable system. The UK Department for Transport's (DfT's) demand modelling software, DIADEM, has been designed for use in the development and appraisal of major transport infrastructure schemes, and was selected as the most appropriate tool for the GIM.

The main form of demand model available in DIADEM is the incremental hierarchical logit model, as recommended in the DfT's Transport Analysis Guidance (WebTAG), and this is the form of demand model selected as most appropriate for the GIM. The incremental model works by adjusting the demand matrices according to changes between forecast travel costs (with scheme) and reference travel costs (without scheme). For the GIM, the demand model has been set up to model the two most sensitive demand responses, namely mode choice and destination choice, with destination choice being more sensitive than mode choice, as recommended in WebTAG.

3.2.4.6 Assignment Method

The standard Wardrop Equilibrium using the Frank-Wolfe algorithm have been adopted as the assignment procedures for the highway model, to be consistent with the Greater Dublin Area model and other regional models.

Tight highway assignment convergence is important in order to provide a robust appraisal. A highway assignment convergence with a %GAP<0.02% was achieved in the GIM, which considerably exceeds WebTAG guidance (%GAP<0.1%).

3.2.4.7 Generalised Cost Parameters

The SATURN assignment procedure builds paths through the network based on the generalised cost formulation. Generalised cost is a linear combination of time and distance, using values of pence per minute (PPM) and pence per kilometre (PPK) to convert distance into generalised minutes. It takes the following form:

Generalised Cost (minutes) = time + distance*PPK/PPM

The values of PPM and PPK within the GIM are based on the guidance on parameter values issued by the Department for Transport (DoT) and set out in the Common Appraisal Framework (CAF). The table below shows the PPM and PPK used in the GIM 2012 Base Year. Note that PPM for commute is lower than education and other because the commute vehicle occupancy is lower, and PPM and PPK are expressed in units per vehicle.

Table 3.2.1 PPM and PPK (2012 values, 2002 prices)

	AM		IP	
Mode	**PPM**	**PPK**	**PPM**	**PPK**
Commute	16.17	6.55	16.17	6.55
Education	33.25	6.55	33.25	6.55
Employers Business	60.36	10.92	60.36	10.92
Other	29.70	6.55	29.70	6.55
Light Goods Vehicle	35.87	10.91	38.29	11.60
Heavy Goods Vehicle 1	39.05	24.35	40.68	25.95
Heavy Goods Vehicle 2	37.73	44.50	39.69	46.41

3.2.4.8 Model Calibration & Validation

Overview of the Calibration and Validation Process

Calibration is the process of adjusting the model to improve the fit to observed data, such as traffic counts or passenger flows, journey times, delays and route choice. Validation is a comparison of the final model flows and journey times against observed data. Two sets of validation statistics are reported: one with the set of counts used during calibration; and the other with a set of independent counts not used during calibration.

For the GIM, calibration was undertaken in two stages:

- Stage 1: sector-level adjustments to the matrices based on a comparison of the model flows against screenlines of observed counts to produce revised prior matrices;
- Stage 2: adjustments to the matrices (through matrix estimation) and networks based on a comparison of the model flows against observed turn and link counts, and model journey times against observed journey times, to produce the final validated networks and matrices.

Highway Assignment Model Validation Results

The GIM highway and public transport assignment models have been calibrated and validated to a 2012 Base Year. The calibration and validation process followed the guidelines in the National Roads Authority's Project Appraisal Guidelines (PAG) and where appropriate the DfT's WebTAG.

The models validate well against the observed data with the results indiciating that the model is calibrated as per the requirements of PAG for link flows.

Demand Model Calibration Results

It is necessary to calibrate the demand model parameters such that the change in travel demand in response to changes in travel costs is sensible.

Two realism tests are required to test the sensitivity of the demand model: one measures the change to vehicle kilometres in response to a 10% fuel price increase, and one measures the change to PT trips in response to a 10% PT fares increase.

The measure used to check the sensitivity of the model is called 'elasticity', where a bigger elasticity value corresponds to a more sensitive model.

The realism tests have shown that the sensitivity of the demand model in response to changes in fuel price and PT fares is sensible and within the ranges recommended in WebTAG. This has been achieved with a set of demand model parameters that are also within the ranges recommended in WebTAG.

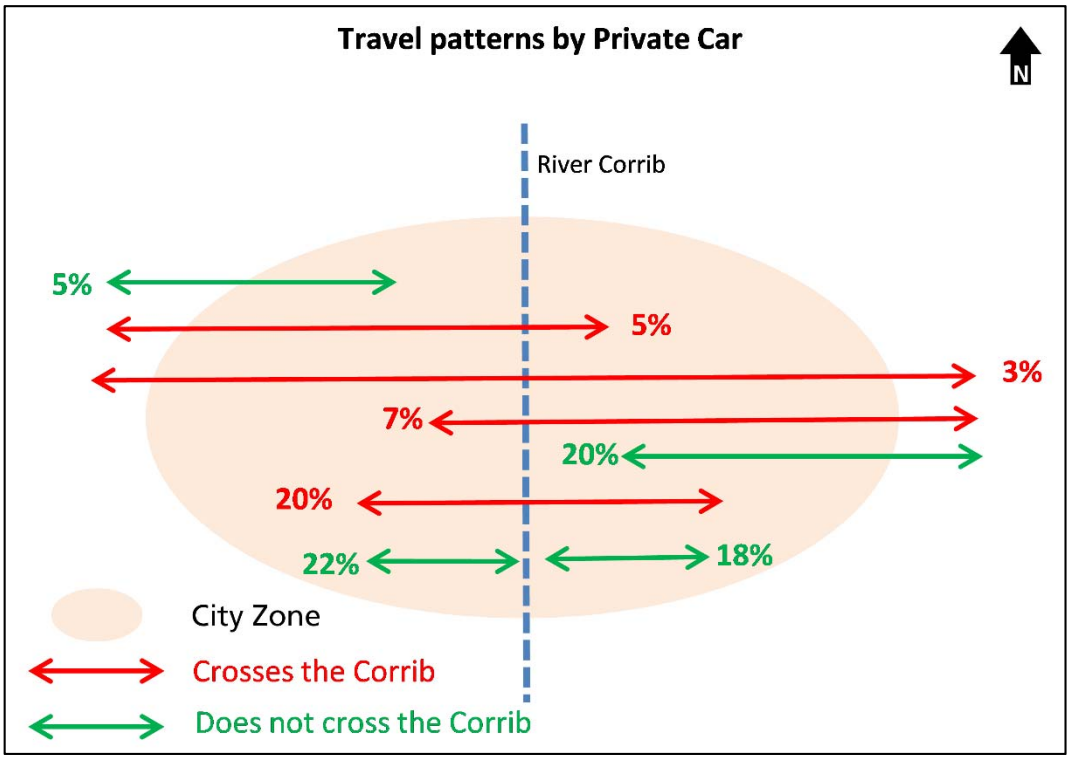
3.2.4.9 Existing Travel Patterns

The figure below is a schematic diagram to illustrate the strategic travel patterns for private car trips to, from or through Galway City in the 2012 Base Year morning peak hour (extracted from the travel demand matrices). Red arrows show movements that cross the Corrib and green arrows show movements that do not cross the Corrib. The arrows include traffic in both directions, inclusive of trips both into the zone and out of the zone.

In total, 35% of all car trips into and around Galway City cross the River Corrib. Of this total number of cross-river trips, approximately 9% are by-passable traffic (i.e. 3% of 35%). Approximately 20% of all trips are to/from the west side of Galway City to/from the east side of Galway City, cross-river trips, within the city zone. Some 40% of all trips remain on the same side of the city as where they started.

This analysis implies that the preferred option must cater for movements from one side of the city to the other in addition to by-passable traffic, rather than a conventional bypass which would mainly cater for wholly by-passable traffic. In particular, the preferred option should cater for the predominant demand which is cross-city demand as opposed to long distance through traffic.

Figure 3.2.3 Travel Patterns 2012 Base Year Morning Peak Hour



Note: arrows include traffic in both directions, inclusive of trips both into the zone and out of the zone

3.2.5 Future Year Model Development

3.2.5.1 Introduction

This section sets out the development of the future year GIM for the scheme opening year (2019) and Design Year (2034). These forecast years will be used for assessing and comparing the performance of the various options. Once a preferred option is selected, a forecast year (2049) will also be prepared.

3.2.5.2 Future Year Network Development

The future year 'Do-Minimum' network includes the 2012 base network plus all the schemes (highway and PT) that are already built or are committed or likely to be built by 2019 and 2034. The list of schemes to be included was developed in coordination with Galway City Council, Galway County Council, TII and NTA and is included in the Traffic Modelling report in **Appendix A.3.1**.

The future year 'Do-Something' networks include the Do-Minimum plus the option(s) to be tested. The first Do-Something developed is the 'Do-Something Public Transport' Alternative (PT Alternative) which is based on the recommendations in the Galway Public Transport Feasibility Study of 2010 and includes smart mobility measures and is detailed in **Section 5.2.3** of this report. Each Do-Something network has been 'optioneered' in the highway model based on analysis of modelled flows and delays in the 2034 Design Year. The optioneering focussed on the junctions along the Do-Something scheme itself rather than any existing or Do-Minimum junctions, with the exception of the N84/N6 Kirwan Junction and the N6/R338 Junction (i.e. Galway Shopping Centre junction) where signal timings only were adjusted to reflect the change in traffic priority at these junctions due to the Do-Something schemes. Details of the 'Do-Something' networks is included in **Section 7.2.2.8**.

3.2.5.3 Future Year Matrix Development

Regional Planning Guideline (RPG) values for future populations are targets rather than modelled projections and these targets are linked to implementation of regional and national policy. It was considered that their suitability for future extrapolation beyond 2022 as a 'High Scenario' presents many problems, not least of which would be the unqualified assumption that particular cornerstone policies will remain in effect at the same levels as were projected from 2009. Therefore, it was concluded that the RPG forecasts would not be used as an input for population projections for this study. However, a sensitivity test will be carried out on the final scheme to check the impact should the population forecasts grow to the RPG target population.

National Transport Authority were involved in the spatial distribution of the predicted growth for the years 2022 and 2034 in accordance with the rules/methodology agreed with Galway City and County Planners for the distribution of population growth at an early stage of the modelling.

Future year population forecasts were developed by demographers Future Analytics in conjunction with the NTA, Galway County Council and Galway City Council. The forecasts were from a base population through the projection of population change and its major demographic components: births, deaths and migration. A copy of the population projections by Future Analytics is included in an appendix to the Traffic Modelling Report in **Appendix A.3.1**.

The following forecast scenarios were agreed for use on this project:

- Low: M2F2 Traditional (Scenario 1). The traditional scenario follows the Central Statistics Office (CSO) moderate path of seeing a return towards the 1996 patterns of inter-regional migration (specifically). The population in the West increases at a moderate pace of natural growth in line with the measured outflow of migrants (net) elsewhere;
- Medium: M2F1 (Scenario 1a). This scenario includes an adjustment on the fertility rate to assume that it reaches 2.1% by 2026;
- High: M2F1 (Scenario 3a) Galway Centric. This scenario redirects a quantum of migrants to the West Region, specifically to Galway County and Galway City. It sees 25% of the inter-regional migrants that would otherwise move to Dublin redirected west. It also allows for the fertility rate of 2.1% by 2026.

The NTA then applied a top-down approach to distribute the population forecasts across the GIM model zones. An assumption was made that the overall growth in employment would be in line with the population growth.

The tables below show the population and employment forecasts developed for this study for the medium growth scenario. Forecasts were prepared for years 2022 and 2031 to be consistent with the RPG and CSO forecast years for comparison. Linear regression was applied to generate forecasts for the 2019 Opening Year and 2034 Design Year.

Table 3.2.2 Population Forecasts - Medium growth

Population Forecasts							
		GCTP Medium		Growth		% Growth	
	CSO 2011	2022	2031	2011 to 2022	2011 to 2031	2011 to 2022	2011 to 2031
Galway City	75,529	82,814	88,548	7,285	13,019	9.6%	17.2%
Galway County	175,124	179,754	187,540	4,630	12,416	2.6%	7.1%
West	445,356	457,498	477,486	12,142	32,130	2.7%	7.2%

Table 3.2.3 Employment Forecasts – Medium growth

Employment Forecasts							
		GCTP Medium		Growth		% Growth	
	CSO 2011	2022	2031	2011 to 2022	2011 to 2031	2011 to 2022	2011 to 2031
Galway City	39,832	43,674	46,698	3,842	6,866	9.6%	17.2%
Galway County	32,860	33,729	35,190	869	2,330	2.6%	7.1%
West	118,181	121,403	126,707	3,222	8,526	2.7%	7.2%

Overview of Method to Develop Future Year Matrices

The process to develop future year matrices based on the population and employment forecasts can be summarised as follows:

- Generate future year trip ends using the version of the National Trip End Model (NTEM) developed specifically for GIM;
- Calculate the growth rates between base and future year NTEM trip ends;
- Apply the growth rates to the validated Base Year trip ends to generate target future year trip ends (taking account of changes to car occupancies);
- Factor the Base Year trip matrices using a row and column balancing procedure, to produce future year 'unconstrained' trip matrices;
- Run the DIADEM demand model in order to constrain the trip matrices to future year costs (such as changes in values of time, vehicle operating costs and congestion levels).

Growth Scenario

The medium growth scenario was developed for this phase of the project in order to compare the different options against each other on an equal basis. Once a preferred option is selected, low and high growth scenarios will also be prepared and the preferred option will be tested in both additional scenarios.

Greenfield Sites

Due to the incremental nature of the GIM system, careful treatment was required to include new developments that are located on Greenfield sites, i.e. where there is little or no population or jobs in the Base Year. Such developments included Ardaun and the Rahoon Business Park.

For these developments, the initial trip generation rates, mode share and trip distributions were cloned from nearby zones with similar landuse to the new developments.

Vehicle Occupancy

Vehicle occupancies were reduced in line with the forecast reduction in vehicle occupancies published in webTAG. It is important to take this into account when producing traffic forecasts as it results in an additional increase in cars on the roads.

Car Ownership

An increase in car ownership was forecast based on the methodology developed for the NTA's Greater Dublin Area Model, taking account of demographics in Galway.

Goods Vehicle Growth

For the GCTP it was assumed that goods vehicle trips (Light Goods Vehicles and Heavy Goods Vehicles) will grow in proportion to the growth in jobs at each model zone.

3.2.5.4 Future Year Parameters

The following parameters all impact how the demand model adjusts the travel demand matrices in response to changes in travel costs.

Vehicle Operating Costs

Vehicle Operating Costs (VOCs) were assumed to remain constant in real terms through time, as recommended in the Common Appraisal Framework.

Values of Time

Values of time were increased in line with the forecast growth in values of time published in webTAG.

Public Transport Fares

Fares were assumed to remain constant in real terms through time. This ensures consistency with the similar assumption made for highway VOCs.

3.2.5.5 Future Year Matrix Totals

A comparison of the morning peak hour trip matrix totals for the Base Year, 2019 Opening Year Do-Minimum and 2034 Design Year Do-Minimum scenarios are outlined in the tables below. These matrix totals do not include for any scheme impacts at this stage.

The growth in car trips is 11% between 2012 and 2019 and 23% between 2012 and 2034. The main reason why the growth in car trips is higher than the growth in population and the growth in public transport trips is because of the increase in car ownership and the reduction in vehicle occupancy.

Table 3.2.4 Matrix Totals 2019 Opening Year

		Morning Peak Hour Trips			
Mode	**Units**	**2012 Base**	**2019 Do-Min**	**Growth**	**%Growth**
Car	Veh	20,116	22,351	2,235	11%
LGV	Veh	2,923	3,058	135	5%
HGV	Veh	711	744	34	5%
Public Transport	Persons	1,452	1,472	20	1%

Table 3.2.5 Matrix Totals 2034 Design Year

		Morning Peak Hour Trips			
Mode	**Units**	**2012 Base**	**2034 Do-Min**	**Growth**	**%Growth**
Car	Veh	20,116	24,655	4,539	23%
LGV	Veh	2,923	3,373	450	15%
HGV	Veh	711	809	99	14%
Public Transport	Persons	1,452	1,697	245	17%

A full assessment of the performance of the Base Year versus the Do-Minimum is included with the assessment of the performance of the 'Do-Something' options developed in **Section 7.2.2.8**.

3.2.5.6 Analysis of the Options

An analysis of the Do-Minimum and 'Do-Something Public Transport' Alternative (PT Alternative) was carried out for the morning peak hour and has been run through the demand model to take account of changes in transport costs, such as vehicle operating costs, values of time, congestion levels and the impact of these schemes.

In 2034 Do-Minimum, the total network delay in the morning peak hour shoots up by 70% relative to the Base Year, far more than the increase in trips, indicating capacity issues on the network. The PT Alterative performs worse than the Do-Minimum in terms of increased delay.

Table 3.2.6 Network Performance Indicators 2034 Design Year

Option	Total Vehicle Distance (pcu.kms)	Total Network Travel Time (pcu.hrs)	Total Network Delay (pcu.hrs)	Average Vehicle Speed (kph)
2012 Base	195815	6429	1749	30.5
2034 Do-Min	223107	8297	2969	26.9
2034 PT Alternative	221743	8452	3151	26.2

The GIM predicts changes to travel patterns based on the population and job forecasts and the changes in travel costs (for example changes in congestion). The strongest change is a re-distribution of trips as people change their destination (e.g. where they work or shop) based on the changes in travel costs over a number of years. In the 2034 Do-Minimum, the overall growth in car trips to/from/through Galway City is 20%. However, the re-distribution impacts result in the growth in car trips crossing the Corrib of just 11%, because the capacity constraints to cross the river suppress some of the cross-river trips.

The other change in travel patterns predicted by the GIM is a change in travel mode based on the changes in travel costs. The tables below present the mode share between private vehicle and public transport for the 2012 Base Year and 2034 Design Year, extracted from the model for the morning peak hour. The mode share analysis shows that there is a low public transport mode share of just 5.0% in the Base Year. The PT Alternative increases PT mode share to 5.8% in 2034, which is

a 17% increase in PT trips relative to the Do-Minimum. However due to the overall low PT mode share, this represents less than a 1% reduction in car trips.

Table 3.2.7 Mode Share 2034 Design Year

	Morning Peak Hour Person Trips			
Option	**Car**	**PT**	**%Car**	**%PT**
2012 Base	27,478	1,452	95.0%	5.0%
2034 Do-Minimum	32,898	1,697	95.1%	4.9%
2034 PT Alternative	32,614	1,992	94.2%	5.8%

Whilst the model indicates a marginal increase in PT mode share for the PT Alternative scenario, it is clear that the public transport alternative, as based on the existing plans adopted for Galway, does not provide an adequate solution to reducing congestion levels in the city. As the N6 GCTP seeks to increase modal share and to provide a sustainable transport solution for Galway, the final overall integrated strategy will have to demonstrate an improved public transport mode share.

Further analysis on journey times for the various options, including all the Do-Something options is included in **Section 7.2.2.8**.

3.2.5.7 Annual Average Daily Traffic (AADT)

The Annual Average Daily Traffic (AADT) flow is defined as the two-way volume of traffic using a road during the year, divided by the number of days in the year. To estimate the annual average daily traffic (AADT), factors were developed that allowed extrapolation of AM peak hour traffic flows to AADT.

PAG suggests using the Permanent Counter method to estimate AADT, however, TII permanent counters are located some distance from Galway City. The Localised Period Count method was therefore preferable and has been applied using 72 ATC count locations around Galway City (7 days, November 2012) which were used as part of the development of the GIM.

Factors were developed based on regression analysis of the 72 ATCs to go from AM peak hour to Weekly Average Daily Traffic (WADT). The regression analysis gave R^2 values of 0.95 for car, 0.96 for LGV and 0.82 for HGV, indicating that the AADT factor would be reasonably accurate.

Four TII permanent counters were then used to develop factors to go from WADT to AADT, taking account of seasonal variability.

Combining the two factors above, the expansion factors to estimate AADT from modelled AM peak hour are:

$$AADT = 12.11 \times AM_{WD} \; for \; cars$$
$$AADT = 11.52 \times AMWD \quad for \; LGVs$$
$$AADT = 8.96 \times AM_{WD} \; for \; HGVs$$

where AM_{WD} is the average 8-9 AM weekday traffic flow (modelled).

The forecast AADT flows on the road network extracted from the models for the 'Do-Something' options are presented in the **Section 7.2.2.8** and the AADT point locations are shown on **Figures 7.2.8.1 to 7.2.8.6** included in the volume of figures.

3.3 Initial Selection of Road Type

The two cross-section types considered are Type 1 Single Carriageway (S2) and Type 2 Dual Carriageway (D2AP). These cross-sections were initially selected as the traffic volumes were estimated to lie in the capacity range of these cross-sections, as detailed in Table 6/1 of TD 9/12 of the NRA DMRB. The cross-section is likely to comprise a dual carriageway at the eastern end which will reduce to a single carriageway at the western end of the scheme. Further details on the selection of the optimum cross-section for each route option is included in the **Appendix A.3.1**.

The cross-sections are indicated in **Figure 4.1** and **4.2** below.

Figure 3.2.11 Type 1 Single Carriageway (S2) Cross-section

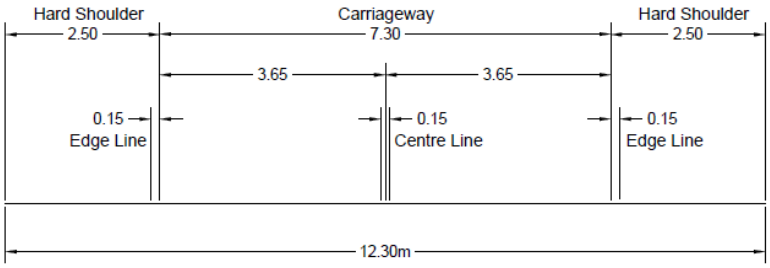
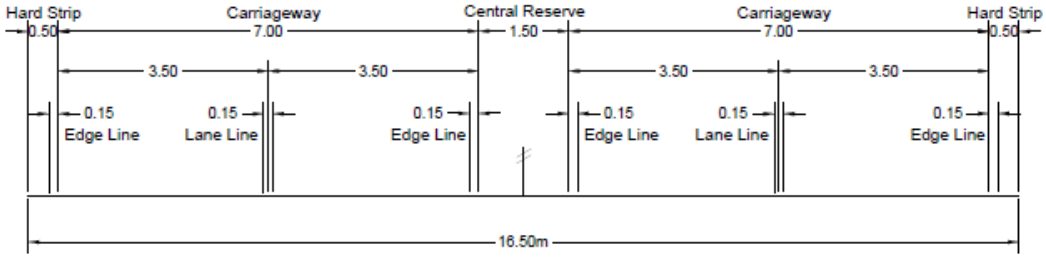


Figure 3.2.12 Type 2 Dual Carriageway (D2AP) Cross-section



At this time, it is considered that a further cross-section choice may consider an express road in place of the dual carriageway should this cross-section be an approved section in the NRA DMRB in the near future.

A full comparative assessment will be carried out on the preferred option in Phase 3: *Design* in various scenarios to finalise the selection. This will be supported by an incremental assessment on alternative cross-sections to ensure adequate provision whilst guarding against over-provision.

3.4 Preliminary Junction Strategy

An analysis of the zonal demand indicates that connectivity to the key employment centres, the city and the residential zones is critical to ensure that the scheme delivers on the project objectives. Therefore, it is anticipated that grade separated junctions will be provided at the N6/M6 interface, and on the N17, N84 and N59. Furthermore it is likely that there will be at least two further at-grade junctions between the N59 grade-separated junction and the R336 tie-in.

Further detailed analysis will be carried out at Phase 3: *Design* to model these junctions at a macro level to ensure that the capacity of the proposed road is not comprised by the proposed junctions. In addition, further iterations will occur on junctions as the integrated solution develops to ensure that connectivity for all modes is provided and to ensure that the optimum use is achieved for all modes from the residual road network.

4 Constraints Study

4.1 Introduction

A Constraints Study was undertaken in order to identify all constraints within the scheme study area of the N6 Galway City Transport Project, in order to inform the development of options for the transport solution for Galway.

The objective of the Constraints Study is to identify the international, national, county and local issues that must be taken into account when planning and designing the scheme so that the phases which follow (options development and selection and environmental impact studies) can be properly informed.

This constraint chapter has been prepared in accordance with the National Roads Authority's (NRA's) National Roads Project Management Guidelines (January 2010) and has been compiled based on desk studies, site survey work (windscreen survey, habitat mapping, species mapping, and field surveys) and consultation with stakeholders.

The constraints are divided into Natural Constraints, Artificial Constraints and External Parameters. Natural constraints are those which are naturally occurring landscapes and features and are detailed in **Sections 4.2 to 4.7** of this chapter. Artificial constraints are those which are forming part of the built environment, and are detailed in **Sections 4.8 to 4.17** of this chapter. External parameters include design standards, policies, procedural and legal issues and are detailed in **Sections 4.18** of this chapter.

4.1.1 Identification of Scheme Study Area

The scheme study area is described as the constraints study area for the N6 Galway City Transport Project. The boundary for the scheme study area was identified to ensure a suitable study area for the examination of alternative transportation solutions, the identification of key constraints and development of feasible options for the transportation solution and to carry out a systematic assessment of these options leading to the selection of a preferred option which will form the basis for the detailed design to follow.

The scheme study area was selected based on the following parameters:

- Northern Boundary;
- Eastern and Western Boundary;
- Southern Boundary;
- Safety; and
- Environmental Criteria.

Northern Boundary

A major defining factor on defining the northern boundary of the scheme study area boundary was the significant natural barrier presented by Lough Corrib. This is a large water body which is designated as a candidate Special Area of Conservation (cSAC) and it would require a significant viaduct structure to cross it.

Therefore, a review was carried out to establish whether it was feasible to cross Lough Corrib from both an ecological perspective and meeting the project objectives.

The conclusion was that even though a crossing of Lough Corrib by viaduct is technically feasible, it was ruled out as it would not satisfy the project objectives and a range of more suitable alternatives remain to be examined which would have significantly less environmental impacts on the Lough Corrib cSAC.

Eastern and Western Boundary

The results of the analysis of the existing traffic conditions and existing desire lines determined that in total 35% of total car trips into and around Galway City cross the River Corrib. Of this total number of cross-river trips, approximately 9% are bypass traffic. Some 40% of all trips remain on the same side of the city as where they started. The strongest movements are from the west side of Galway City to the east side of Galway City which represents 20% of all trips, and from the east of Galway City to the west side of Galway City which represent a further 20%.

Therefore, the extremity of the scheme study area was established along the lines of the former N6 Galway City Outer Bypass (2006) route as it was determined that it represented a reasonable distance disparate from the city that traffic may divert to use. The initial desire line analysis showed that routes further out from the city than this route would attract less traffic. It was concluded that the boundary as defined is sufficiently large to allow inclusion of all feasible route options.

Southern Boundary

Another major defining factor on the scheme study area boundary is the physical constraint presented by Galway Bay to the south and this too is a designated site, Galway Bay Complex cSAC. A review was carried out to establish whether it was feasible to run another major transport corridor along the coast, which would also include a crossing of the River Corrib at the confluence of the river and the bay.

The conclusion was that even though a coastal route is technically feasible, it was ruled out as it would not satisfy the project objectives and a range of more suitable alternatives remained to be examined which would have significantly less environmental impacts on the Galway Bay Complex cSAC. Therefore, the conclusion from this study was that the southern boundary of the scheme study area did not need to include Galway Bay.

A review was carried out on whether it was possible to move the southern boundary of the study area to the north of the built environment of the city. However, it was determined that the urban city area should be retained within the scheme study area as the zone of influence of any potential option involving an upgrade of the existing N6 could extend to within the existing city street network. It was deemed necessary to include the extents of the city street network so that a full range of impacts of all potential solutions could be assessed.

Therefore, to ensure that the full zone of influence was captured for any potential options along the existing N6, the southern boundary of the scheme study area was established along the southern extremities of the city street network.

Safety

During Phase 1, *Scheme Concept & Feasibility Studies,* a Road Safety Impact Assessment was undertaken. This examined the main road corridors approaching, within and travelling through Galway City. This study highlighted the need to consider the road networks and the associated transport issues at a distance from the city boundary. This reinforced the need to extend the scheme study area to the north, east and west along the radial routes entering the city and joining the existing N6, which currently acts as a bypass.

The scheme study area includes a sufficient length along the radial routes into the city to ensure that an analysis of the transport issues along those radial routes would be examined as part of this project.

Environmental Criteria

The boundary of the scheme study area was targeted with a view to including the potential maximum receiving environment of any potential option which may provide a transportation solution. The environmental team assessed an effective area over which change would likely occur to ensure that the boundary encompassed this area.

It became apparent, as environmental surveys were being carried out, that there was a significant area of priority habitat, namely Limestone pavement, extending to the limits of the study area boundary west of Ballindooley, the scheme study area boundary was extended to the north so that the full extents or extremity of this particular habitat could be established. This is the reason that there is a notable bulge to the north in the area of Killoughter.

4.1.2 Description of the Scheme Study Area

The scheme study area as shown on **Figure 4.1** encompasses Galway City, extending from Galway Bay to Lough Corrib, and includes the entire city built environment plus a significant portion of the Lough Corrib candidate Special Area of Conservation (cSAC) and Lough Corrib Special Protection Area (SPA) and a portion of Galway Bay Complex cSAC.

The scheme study area is bounded by the Lough Corrib to the North and Galway Bay to the south and extends from the R336 immediately west of Bearna to the N6 at Coolagh in the east. The scheme study area is divided in two by the River Corrib which flows between the Lough Corrib and Galway Bay. Four national roads the N6, N17, N84 and the N59 are all located within the scheme study area.

4.1.3 Public Consultation No. 1 – Constraints

As part of the Constraints Study, public consultation sessions were held on Monday 14 July 2014 in the Westwood Hotel, Dangan from 10:00am to 9:00pm and on Tuesday 15 July 2014 in the Pillo Hotel, Headford Road from 10:00am to 9:00pm.

The initial results of the constraints study were displayed to the public at the consultation sessions. The aim of this was to receive feedback from the public and gain invaluable information from their local knowledge of constraints that may have been overlooked.

Representatives from Arup and Galway County Council were in attendance to assist the public in explaining the material on display. Over 100 people signed the attendance register.

The main findings from this public consultation are as follows:

1. The scheme study area should extend further west and north;
2. Concerns were raised in relation to the N6 Galway City Outer Bypass (2006) and the restrictions on lands located along this previous scheme;
3. An additional crossing of the River Corrib was required and this new bridge should not adversely affect the navigation of the River Corrib;
4. Current traffic and congestion issues, including inadequacies in the current public transport network were highlighted. Bus frequencies, routes and infrastructure need to be improved;
5. Provision of a connection to the R336 west of Bearna;
6. Proposals to tunnel under the Limestone pavement;
7. Provision of school buses would provide a safe mode of transport for children and ease congestion at peak morning times; and
8. Additional constraints were identified.

Full details of this consultation and submissions received from the public are included in **Appendix A.4.1** Public Consultation No. 1.

4.2 Natural Constraints

Natural Constraints are those which are naturally occurring landscapes and features, namely Ecology which is detailed in **Section 4.3 Ecology**, Soils and Geology which is detailed in **Section 4.4 Soils and Geology**, Hydrogeology which is detailed in **Section 4.5 Hydrogeology**, Hydrology which is detailed in **Section 4.6 Hydrology** and Landscape and Visual which is detailed in **Section 4.7 Landscape and Visual**.

4.3 Ecology

4.3.1 Introduction

This section describes the ecological constraints identified within the scheme study area for the N6 Galway City Transport Project. The specific objective of the ecological constraints study is to identify the international, national, county and local constraints that must be taken into account for the proposed scheme. Ecological constraints are presented in **Figures 4.3.1** to **4.3.23.**

Section 4.3.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.3.3** describes the ecological constraints identified within the scheme study area. A summary is presented in **Section 4.3.4** and references are listed in **Section 4.3.5**.

A considerable amount of information was collected during the desk study and field surveys as part of this ecological constraint study. This section provides a summary of this study.

Therefore, this section needs to be read in conjunction with **Appendix A4.2 Ecological Constraints Report** where the full details of the methodologies employed to carry out the various surveys, along with the full details of the survey results, are described.

4.3.2 Methodology and Sources of Information

This section describes the background legislation, policy context and guidance along with a summary of the methods used to collate information on the ecological constraints. The full details of the methodologies employed to carry out the various surveys are described in **Appendix A4.2 Ecological Constraints Report**.

The preparation of the ecological constraints study has had regard to the following guidance documents.

Guidance Documents:

- Guidelines on the information to be contained in Environmental Impact Statements (Environmental Protection Agency, 2002);
- Advice Notes on Current Practice (in the preparation of Environmental Impact Statements) (Environmental Protection Agency, 2003);
- Guidelines for Ecological Impact Assessment in the United Kingdom (Chartered Institute of Ecology and Environmental Management, 2006); and
- The National Roads Authority's Environmental Planning and Construction Guidelines series (2004 to 2009) including in particular:
  - Environmental Impact Assessment of National Road Schemes – A Practical Guide (National Roads Authority, 2008);
  - Guidelines for Assessment of Ecological Impacts of National Road Schemes (National Roads Authority, 2009a); and
  - Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes (National Roads Authority**,** 2009b).

4.3.2.1 Consultation

The following organisations/individuals with relevance to collating information on ecological constraints were consulted as part of the constraints study:

- National Parks & Wildlife Service (NPWS);
- Inland Fisheries Ireland (IFI);
- BirdWatch Ireland (BWI);
- Bat Conservation Ireland (BCI);
- Vincent Wildlife Trust; and
- Other members of the public with local knowledge/records (e.g. relating to bat roosts).

4.3.2.2 Desktop Study

The desktop study involved collection and review of relevant published and unpublished sources of data, collation of existing information on the ecological environment and consultation with relevant statutory bodies.

Desktop Data Sources

The following sources were consulted during the desktop study and informed the constraints study:

- Online data available on Natura 2000 sites (hereafter referred to as European sites)[1] and designated sites protected at the national level (i.e. Natural Heritage Areas, or NHAs, and proposed Natural Heritage Areas, or pNHAs) as held by the National Parks and Wildlife Service (NPWS). Available online at <www.npws.ie/protectedsites/> and < http://webgis.npws.ie/npwsviewer/>. Accessed 23/05/2014;
- National Biodiversity Data Centre (NBDC) Online Database. Available online at <http://maps.biodiversityireland.ie/#/Map>. Accessed 23/05/2014;
- Ordnance Survey Ireland (OSI) orthophotography (from 2012) for the N6 Galway City Transport Project study area;
- Records of rare and protected species for the 10km grid squares M22 and M32, provided by the NPWS;
- Habitat and species GIS datasets provided by the NPWS;
- Results of the NBDC's 'Bioblitz' event at the NUI Galway campus;
- Bat records from Bat Conservation Ireland's (BCI) database; and
- A wide range of published and unpublished reports including (full lists of all references/sources are provided in the **Appendix A4.2 Ecological Constraints Report**:
  - Environmental Impact Statements and other environmental reports prepared, in particular for the proposed N6 Galway City Outer Bypass and the proposed R336 to N59 Road Scheme but also for a range of proposed developments in the Galway city area;
  - Available land use plans including county development plans and local area plans;
  - County and city biodiversity action plans;
  - Ecological studies/report undertaken for the area in question; and
  - Scientific literature.

[1] European sites, are defined under the Habitats Directive (Article 3) as a European ecological network of Special Areas of Conservation and Special Protection Areas, composed of sites which host the natural habitat types listed in Annex I and habitats of the protected species listed in Annex II. The aim of the network is to aid the long-term survival of Europe's most vulnerable and threatened species and habitats. In Ireland these sites are designated as European sites – defined under the Planning Acts and/or Birds and Habitats Regulations as (a) a candidate site of Community importance, (b) a site of Community importance, (c) a candidate special are of conservation, (d) a special area of conservation, (e) a candidate special protection area, or (f) a special protection area. They are commonly referred to in Ireland as Special Areas of Conservation (cSACs) and Special Protection Areas (SPAs).

The list of bryophyte species proposed for inclusion in the proposed revised Flora Protection Order legislation was reviewed with the view of assessing, on a combination of a species' habitat requirements, distribution, habitats present within the scheme study area and expert judgement, whether or not any of these species could potentially occur within the scheme study area.

4.3.2.3 Field Study

The approach to identifying and collating baseline information on ecological constraints has been guided by the following principle; to provide enough data to identify the least damaging option; not only in terms of impacts on sites designated for nature conservation (i.e. candidate Special Areas of Conservations (cSACs), Special Protection Areas (SPAs) and National Heritage Areas (NHAs)) but also on non-designated Annex I habitats, Annex II/IV fauna species (other than birds) and Annex I bird species.[2]

Given the nature of the ecological constraints within the scheme study area identified from the desktop study and through consultation, it was determined that detailed ecological surveying was required in order to develop feasible alternatives and to identify an option that has the least adverse impact on the ecological environment.

Ecological constraints considered within the scope for more detailed survey work at the constraints stage were those habitats or species protected at a European or national level, of a high conservation value or concern at a European or national level, and considered to be particularly vulnerable to significant negative impacts from road development. Of key importance were those habitats and species listed as qualifying interests of Lough Corrib cSAC, as this designated site traverses the entire scheme study area; the full list of qualifying interests for the Lough Corrib cSAC are provided in **Table 4.3.2.**

Table 4.3.1 below, lists the suite of ecological surveys carried out over the period July 2013 to March 2015 with the purpose of identifying and mapping ecological constraints to inform the development of potential options within the scheme study area. The study areas associated with each of the survey elements are shown on **Figures 4.3.1** to **4.3.23**.

[2] Annex I habitats and Annex II/IV fauna species are those habitats and species listed on the corresponding Annex of *Council Directive 92/43/EEC of 21 May 1992 on the conservation of natural habitats and of wild fauna and flora*; Annex I bird species are those bird species listed on Annex I of *Directive 2009/147/EC of the European Parliament and of the Council of 30 November 2009 on the conservation of wild birds*

Table 4.3.1 Ecological Surveys and Survey Dates between 2013 and 2015

Survey	Survey Date(s)	Surveyor(s)
Habitat surveys: Lough Corrib candidate Special Area of Conservation (cSAC) Study Area Ecological Sites [3] Petrifying Springs Survey Aquatic Annex I Habitats	July to September 2013 & March to September, 2014	Botanical, Environmental & Conservation (BEC) Consultants Ltd., Scott Cawley Ltd. and various freelance botanists including Dr Joanne Denyer, Dr John Conaghan, Dr Janice Fuller, Katharine Duff. Eamon O'Sullivan, Roger Goodwillie and Dr Cilian Roden.
Protected plant species: Varnished hook-moss*Hamatocaulis vernicosus* Slender naiad*Najas flexilis*	May to September, 2014	Varnished hook-moss survey carried out by Rory Hodd. Slender naiad surveyed for in conjunction with aquatic habitat surveys by Dr Cilian Roden,
Bat surveys[4]: A population assessment analysis was carried out to establish the importance of the Menlo Castle roost Survey of potential Lesser horseshoe bat hibernation sites Survey of buildings with the potential to support roosting bats Bat detector survey of driven transect and walked transect routes Static bat detector monitoring at twenty-four sites within the scheme study area Radio-tracking studies (three sessions)	March 2013 to March 2014	Scott Cawley Ltd., Greena Ecological Consultancy Ltd., Geckoella Ltd. and various freelance bat workers including Conor Kelleher, Brian Keeley and Isobel Abbott
Otter survey	April and May, 2014	Scott Cawley Ltd.
White-clawed crayfish survey	September, 2014	Scott Cawley Ltd. and Dr Julian Reynolds
Molluscan surveys	August, 2014	Evelyn Moorkens and Ian Killeen
Marsh fritillary survey	September 2013 & September/October, 2014	Woodrow Environmental Consultants Ltd.
Red grouse survey	June to August, 2014	Dr Chris Peppiatt
Barn owl survey	June and July, 2014	BirdWatch Ireland

[3] Ecological sites, in this case, are sites of potential ecological value for the habitats present; the boundaries of which were initially defined based on interpretation of orthophotography and collation of available existing habitat information, in conjunction with a ground truthing exercise to verify the orthophotography interpretation. These boundaries were then refined, where appropriate, based on the findings of the various habitat surveys undertaken.

[4]At the constraints and route selection stage of the project, a greater proportion of the survey effort in relation to bats was focused on the Lesser horseshoe bat given its status as a qualifying interest species of the Lough Corrib cSAC (through which any option will pass).

Survey	Survey Date(s)	Surveyor(s)
Wintering bird survey	September, 2014 to March, 2015	Scott Cawley Ltd., Dr Chris Peppiatt, Gerry Murphy and Tom Cuffe.

Surveys were carried out during the appropriate survey seasons for the various habitats and species concerned. A detailed description of the methodologies employed to carry out the various surveys is provided in the **Appendix A.4.2 Ecological Constraints Report**.

An Appropriate Assessment (AA) screening statement was prepared by Scott Cawley Ltd. to provide the information required by the local authority to assess the potential for the ecological surveys to significantly affect European sites. This AA screening statement objectively concluded that there was no likelihood of any significant effects on any European sites arising from the proposed ecological surveys, either alone or in combination with other plans or projects, and that an AA for these surveys was not required.

Dedicated surveys for Atlantic salmon *Salmo salar* and lamprey species were not carried out as, through the desk review and consultations with the statutory agencies, sufficient data had been collated on the presence of these species to inform the development of potential options within the scheme study area. Breeding bird surveys were restricted to Barn owl and Red grouse, as species known to occur within the study area, of a high conservation concern, and being particularly vulnerable to significant negative effects from road developments.

4.3.3 Existing Environment

This section describes the ecological constraints identified within the scheme study area.

4.3.3.1 Desktop Study

There are 40 designated areas for nature conservation within 15km of the proposed scheme: Fourteen candidate Special Areas of Conservation (cSACs), five Special Protection Areas (SPAs), three Natural Heritage Areas (NHAs), and 18 proposed Natural Heritage Areas (pNHAs).

Two of the cSACs are located within the scheme study area - Lough Corrib cSAC and Galway Bay Complex cSAC; along with two SPAs - Lough Corrib SPA and Inner Galway Bay SPA; one NHA - Moycullen Bogs NHA; and two pNHAs – Lough Corrib pNHA and Galway Bay Complex pNHA.

The locations of the designated areas for nature conservation are listed below in **Tables 4.3.2 and 4.3.3**, along with their location in relation to the scheme study area, and a summary of the reasons for site designation. Their locations are also shown on **Figures 4.3.1** and **4.3.2.**

Table 4.3.2 European Sites (cSACs and SPAs) within 15km of the scheme study area

Site Name	Distance	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
Galway Bay Complex cSAC 000268	within scheme study area	[1140] Mudflats and sandflats not covered by seawater at low tide [1150] Coastal lagoons* [1160] Large shallow inlets and bays [1170] Reefs [1220] Perennial vegetation of stony banks [1310] *Salicornia* and other annuals colonising mud and sand [1330] Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1355] Otter *Lutra lutra* [1365] Harbour seal *Phoca vitulina* [1410] Mediterranean salt meadows (*Juncetalia maritimi*) [3180] Turloughs* [5130] *Juniperus communis* formations on heaths or Calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [7210] Calcareous fens with *Cladium mariscus* and species of the Caricion davallianae* [7230] Alkaline fens
Lough Corrib cSAC 000297	within scheme study area	[1029] Freshwater pearl mussel *Margaritifera margaritifera* [1092] White-clawed crayfish *Austropotamobius pallipes* [1095] Sea lamprey *Petromyzon marinus* [1096] Brook lamprey *Lampetra planeri* [1106] Atlantic salmon *Salmo salar* (only in fresh water) [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [1355] Otter *Lutra* [1393] Varnished hook-moss *Drepanocladus (Hamatocaulis) vernicosus* [1833] Slender naiad *Najas flexilis* [3110] Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3130] Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or of the *Isoëto-Nanojuncetea*[5] [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites)

[5] Although not yet listed on the version of the sites conservation objectives available from the NPWS, *Conservation objectives for Lough Corrib cSAC [000297]*, the NPWS have advised that this Annex I habitat has been approved for inclusion as a qualifying interest of the Lough Corrib cSAC

Site Name	Distance	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[6410] Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [7110] * Active raised bogs [7120] Degraded raised bogs still capable of natural regeneration [7150] Depressions on peat substrates of the *Rhynchosporion* [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [7230] Alkaline fens [8240] * Limestone pavements [91A0] Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles [91D0] * Bog woodland
Ardrahan Grassland cSAC 002244	13.5km south-east of the scheme study area	[4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or alcareous grasslands [8240] * Limestone pavements
Connemara Bog Complex cSAC 002034	5.5km north-west of the scheme study area	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia* [1106] Atlantic salmon *Salmo salar* (only in fresh water) [1150] * Coastal lagoons [1170] Reefs [1355] Otter *Lutra lutra* [1833] Slender naiad *Najas flexilis* [3110] Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3160] Natural dystrophic lakes and ponds [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4010] Northern Atlantic Wet heaths with *Erica tetralix* [4030] European Dry heaths [6410] *Molinia* meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [7130] Blanket bogs (* if active only) [7140] Transition mires and quaking bogs [7150] Depressions on peat substrates of the *Rhynchosporion* [7230] Alkaline fens [91A0] Old sessile oak woods with *Ilex* and *Blechnum* in the British Isles
Ross Lake And Woods cSAC 001312	9km north-west of the scheme study area	[1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp.
Lough Fingall Complex cSAC 000606	10.1km south of the scheme study area	[1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3180] * Turloughs [4060] Alpine and Boreal heaths

Site Name	Distance	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(* important orchid sites) [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [8240] * Limestone pavements
Black Head-Poulsallagh Complex cSAC 000020	10.5km south of the scheme study area	[1170] Reefs [1220] Perennial vegetation of stony banks [1395] Petalwort *Petalophyllum ralfsii* [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6510] Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [7220] Petrifying springs with tufa formation (*Cratoneurion*) [8240] Limestone pavements [8330] Submerged or partially submerged sea caves
Rahasane Turlough cSAC 000322	11.3km south-east of the scheme study area	[3180] * Turloughs
Castletaylor Complex cSAC 000242	12.2km south-east of the scheme study area	[3180] * Turloughs [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [8240] * Limestone pavements
East Burren Complex cSAC 001926	12.3km south of the scheme study area	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas, Hypodryas*) *aurinia* [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [1355] Otter *Lutra lutra* [3140] Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3180] * Turloughs [3260] Water courses of plain to montane levels with the *Ranunculion fluitantis* and *Callitricho-Batrachion* vegetation [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands

Site Name	Distance	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		[6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(*important orchid sites) [6510] Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [7210] * Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [7230] Alkaline fens [8240] * Limestone pavements [8310] Caves not open to the public [91E0] * Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*)
Gortnandarragh Limestone Pavement cSAC 001271	12.3km north of the scheme study area	[8240] * Limestone pavements
Kiltiernan Turlough cSAC 001285	12.3km south-east of the scheme study area	[3180] * Turloughs
Moneen Mountain cSAC 000054	13km south of the scheme study area	[1065] Marsh fritillary butterfly *Euphydryas* (*Eurodryas*, *Hypodryas*) *aurinia* [1303] Lesser horseshoe bat *Rhinolophus hipposideros* [3180] * Turloughs [4060] Alpine and Boreal heaths [5130] *Juniperus communis* formations on heaths or calcareous grasslands [6130] Calaminarian grasslands of the *Violetalia calaminariae* [6210] Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco Brometalia*)(* important orchid sites) [7220] * Petrifying springs with tufa formation (*Cratoneurion*) [8240] * Limestone pavements
Ballyvaughan Turlough cSAC 000996	15km south of the scheme study area	[3180] * Turloughs
Inner Galway Bay SPA 004031	within scheme study area	Great Northern Diver (*Gavia immer*) [A003] - wintering Cormorant (*Phalacrocorax carbo*) [A017] - breeding Grey Heron (*Ardea cinerea*) [A028] - wintering Light-bellied Brent Goose (*Branta bernicla hrota*) [A046] - wintering Wigeon (*Anas penelope*) [A050] - wintering Teal (*Anas crecca*) [A052] - wintering Shoveler (*Anas clypeata*) [A056] - wintering Red-breasted Merganser (*Mergus serrator*) [A069] - wintering Ringed Plover (*Charadrius hiaticula*) [A137] - wintering Golden Plover (*Pluvialis apricaria*) [A140] - wintering

Site Name	Distance	Reasons for Designation – Qualifying Interests (QIs) or Special Conservation Interests (SCIs)
		Lapwing (*Vanellus vanellus*) [A142] - wintering Dunlin (*Calidris alpina*) [A149] - wintering Bar-tailed Godwit (*Limosa lapponica*) [A157] - wintering Curlew (*Numenius arquata*) [A160] - wintering Redshank (*Tringa totanus*) [A162] - wintering Turnstone (*Arenaria interpres*) [A169] - wintering Black-headed Gull (*Chroicocephalus ridibundus*) [A179] - wintering Common Gull (*Larus canus*) [A182] - wintering Sandwich Tern (*Sterna sandvicensis*) [A191] - breeding Common Tern (*Sterna hirundo*) [A193] - breeding Wetlands & Waterbirds [A999]
Lough Corrib SPA 004042	within scheme study area	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering Gadwall (*Anas strepera*) [A051] - wintering Shoveler (*Anas clypeata*) [A056] - wintering Pochard (*Aythya ferina*) [A059] - wintering Tufted Duck (*Aythya fuligula*) [A061] - wintering Common Scoter (*Melanitta nigra*) [A065] - breeding Hen Harrier (*Circus cyaneus*) [A082] – post-breeding/roost Coot (*Fulica atra*) [A125] - wintering Golden Plover (*Pluvialis apricaria*) [A140] - wintering Black-headed Gull (*Chroicocephalus ridibundus*) [A179] - breeding Common Gull (*Larus canus*) [A182] - breeding Common Tern (*Sterna hirundo*) [A193] - breeding Arctic Tern (*Sterna paradisaea*) [A194] – breeding Wetlands & Waterbirds [A999]
Cregganna Marsh SPA 004142	2.4km south of the scheme study area	Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering
Connemara Bog Complex SPA 004181	9km west of the scheme study area	Cormorant (*Phalacrocorax carbo*) [A017] - breeding Merlin (*Falco columbarius*) [A098] - breeding Golden Plover (*Pluvialis apricaria*) [A140] - breeding Common Gull (*Larus canus*) [A182] - breeding
Rahasane Turlough SPA 004089	11.2km south-east of the scheme study area	Whooper Swan (*Cygnus cygnus*) [A038] - wintering Wigeon (*Anas penelope*) [A050] - wintering Golden Plover (*Pluvialis apricaria*) [A140] - wintering Black-tailed Godwit (*Limosa limosa*) [A156] - wintering Greenland White-fronted Goose (*Anser albifrons flavirostris*) [A395] - wintering Wetlands & Waterbirds [A999]

Table 4.3.3 Natural Heritage Areas (and proposed Natural Heritage Areas) within 15km of the Scheme Study Area

Site Name	Distance	Features of Interest[6]
Moycullen Bogs NHA 002364	within scheme study area	Peatland [T010]
Cregganna Marsh NHA 000253	2.4km south of the scheme study area	not available
Oughterard District Bog NHA 002431	14.5 north-west of the scheme study area	Peatland [T010]
Galway Bay Complex pNHA 000268	within scheme study area	see above under Galway Bay Complex cSAC and Inner Galway Bay SPA
Lough Corrib pNHA 000297	within scheme study area	see above under Lough Corrib cSAC and Lough Corrib SPA
Kiltullagh Turlough pNHA 000287	1.5km north of the scheme study area	turlough feature
Furbogh Wood pNHA 001267	2.2km west of the scheme study area	oak woodland
Ballyquirke Lough pNHA 000228	3.3km north-west of the scheme study area	data unavailable
Connemara Bog Complex pNHA 002034	5.5 north-west of the scheme study area	see above under Connemara Bog Complex cSAC and Connemara Bog Complex SPA
Killarainy Lodge, Moycullen pNHA 002083	6km north-west of the scheme study area	Natterer's bat nursery roost
Drimcong Wood pNHA 001260	7km north-west of the scheme study area	mixed broadleaved and coniferous woodland
Ross Lake And Woods pNHA 001312	9km north-west of the scheme study area	see above under Ross Lake And Woods cSAC
Lough Fingall Complex pNHA 000606	9.7km south-east of the scheme study area	see above under Lough Fingall Complex pNHA
Black Head-Poulsallagh Complex pNHA 000020	10.5km south-west of the scheme study area	see above under Black Head-Poulsallagh Complex cSAC
Rahasane Turlough pNHA 000322	11.3 south-east of the scheme study area	see above under Rahasane Turlough cSAC and Rahasane Turlough SPA
Castletaylor Complex pNHA 000242	12.1 south-east of the scheme study area	see above under Castletaylor Complex cSAC
East Burren Complex pNHA 001926	12.2km south of the scheme study area	see above under East Burren Complex cSAC

[6]information taken from the site synopses, where available from http://www.npws.ie/protected-sites

Site Name	Distance	Features of Interest[6]
Gortnandarragh Limestone Pavement pNHA 001271	12.2km north-west of the scheme study area	see above under Gortnandarragh Limestone Pavement cSAC
Kiltiernan Turlough pNHA 001285	12.3km south-east of the scheme study area	see above under Kiltiernan Turlough cSAC
Moneen Mountain pNHA 000054	13km south of the scheme study area	see above under Moneen Mountain cSAC
Turloughcor pNHA 001788	13.6km north of the scheme study area	wetland site supporting wintering bird populations

Habitats

All available information relating to habitats within the scheme study area was reviewed and existing habitat classifications taken into consideration by the survey teams.

The most extensive habitat information available related to previous large scale habitat mapping exercises carried out for other large scale infrastructure developments (RPS, 2006; RPS, 2012a; RPS, 2012b; RPS, 2013a; RPS, 2013b; RPS, 2013c; and Galway Harbour Company, 2014), surveys to inform land use planning (Natura Environmental Consultants, 2005; and, Nature Environmental Consultants, 2012), and other surveys carried out to document ecological biodiversity at a local level in Galway City and environs - e.g. Bearna Woods by Browne *et al*., 2009; Merlin Woods by Browne & Fuller (2009), and Stanley (2013a, and 2013b). This was supplemented by information gathered from other smaller scale development projects where habitat surveys had been carried out in the preparation of an Environmental Impact Statement or other environmental reports.

Some areas of high biodiversity value noted included: the Rusheen Bay and Bearna area; the peatland habitats between Bearna and Ballagh; the River Corrib and the adjoining wetlands and lakes at Coolagh; the area between Menlough Village and the N84; Ballindooley Lough and Castlegar; Merlin Woods; and orchid rich grassland at Doughiska.

The habitat information collated from the desktop review sources were used to help define the boundaries of the Ecological Sites, all of which were subject to detailed botanical survey in 2014.

4.3.3.2 Records of Protected, Rare and Other Notable Species

Flora

Desktop records of protected, rare, or other notable plant species are listed below in **Table 4.3.4**. Where a grid reference is available for the record, the location is mapped on **Figure 4.3.4.**

Table 4.3.4 Records of Protected, Red-listed or Notable Flora Recorded from the Desk Study within the scheme study area

Common Name/ Scientific name	Legal Status[7]	Red List Status[8]	Source
Slender cottongrass *Eriophorum gracile*	FPO	Rare	NPWS online database[9] Galway City Council (2013) Galway Harbour Company (2014)
Small-white orchid *Pseudorchis albida*	FPO	Vulnerable	Galway City Council (2013) Galway Harbour Company (2014) Natura Environmental Consultants (2012) Roden (2005)
Chives *Allium schoenoprasum*	FPO	Rare	NPWS online database record NBDC online database record[10]
Henbane *Hyoscyamus niger*	none	Rare	NBDC online database record
Northern yellow-cress *Rorippa islandica*	none	Rare	NBDC online database record
Blue fleabane *Erigeron acer*	none	Endangered	NBDC online database record
Cornflower *Centaurea cyanus*	none	Endangered	NBDC online database record
Funck's rustwort *Marsupella funckii*	none	Near threatened	NPWS online database record
Fine-leaved marsh feather-moss *Campyliadelphus elodes*	none	Near threatened	NPWS online database record NBDC online database record
Lesser striated feather-moss *Eurhynchium striatulum*	none	Near threatened	NPWS online database record NBDC online database record
Red-neck forklet-moss *Dicranella cerviculata*	none	Near threatened	NPWS online database record
Saltmarsh thread-moss *Bryum salinum*	none	Near threatened	NPWS online database record NBDC online database record
Woodsy thyme-moss *Plagiomnium cuspidatum*	none	Near threatened	NPWS online database record NBDC online database record

The majority of the bryophyte species proposed for inclusion in the proposed revised Flora Protection Order legislation were considered highly unlikely to occur within the scheme study area, based on a review of the habitat preferences for each species and on the habitats present within the scheme study area. Two species were considered to have potential to occur: *Hamatocaulis vernicosus*, which was subject

[7] HDII/IV/V = Habitats Directive Annexes II/IV/V; FPO = Flora (Protection) Order, 1999; WA = Wildlife Acts
[8] Vascular Flora from the Irish Red Data Book 1 Vascular Plants (Curtis & McGough, 2005)
[9]National Parks and Wildlife Service (NPWS) online database (http://webgis.npws.ie/npwsviewer/) accessed in May 2014.
[10]National Biodiversity Data Centre (NBDC) records (http://maps.biodiversityireland.ie/#/Map) accessed in May 2014.

to a dedicated survey; and *Pallavicinia lyellii*, which is known to occur on wet, peaty ground in bogs and mires, such as that found in the peaty areas in the western part of the scheme study area.

Fauna

There are a number of European and Nationally protected mammal, bird, fish and amphibian species, and/or species of a high conservation concern, which have been recorded within the scheme study area. These include:

- Mammals – *e.g.* bat species (including the Lesser horseshoe bat *Rhinolophus hipposideros*), Otter *Lutra lutra*, Badger *Meles meles*, Hedgehog *Erinaceus europaeus*, Irish hare *Lepus timidus hibernicus*, Pine marten *Martes martes*, Red squirrel *Sciurus vulgaris*, Pygmy shrew *Sorex minutus*, and Stoat *Mustela erminea*;
- Amphibians – Common frog *Rana temporaria* and the Smooth newt *Lissotriton vulgaris*;
- Reptiles – Common lizard *Lacerta vivipara*;
- Fish – including Atlantic salmon *Salmo salar*, lamprey species, and the Eel *Anguilla anguilla*;
- Crustaceans – the White-clawed crayfish *Austropotamobius pallipes*;
- Invertebrates – e.g. the Marsh fritillary butterfly *Euphydryas aurinia*; and
- Birds – a range of breeding and wintering birds, including species listed on Annex I of the Birds Directive (e.g. Peregrine, Hen harrier, Kingfisher) and species on the Birds of Conservation Concern in Ireland (BoCCI) Red and Amber Lists[11].

The full results of the desktop study are provided **Section 3.2** of **Appendix A.4.2 Ecological Constraints Report**.

4.3.3.3 Field Survey

Terrestrial Habitats

The Lough Corrib cSAC is comprised of a range of wetland and peatland habitats along the River Corrib valley, including the Coolagh Lakes, grading to an expanse of exposed, wooded and scrub covered Limestone pavement and calcareous grassland covering an area of raised ground between Menlough and Ballindooley. Within the scheme study area, the Lough Corrib cSAC supports 13 different Annex I habitat Types (see **Table 4.3.5** below).

Outside of Lough Corrib cSAC, a total of 58 Ecological Sites were identified and mapped within the scheme study area[12] (see **Table 4.3.6** and **Figure 4.3.3**). East of the River Corrib, these sites were characterised by areas of agricultural grassland, Limestone pavement, with isolated patches of woodland and scrub, along with wetland habitats along the Terryland Stream valley and around Ballindooley Lough.

[11]from Birds of Conservation Concern in Ireland (Colhoun & Cummins, 2013)
[12]Originally 63 Ecological Sites were selected based on the findings of the desktop study and a review of orthophotography – however, following ground truthing and selecting only those sites within the boundary of the scheme study area this number was reduced to 58

West of the River Corrib, the Ecological Sites were predominantly peatland habitats on the higher ground to the north, with agricultural grasslands and scrub covered abandoned fields towards the R336 along the Bearna coastline, and agricultural fields towards the N59 and the suburban development around the outskirts of Galway City. Blocks of woodland and areas of wetland habitats are present along the river valley from the NUI Galway campus to Kentfield.

A total of 23 Annex I habitat types were recorded within the areas surveyed during the course of the botanical and aquatic surveys – including seven priority Annex I habitats. These are listed below in **Table 4.3.5** and are shown on **Figures 4.3.5** and **4.3.6**.

The Annex I habitats Perennial vegetation of stony banks [1220] and Atlantic salt meadows [1330] were recorded outside of the scheme study area along the coastline at Bearna. The priority Annex I habitat type *Petrifying springs with tufa formation (*Cratoneurion*) [*7220] was not recorded within the scheme study area. The nearest recorded location of this habitat is at Annaghdown, 8.3km to the north.

Table 4.3.5 Annex I (and priority Annex I – denoted with an *) habitat types recorded during the habitat surveys

Annex I Habitat Type	Note on Location	Within Lough Corrib cSAC?
Perennial vegetation of stony banks [1220]	Recorded outside of the scheme study area	×
Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*) [1330]	Recorded outside of the scheme study area	×
Oligotrophic waters containing very few minerals of sandy plains (*Littorelletalia uniflorae*) [3110]	Lough Inch	×
Oligotrophic to mesotrophic standing waters with vegetation of the *Littorelletea uniflorae* and/or *Isoeto-Nanojuncetea* [3130]	Lough Inch	×
Hard oligo-mesotrophic waters with benthic vegetation of *Chara* spp. [3140]	Northern part of River Corrib channel, Coolagh Lakes and Ballindooley Lough	✓
Natural dystrophic lakes and ponds [3160]	At Coolanillaun and two small lakes in EC25	✓
* Turloughs [3180]	Scattered distribution throughout the eastern part of the scheme study area	×
Northern Atlantic Wet heaths *with Erica tetralix* [4010]	River Corrib Valley and western part of the scheme study area	✓
European Dry heaths [4030]	Lough Corrib cSAC Limestone pavement and western part of the scheme study area	✓
Alpine and Boreal heaths [4060]	Lough Corrib cSAC Limestone pavement and western part of the scheme study area	✓
Semi-natural dry grasslands and scrubland facies on calcareous substrates (*Festuco-Brometalia*) (* important orchid sites) [6210]	Scatted distribution throughout the eastern part of the scheme study area	✓

Annex I Habitat Type	Note on Location	Within Lough Corrib cSAC?
* Species-rich *Nardus* grasslands, on siliceous substrates in mountain areas (and submountain areas, in Continental Europe) [6230]	Small area in EC10	×
Molinia meadows on calcareous, peaty or clayey-silt-laden soils (*Molinion caeruleae*) [6410]	Lough Corrib cSAC, Ballindooley Lough and scatted distribution throughout the western part of the scheme study area	✓
Hydrophilous tall herb fringe communities of plains and of the montane to alpine levels [6430]	River Corrib Valley and Coolagh Lakes	✓
Lowland hay meadows (*Alopecurus pratensis*, *Sanguisorba officinalis*) [6510]	Scatted distribution throughout the eastern part of the scheme study area	×
Blanket bogs (* if active bog) [7130]	River Corrib Valley and western part of the scheme study area	✓
Transition mires and quaking bogs [7140]	River Corrib Valley and western part of the scheme study area	✓
Depressions on peat substrates of the *Rhynchosporion* [7150]	In western part of the scheme study area	×
*Calcareous fens with *Cladium mariscus* and species of the *Caricion davallianae* [7210]	River Corrib Valley and Coolagh Lakes	✓
*Petrifying springs with tufa formation (*Cratoneurion*) [7220]	Annaghdown, 8.3km north of scheme study area	×
Alkaline fens [7230]	River Corrib Valley and Coolagh Lakes, and in EC22	✓
* Limestone pavements [8240]	Found throughout the eastern part of the scheme study area	✓
* Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior* (*Alno-Padion*, *Alnion incanae*, *Salicion albae*) [91E0]	River Corrib Valley and Coolagh Lakes, Terryland Stream Valley, and Ballindooley Lough	✓

Table 4.3.6 Ecological sites within the scheme study area

Ref. No.	Ecological Site Name	Description[13]
EC03	An Baile Nua to Bearna	Dry grassland and dense bracken with small areas of saltmarsh [1330], dry heath [4030], shingle vegetation [1220] and blackthorn/gorse scrub also present.
EC04	Bearna to Rusheen Bay	Grassland habitats (wet grassland frequent) with small areas of saltmarsh [1330], shingle vegetation [1220], conifer plantation and scrub also present.
EC05	Na Foraí Maola Thiar_1	Abandoned agricultural fields overgrown by dense bracken and scrub. Some outcropping granite and dry heath [4030] on elevated ground in the centre of the site. Grazed areas in the north and south of the site were characterised by acid/wet grassland fields.
EC06	Na Foraí Maola Thiar_2	Abandoned agricultural fields covered by dense scrub and bracken with a few small areas of more open grassland at the northern and southern

[13] where Annex I habitat types are present, the corresponding Annex I habitat code are given in parenthesis - see the *Interpretation Manual of European Union Habitats* (European Commission, 2007)

Ref. No.	Ecological Site Name	Description[13]
		extremities of the site. Remnant patches of dry heath [4030] were present in the northern part of the site, covering an area of only 2m^2.
EC07	Na Foraí Maola Thoir_1	Abandoned agricultural fields covered by dense scrub and bracken.
EC08	Na Foraí Maola Thior_2	Abandoned agricultural fields covered by dense scrub and bracken. Small marsh area in the east of the site.
EC09	Bearna	Complex of abandoned and low intensity farmland with large areas overgrown by dense scrub and bracken. The northern part of the site was mostly low-lying fields of wet grassland with small, localised areas of dry heath [4030], wet heath [4010] and *Molinia* meadow [6410]. The central and southern parts of the site were drier with more improved or semi-improved grasslands.
EC10	Knockaunnacarragh	Complex of abandoned and low intensity farmland with large areas overgrown by dense scrub and bracken. The northern part of the site mostly supported species-poor wet grassland and semi-improved acid grassland. The central part of the site supported small areas of dry heath [4030], wet heath [4010], *Molinia* meadow [6410], and *Nardus* grassland [6230].
EC11	Na Foraí Maola Thiar_3	Large complex of peatland habitats including lowland blanket bog [*7130], *Rhynchosporion* depressions [7150], heath [4030, 4010], and *Molinia* meadow [6410]. Although portions of the site had been damaged by grazing, cutting, burning and drainage, much of the site was still an active peatland and was connected to a larger expanse further to the west. The eastern margins of the site consisted of abandoned and low intensity farmland with large areas in the south-east overgrown by dense bracken and scrub.
EC12	Na Foraí Maola Thoir_3	Dry and wet heath [4030, 4010] present on higher ground in the centre of the site with much of the remainder consisting of abandoned agricultural fields covered by dense scrub and bracken, or low intensity farmland.
EC13	Na Foraí Maola Thior_4	Low hill of outcropping siliceous rock supporting a mosaic of peatland habitats [*7130, 7150, 4010, 4030]. Much of the site was disturbed, with bare peat present; yet pockets of bog habitats were found to persist in the hollows. The north-eastern part of the site had some low intensity agricultural fields (wet/acid grassland) with scrub encroachment evident.
EC14	Trusky West/Ahaglugger	Mosaic of wet and dry heath habitats [4010, 4030], with a small area of blanket bog [*7130], in the northern part of the site with scrub encroachment evident. The southern portion of the site comprised a complex of abandoned and low intensity farmland with areas overgrown by dense scrub and bracken.
EC15	Lough Inch Shore South	A series of small, low-lying fields, mostly covered by wet grassland and scrub, and many of which have been abandoned. Small patches of *Molinia* meadow [6410] were present [6410]. Core area of peatland habitats on the shore of Lough Inch and Loughinch River: lowland blanket bog [*7130], *Rhynchosporion* depressions [7150], and heath [4010, 4030]. Also includes Lough Inch which was classified as an Annex I lake habitat [3110, 3130].
EC16	Lough Inch East	Low-lying agricultural wet grassland fields with encroaching scrub in the western part of the site (with some scrub clearance underway). The eastern part of the site was comprised mainly of wet heath [4010] with patches of blanket bog [*7130], *Rhynchosporion* depressions [7150], and dry heath [4030] present; grading to abandoned/low-intensity

Ref. No.	Ecological Site Name	Description[13]
		agricultural wet grassland fields and scrub/bracken along the southern margins.
EC17	An Chloch Scoilte/Aille	Core area of wet heath [4010], with small patches of dry heath [4030] and blanket bog [*7130], surrounded by wet/acid grassland fields and patches of scrub. A small Sitka spruce plantation was present in the south-western corner.
EC18	Aille South	Dry heath [4030], scrub and outcropping rock on higher ground grading to wet heath [4010] and acid/wet grassland in lower lying areas north of Bearna Woods. Much of the land was unmanaged or partially grazed and the habitats formed a mosaic of acid grassland, scrub and bracken. Localised patches of *Molinia* meadow [6410] were also present.
EC19	Aille North	Wet and dry heath complex [4010, 4030] in the centre of the site, with more isolated patches at the eastern end. Interspersed with wet/acid grassland fields and scrub. Considerable disturbance (vegetation clearance and grazing) evident in places.
EC20	Cappagh/Keeraun	Large complex of blanket bog [*7130] and heath [4010, 4030] with small areas of transition mire [7140] and *Molinia* meadow [6410]. Extensive bracken and gorse cover in the southern part of the site; some of which had been cleared for development.
EC21	Ballyburke	Small pockets of wet and dry heath present in the southern and northern parts of the site. The remainder consisted of a mosaic of improved agricultural grassland, semi-improved wet/acid grassland fields, and extensive scrub and bracken cover.
EC22	Tonabrocky	Includes a large complex of peatland habitats with the Moycullen Bogs NHA: blanket bog [*7130], *Rhynchosporion* depressions [7150], transition mire [7140], and wet and dry heath [4010, 4030]. Transition mire habitat supports a population of the FPO protected plant species Slender cottongrass *Eriophorum gracile*. There was a small area of calcareous grassland [6210] along an access track to the bog. A second peatland area was present to the east of the NHA, somewhat degraded, surrounded by a mosaic of wet/acid grassland fields, swamp and fen [7230], scrub, and bracken.
EC23	Tonabrocky to Rahoon	Isolated patches of wet/acid grassland, scrub and bracken; includes one small marsh area.
EC24	Boleynasruhaun	Isolated areas of wet and dry heath [4010, 4030], with small areas of transition mire [7140] and blanket bog [*7130], and wet/acid grassland, improved agricultural grassland, and some scrub/bracken cover. There was a block of conifer plantation present in the western part of the site.
EC25	Ballagh/Leiteragh	Includes a complex of peatland habitats within the Moycullen Bogs NHA: blanket bog [*7130], *Rhynchosporion* depressions [7150], transition mire [7140], and wet and dry heath [4010, 4030]. There were also two small lakes [3160] within the NHA boundary. To the east of the NHA there were isolated patches of dry heath [4030] amongst wet/acid grassland fields, scrub and bracken; and a grassland meadow [6510] to the north.
EC26	Gortacleva	Small elevated site dominated by a mosaic of wet grassland, scrub and bracken. A small Annex I grassland meadow [6510] was also present.
EC28	Glenlo Abbey Hotel and Riverbank	Complex of alluvial woodland [91E0], blanket bog [*7130], wet woodland, wet grassland and scrub along the River Corrib valley.
EC29	Kentfield	Linear strip of grassland habitats, including calcareous grassland [6210], and scrub along the old Galway to Clifden rail line.

Ref. No.	Ecological Site Name	Description[13]
EC30	Kentfield/NUI Galway Recreational Facilities	Planted amenity mixed broadleaved woodland within the grounds of NUI Galway.
EC31	Dangan	Alluvial woodland [91E0], calcareous grasslands [*6210, 6510] surrounded by areas of broadleaved woodland (with patches of native and non-native species), scrub and wet grassland, within the grounds of NUI Galway.
EC33	Coolanillaun/Menlough West	Patch of alluvial woodland [91E0] at Menlo Pier; grassland meadows south of Menlough Village; and, a complex of limestone pavement [*8240] and calcareous grassland [6510 and 6210] to the north of the village.
EC34	Menlough South to Jordan's Island	Strip of calcareous grassland meadow [6510] along the bank of the River Corrib
EC35	Menlough North-East	Mosaic of semi-natural woodland, scrub and grassland meadows which contains small patches of limestone pavement [*8240], a turlough [*3180], and an area of calcareous grassland meadow [6510].
EC36	Menlough East	Small isolated pockets of habitat surrounded by the Lough Corrib cSAC which include: agricultural grasslands, calcareous grasslands [*6210, 6210, and 6510], limestone pavement [*8240], and a turlough [*3180].
EC37	Coolagh South	Complex of limestone pavement [*8240] and calcareous grassland [6210] broken up by patches of scrub, semi-natural woodland, agricultural and semi-natural grasslands.
EC38	Coolagh North	Complex of isolated patches of calcareous meadow [6510] and limestone pavement [*8240], and a turlough [*3180] amongst patches of scrub, agricultural and semi-natural grasslands.
EC39	Ballindooley Lough	Semi-natural wetland habitats, including fen and *Molinia* meadow [6410], and wet woodland [91E0] around the shores of Ballindooley Lough [3140] with more isolated patches of limestone pavement [*8240], calcareous grasslands [6210 and 6510], and a turlough [*3180] to the south and south-east. Also a number of smaller water bodies within the wetland complex to the south west of Ballindooley Lough.
EC40	Castlegar/N84	Isolated patch of wooded limestone pavement [*8240] surrounded by scrub and unmanaged grassland fields.
EC41	Castlegar River Valley	The western part of the site is dominated by recently established woodland [91E0] along the Terryland Stream Valley. The eastern part comprises wet and semi-natural calcareous grassland fields [6210 and 6510] along the floodplain with a wooded limestone escarpment [*8240] next to Glenburren Park.
EC42	Ballygarraun Quarry SW	Complex of limestone pavement [*8240] and scrub adjacent to the south-western margins of the quarry. A small marsh area was also present with links to the turlough [*3180] habitat type.
EC43	Ballygarraun Quarry N	Large complex of limestone pavement [*8240] and calcareous grassland [6210 and 6510], semi-natural grassland and scrub along the northern margins of the quarry.
EC44	Ballygarraun Quarry SE	Limestone pavement [*8240] and calcareous grassland [6210], along with semi-natural woodland, scrub and grassland along the south-eastern margins of the quarry.
EC45	Ballygarraun Quarry East	Limestone pavement [*8240] and calcareous grassland [6210], along with scrub, recolonising bare ground and semi-natural grassland along south-eastern margins of the quarry.

Ref. No.	Ecological Site Name	Description[13]
EC46	Pollkeen	Isolated patch of limestone pavement [*8240] and calcareous grassland [6210 and 6510].
EC47	Twomileditch	Isolated patches of limestone pavement [*8240], semi-natural woodland/scrub and semi-natural grassland.
EC48	Cappanabornia	Isolated patch of semi-natural woodland/scrub on the hillside.
EC49	Parkmore	Isolated mosaic of semi-natural woodland/scrub and grassland.
EC51	Brockagh	Large expanse of calcareous grassland [6210 and 6510], the majority of which is overgrown by encroaching scrub, with a remnant patch of limestone pavement [*8240].
EC52	Breanloughaun	Patchy mosaic of semi-natural woodland and grassland, with extensive scrub cover.
EC53	Ballybrit	Isolated, remnant patch of limestone pavement [*8240] with a mosaic of semi-natural and wet grassland within the Galway Racecourse.
EC54	Breanloughaun E	Isolated patch of limestone pavement [*8240], semi-natural woodland/scrub and grassland.
EC55	Merlin Park Woods/Doughiska	Northern part of the site characterised by an expanse of limestone pavement [*8240] and calcareous grassland [6210 and 6510]. The remainder of the site comprises a large expanse of both broadleaved and coniferous woodland habitats with linear strips of calcareous grassland along the road margins that cross the site. Larger areas of Annex I grassland were present amongst the woodland north and south of the R338.
EC56	Doughiska/N6 Roundabout	Patches of limestone pavement [*8240] and calcareous grassland [6210], scrub and semi-natural grassland around the existing N6 junction at Doughiska.
EC57	Ardaun N	Remnant patches of limestone pavement [*8240] and calcareous grassland [*6210 and 6210] amongst scrub, semi-natural grassland fields and improved agricultural grassland.
EC58	Ardaun S	Remnant patches of limestone pavement [*8240] and calcareous grassland [*6210 and 6210] amongst patches of scrub, semi-natural woodland, semi-natural grassland fields and improved agricultural grassland.
EC59	Ardaun West	Isolated patch of wooded limestone pavement [*8240] within the hospital grounds.
EC60	Cartron West	Expanse of limestone pavement [*8240] and calcareous grasslands [*6210, 6210 and 6510] with patches of scrub and semi-natural grassland.
EC61	Cartron East	Isolated patches of semi-natural woodland, grassland, and scrub.
EC62	Deerpark	Remnant, isolated patches of limestone pavement [*8240], a turlough [*3180] and semi-natural woodland.
EC63	Rahoon/Ballymoneen	Mosaic of small patches of scrub, rank grassland, wet grassland, and disturbed/recolonising bare ground.

Aquatic Habitats

The results of the aquatic habitat surveys confirmed the presence of the following aquatic Annex I habitat types within the scheme study area:

- Lough Inch corresponds with *Oligotrophic waters containing very few minerals of sandy plains (Littorelletalia uniflorae) [3110] and Oligotrophic to mesotrophic standing waters with vegetation of the Littorelletea uniflorae and/or Isoeto-Nanojuncetea [3130];* and
- Ballindooley Lough and the Coolagh Lakes correspond with *Hard oligo-mesotrophic waters with benthic vegetation of Chara spp.* [3140].

The results of the aquatic surveys have been incorporated into the habitat map of the Lough Corrib cSAC study area and that of the Ecological Sites – **Figure 4.3.3**. A detailed description of the results of the aquatic surveys is provided in **Appendix A.4.2 Ecological Constraints Report**.

Rare and/or Protected Plant Species

Slender cottongrass *Eriophorum gracile* was the only protected plant species recorded during the course of the habitat surveys. It was recorded at two locations: Tonabrocky Bog and in Coolanillaun. Its presence at Tonabrocky Bog is consistent with the findings of the desktop review; the location at Coolanillaun is a new record.

The presence of the FPO listed bryophyte species Varnished hook-moss was confirmed at Gortachalla, 9.4km to the north of the scheme study area. It was not recorded within the study area during dedicated surveys for this species.

Records of all rare or protected plant species known from the scheme study area, or recorded during the field surveys, are shown on **Figure 4.3.4**.

Bats

The bat surveys carried out as part of the constraints study confirmed the presence of the following bat species from the scheme study area:

- Lesser horseshoe bat *Rhinolophus hipposideros*;
- Whiskered bat *Myotis mystacinus*;
- Natterer's bat *Myotis nattereri*;
- Daubenton's bat *Myotis daubentonii*;
- Leisler's bat *Nyctalus leisleri*;
- Brown long-eared bat *Plecotus auritus*;
- Nathusius' pipistrelle *Pipistrellus nathusii*;
- Common pipistrelle *Pipistrellus pipistrellus*; and
- Soprano pipistrelle *Pipistrellus pygmaeus*.

Overall, 90 bat roosts were identified from the surveys undertaken, broken down as follows: 24 Lesser horseshoe bat roosts; two Whiskered bat roost; four Natterer's roosts; eight Daubenton's bat roosts; three Leisler's bat roosts; 14 Brown long-eared bat roosts, five Common pipistrelle roosts; twenty-nine Soprano pipistrelle roosts; and, one pipistrelle roost (species unknown) – see **Figures 4.3.11 – 4.3.16**.

The area used by the Menlough Lesser horseshoe bat population was assessed through the combination of radio-tracking surveys, building and cave inspections, and the results of detector surveys – this included identifying roosting sites (including maternity, mating and hibernation sites), foraging areas and commuting

routes. The full results of the Lesser horseshoe bat surveys are shown on **Figure 4.3.12**.

The result of the bat surveys, which include detector records, roost sites, and any identified commuting routes or foraging areas, are shown on **Figures 4.3.11 – 4.3.16**.

Otter

Otter activity was present throughout the surveyed area, extending from the shores of Lough Corrib at Coolanillaun to the Salmon Weir in Galway City. The highest concentration of Otter activity was recorded at Coolanillaun, which included numerous couch/holt sites. The results of the Otter survey are shown on **Figure 4.3.17**.

White-clawed crayfish

There were no White-clawed crayfish recorded at any of the survey sites within the scheme study area and no other evidence of the presence of the species within the scheme study area was observed (i.e. Otter spraints will commonly contain crayfish remains if they form part of their diet). The locations of the survey sites are shown on **Figure 4.3.18.**

Freshwater pearl mussel

There were no populations, or individual records, of the Freshwater pearl mussel recorded within the scheme study area. However, a portion of the north-western part of the study area does fall within the catchment of the Knock and Lough Inch Rivers (**Figure 4.3.19**), where there is a Freshwater pearl mussel population present.

Other Annex II molluscan species

The *Vertigo* species surveys found no nationally or internationally rare or protected molluscan species within the scheme study area. A total of 39 molluscan species were recorded with the species assemblage considered to be of local interest in some survey sites. The full list of molluscan species recorded are provided in **Appendix A.4.2 Ecological Constraints Report**.

Marsh fritillary

The majority of the suitable Marsh fritillary habitat within the scheme study area was recorded in the upland areas, west of the N59 (*c.*81%). Patches of suitable habitat were also recorded at Kentfield, Killeen, Coolanillaun, Coolagh, Ballindooley, Galway Racecourse, Ardaun, and Cartron. A total of 111 larval web locations were recorded and mapped. With the exception of a record from Galway Racecourse, two records from Cartron, and a single record from Kentfield, all larval webs were recorded within the scheme study area were to the west of the N59. The location of the areas of suitable habitat along with the distribution of the larval web sites are shown on **Figure 4.3.20**.

Red grouse

No sightings, or evidence, of Red grouse was recorded during the survey. However, during the course of other survey work in September 2014, evidence of Red grouse (droppings) was recorded adjacent to the scheme study area at Na Foraí Maola/Lough Inch (see **Figure 4.3.21**).

Barn owl

A total of 76 sites were comprehensively surveyed for the presence of Barn owls in the scheme study area; with the presence of Barn owl confirmed at five of these. These included two castles (nest sites at Menlo Castle and Ardfry House), a ruined mansion (roost site at Rinville House), a derelict two-story farmhouse and a quarry (both roost sites). The distribution of all recorded Barn owl sites is shown on **Figure 4.3.22**.

All records of other raptor species encountered during survey work or known to be active within the scheme study area in 2014 are shown on **Figure 4.3.22**. A total of 17 other raptor sites were confirmed, which included eight Kestrel sites (three nests and five roosts), six Peregrine sites (three nests and three roosts), two Sparrowhawk sites (one nest and one displaying pair) and a single Long-eared Owl nest.

Wintering Birds

The wintering bird surveys covered a total of 60 sites across the scheme study area (**Figure 4.3.23**). These included wetlands, peatlands, coastal sites, farmland, amenity and recreational grasslands. Provisional survey results indicate 76 bird species were recorded across the study area including:

- 6 bird species listed on Annex I of the EU Birds Directive;
- 13 Qualifying Interests of Inner Galway Bay SPA;
- 7 Qualifying Interests of Lough Corrib SPA;
- 13 bird species on the BoCCI Red List; and
- 28 bird species on the BoCCI Amber List.

The full list of bird species recorded during the wintering bird surveys is provided in **Appendix A.4.2 Ecological Constraints Report**.

4.3.4 Summary

Given the legal protection and conservation importance afforded to these sites under the Habitats and Birds Directives, the most significant ecological constraints within the scheme study area, and those most likely to have the greatest effect on the option selection process, relate to European protected sites and the suite of habitats and species they support. Bisecting the scheme study area, the Lough Corrib cSAC is the most significant ecological constraint as it will likely be affected by any options considered as part of the N6 Galway City Transport Project at the option selection stage.

Nationally designated sites are also present within the scheme study area: Moycullen Bogs NHA, Galway Bay Complex pNHA and Lough Corrib pNHA (the majority of which are overlap with the boundaries of Lough Corrib cSAC/SPA, Galway Bay Complex cSAC, and Inner Galway Bay SPA).

Outside of the designated sites for nature conservation there are areas of Annex I habitat types present, populations of Annex II and Annex IV species and the associated habitats that support these species, plant and fauna species protected under national legislation – many of which are vulnerable to impacts from road developments and are, based on current population trends, of conservation concern

- which are likely to be affected by options being considered at the option selection phase.

The results of the desktop review and field surveys have highlighted the diversity of flora and fauna species both within Galway City and its environs and the range of ecological constraints to be considered at the option selection stage of the N6 Galway City Transport Project.

4.3.5 References

Browne, A., Connolly, K., McDonnell, R, Peppiatt, C., Springer, S, Williams, C. & Fuller, J. (2009) *The Bearna Woods Project, Biodiversity Report*. Galway City Council.

Browne, A. & Fuller, J. (2009) *Merlin Park Woodland Habitat Survey and Management Plan*. Galway City Council.

Colhoun, K. & Cummins, S. (2013) *Birds of Conservation Concern in Ireland 2014-2019. Irish Birds 9*:523-544.

Curtis, T.G.F., & McGough, H.N. (2005) *The Irish Red Data Book, 1 Vascular Plants*. Updated Version.

Environmental Protection Agency. **(**2002) *Guidelines on the information to be contained in Environmental Impact Statement.* Environmental Protection Agency. Wexford.

Environmental Protection Agency. (2003) *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements).* Environmental Protection Agency. Wexford.

Galway Harbour Company. (2014) *Galway Harbour Extension Environmental Impact Statement*.

Institute of Ecology and Environmental Management. (2006) *Guidelines for Ecological Impact Assessment. Institute of Ecology and Environmental Management*

National Roads Authority. (2008) *Environmental Impact Assessment of National Road Schemes – A Practical Guide*. National Roads Authority.

National Roads Authority. (2009a) *Ecological Surveying Techniques for Protected Flora and Fauna during the Planning of National Road Schemes*. National Roads Authority.

National Roads Authority. (2009b) *Guidelines for Assessment of Ecological Impacts of National Roads Schemes: Revision 2*. National Roads Authority.

Roden, C. (2005) *Pseudorchis albida at Doughiska, Galway City – Report of a search in May-June 2005*.

RPS. (2006) *N6 Galway City Outer Bypass. Environmental Impact Statement.* Galway County Council and Galway City Council.

RPS. (2012a) *Flora and Habitat Survey Proposed R336 to N59 Road Scheme, Co. Galway*. Unpublished Report by RPS Planning & Environment Ltd.

RPS. (2012b) *R336 to N59 Road Scheme, Co. Galway Marsh Fritillary Survey Report*. Unpublished Report by RPS Planning & Environment Ltd.

RPS. (2013a) *R336 to N59 Road Scheme, Co. Galway Bat Survey Report*. Unpublished Report by RPS Planning & Environment Ltd.

RPS. (2013b) *R336 to N59 Road Scheme, Co. Galway Mammal Survey Report*. Unpublished Report by RPS Planning & Environment Ltd.

RPS. (2013c) *R336 to N59 Road Scheme, Co. Galway Wintering Bird Survey Report*. Unpublished Report by RPS Planning & Environment Ltd.

Stanley, C. (2013a) *The Butterflies of Merlin Woods*. Friends of Merlin Woods.

Stanley, C. (2013b) *The Wildflowers of Merlin Woods*. Friends of Merlin Woods.

4.4 Soils and Geology

4.4.1 Introduction

This section describes the soils and geological constraints identified within the scheme study area for the N6 Galway City Transport Project. Soils and geological constraints are presented in **Figures 4.4.1** to **4.4.11.**

Section 4.4.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.4.3** describes the soils and geological constraints identified within the scheme study area. A summary is presented in **Section 4.4.4** and references are listed in **Section 4.4.5.**

4.4.2 Methodology and Sources of Information

4.4.2.1 Methodology

This assessment was prepared taking cognisance of the requirements of the National Roads Authority (NRA) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA 2009* which in this report is referred to as the NRA guidelines.

The assessment is based on the results of a desk study, ground investigation results and fieldwork survey. The desk study included a review of the information sources listed in **Section 4.4.2.2** below to identify the constraints associated with soils and geology within the scheme study area.

The desk study also included a detailed review of data to identify potential karst features within the scheme study area and in the surrounding similar limestone area. The desk study was followed by a field survey of the identified karst features in October and November 2014.

A ground investigation was commissioned to investigate the ground conditions in Rahoon in June 2014. Two 30m deep rotary boreholes were drilled in addition to a geophysical survey to estimate the depth to bedrock. A copy of the report of this geotechnical survey is included in **Appendix A.4.3**.

The NRA guidelines provide useful criteria for ranking the importance of the identified soils and geological constraints and these criteria are presented in **Table 4.4.1**. This assessment is generally consistent with the approach presented in the NRA guidelines as the assessment is undertaken using the criteria for importance ranking which inform the assessment of the potential impacts.

Table 4.4.1 Criteria for rating the importance of identified features (based on NRA Guidelines; Box 4.1 entitled 'Criteria for Rating Site Attributes - Estimation of Importance of Soil and Geology Attributes')

Importance	Criteria	Typical Example
Very High	Attribute has a high quality, significance or value on a regional or national scale. Degree or extent of soil contamination is significant on a national or regional scale.	Geological feature rare on a regional or national scale (NHA). Large existing quarry or pit proven economically extractable mineral resource.

Importance	Criteria	Typical Example
	Volume of peat and/or soft organic soil underlying route is significant on a national or regional scale.	
High	Attribute has a high quality, significance or value on a local scale. Degree or extent of soil contamination is significant on a local scale. Volume of peat and/or soft organic soil underlying route is significant on a local scale.	Contaminated soil on site with previous heavy industrial usage. Large recent landfill site for mixed wastes. Geological feature of high value on a local scale (County Geological Site). Well drained and/or highly fertility soils.
Medium	Attribute has a medium quality, significance or value on a local scale. Degree or extent of soil contamination is moderate on a local scale. Volume of peat and/or soft organic soil underlying route is moderate on a local scale.	Contaminated soil on site with previous light industrial usage. Small recent landfill site for mixed wastes. Moderately drained and/or moderate fertility soils. Small existing quarry or pit.
Low	Attribute has a low quality, significance or value on a local scale. Degree or extent of soil contamination is minor on a local scale. Volume of peat and/or soft organic soil underlying route is small on a local scale*.	Large historical and/or recent site for construction and demolition wastes. Small historical and/or recent landfill site for construction and demolition wastes. Poorly drained and/or low fertility soils. Uneconomically extractable mineral resource.

** relative to the total volume of inert soil disposed of and/or recovered*

4.4.2.2 Sources of Information

The following sources of information were reviewed as part of the constraints study to identify soils and geological constraints within the scheme study area:

- Current and historical Ordnance Survey maps available for the scheme study area (1:2,500 and 1:10,560 scales);
- Aerial photography (2012) of the scheme study area;
- Geological maps of the site area produced by the Geological Survey of Ireland (GSI) (www.dcenr.gov.ie):
  - Bedrock Geology;
  - Karst Features;
  - Aquifer Classification;
  - National Draft Generalised Bedrock map;
  - Aggregate Potential;
  - National Groundwater Vulnerability; and
  - Landslides.

- MacDermot, C.V., McConnell, B. and Pracht, M. (2003) *Geology of Galway Bay 1:100,000 scale Bedrock Geology Map Series*, Sheet 14, Galway Bay, Geological Survey of Ireland;
- Teagasc and the Environmental Protection Agency Irish Soil Information System (http://gis.teagasc.ie/soils/index.php);
- Ground investigation reports held by the Geological Survey of Ireland for the scheme study area;
- Aerial imagery from Google (imagery from 2001 to 2014) and Bing accessed in 2014;
- Ground investigation reports held by Arup for the scheme study area;
- A ground investigation commissioned for this constraints study;
- Flood, P. and Eising, J. (1987). *The use of vertical band drains in the construction of the Galway Eastern Approach Road*. Proceedings of the 9th European Conference on Soil Mechanics and Foundation Engineering, Dublin, Ireland;
- Gannon, M.J. (year unknown). Corrib Quincentenary Bridge, Paper presented to Engineers Ireland;
- Lidar elevation data provided by a third party information provider;
- Results from karst field surveys carried out in October and November 2014;
- Constraints reports from the previous N6 Galway City Outer Bypass Scheme (GCOB):
    - Galway City Outer Bypass R336 Western Approach Constraints Study Report 2000; and
    - N6 Galway City Outer Bypass Constraints Study Report (2000).
- N6 Galway City Outer Bypass Environmental Impact Statement (2006).

Consultation was carried out with the relevant bodies as detailed below:

- Geological Survey of Ireland;
- Teagasc;
- Office of Public Works (OPW);
- Galway County Council;
- Galway City Council;
- Environmental Protection Agency (EPA);
- National Parks and Wildlife Services (NPWS); and
- Landowners.

Topographical Maps

The Ordnance Survey of Ireland (OSI) Discovery Series Map 46 and 52: Galway, 1:50,000 scale and a digital topographical survey, imported as a data set into Geographical Information System (GIS), were reviewed in relation to the proposed scheme.

A number of historical maps for the scheme location were also available through Ordnance Survey Ireland:

- Ordnance Survey Ireland (OSI) 6 inch mapping series, Galway, 1:10,560, 1837 – 1842; and
- Ordnance Survey Ireland (OSI) 25 inch mapping series, Galway, 1:2,500, 1888 – 1913.

Geological Maps and Memoirs

A series of geological maps were available through Geological Survey Ireland (GSI) (www.gsi.ie), Environmental Protection Agency and the Irish Historical Geological Maps website. Additional information was available from research theses carried out by researchers at NUI, Galway.

Drift Maps

The following drift maps were reviewed:

- Subsoil map (Teagasc Classification) and 'Soil Parent Material Classification and Map Codes' (Teagasc 2004); and
- 1:575,000 general soil map of Ireland and the accompanying soil survey bulletin (Gardiner and Radford, 1980), The National Soil Survey, An Fóras Taluntais.

The following datasets from the Geological Survey of Ireland (GSI) (http://www.dcenr.gov.ie/Spatial+Data/Geological+Survey+of+Ireland/GSI+Spatial+Data+Downloads.htm [30 September 2014]) were used:

- Quaternary Geology of Ireland (1:50,000 scale).

The following datasets from Teagasc and the Environmental Protection Agency (EPA) (http://gis.epa.ie/GetData/Download [30 September 2014]) were used:

- Teagasc-EPA Soils; and
- Teagasc-EPA Subsoils.

Solid Geology

The following datasets and maps were available through the GSI (http://www.dcenr.gov.ie/Spatial+Data/Geological+Survey+of+Ireland/GSI+Spatial+Data+Downloads.htm [30 September 2014]):

- Bedrock Geology of Ireland (1:100,000 scale);
- Grouped Rock Units / National Draft Generalised Bedrock Map for Groundwater;
- Geological Map – Sheet 14 Geology of Galway Bay (Geological Survey of Ireland 1:100,000 Bedrock Geology Map); and
- Geological 'Memoir' – Geology of Galway Bay. Pracht, M; Lees, B; Leake, B; Feely, M; Long, B; Morris, J. and McConnell, B. (2004) A Geological Description to Accompany the Bedrock Geology 1:100,000 Scale Map Series, Sheet 14, Galway Bay.

Aerial Photographs

Aerial photography of the study area dating from 1995, 2000 and 2005 was available from the Ordnance Survey of Ireland records.

Aerial photography from Bing and Google maps has been used as a preliminary source to identify surface features such as potential buried karst features.

A comparison was carried out between the historic aerial photography from OSI and with recent images from Bing and Google. Any changes in the land form (surface anomalies, unusual features) between aerial photography were noted and marked for assessment during the site walkover.

Walkover inspections of areas of potential karst features have been carried out to confirm the aerial photography findings.

Records of Mines and Mineral Deposits

In order to identify aggregate and mineral extraction sites near to and on the proposed route corridors and to establish any that may have an impact on the construction works the following datasets from the Minerals Ireland online database, available through Geological Survey of Ireland (http://www.dcenr.gov.ie/Spatial+Data/Geological+Survey+of+Ireland/GSI+Spatial+Data+Downloads.htm [30 September 2014]) were examined:

- GSI Quarry Directory; and
- Mineral locality database, minlocs.shp.

Land Use and Soil Survey Information

Land use in the area has been identified by Co-ordinated Information on the Environment (CORINE) (http://gis.epa.ie/GetData/Download [30 September 2014]) and from walk over surveys of the study area.

Existing Ground Investigations

A compilation of previous ground investigation reports has been compiled from the GSI, Galway County Council, Galway City Council, NUI, Galway, Arup and other consultants. A ground investigation consisting of two rotary core boreholes and geophysical surveys was carried out in Rahoon for this project in 2014.

4.4.3 Existing Environment

This section describes the soils and geological constraints identified within the scheme study area. Constraints associated with geomorphology, solid geology, soils and superficial deposits, manmade geological features, landfills, contaminated land, licenced facilities and geological heritage within the scheme study area are described. Soils and geological constraints are presented in **Figures 4.4.1** to **4.4.11.**

4.4.3.1 Geomorphological Study

Geomorphology is the study of the landforms which comprise the earth's surface, the processes which have modified and shaped it in the past and which continue to modify and shape it at the present time. The majority of Irish landforms are derived from mountain building events which occurred in the geologic past and more recent sculpting during the last ice age. The geomorphic processes in action at the present time are erosion and deposition which are driven by ice, water and wind.

The geomorphology of the western part of the scheme study area consists of gently undulating to hummocky topography in areas overlying granite. The ground level

is lowest at the shores of Lough Corrib and along the coast (10 mOD) and rises to the high points at Gortacleva/Tonabrocky (111m OD), Derry Crih (96 m OD) and Corcullen (90 mOD). Ridge lines exist at Tonabrocky and Derry Crih which run northwest-southeast.

The topography to the east of the scheme study area is less pronounced than in the west. The area around the River Corrib is relatively flat and rises to the east. The highest point is at Castlegar-Coolagh Hill (65 mOD). From this high point the ground surface gently slopes towards Ballindooley Lough and rises again towards Twomileditch (60 mOD).

The constraints associated with hydrology within the scheme study area are described in Section 4.6 Hydrology. Water has a significant influence on the deposition of soft ground. The larger the river the more likely that there will be significant deposits of soft ground.

The largest river in the scheme study area is the River Corrib. The River Corrib drains Lough Corrib and flows south discharging into Galway Bay. Soft sediments have been deposited at the head of the river. Approximately 2 km from the outflow location the River Corrib branches off into the Terryland River which typically flows east and discharges into two swallow holes. Numerous smaller streams are located to the west of the River Corrib. These streams drain south directly into Galway Bay or the River Corrib. To the east, the area is notably absent of surface water drainage, suggesting that the karstic landscape results in surface water seeping downwards.

A bathymetric survey of the River Corrib (www.corribcharts.com) suggests that mean water depths are typically 2.0 – 5.0m deep at the upper reaches of the river. A depression in the river bed, up to 17m deep, is located where the river changes direction. The depression is likely to be a scour feature.

There are extensive soft soil deposits in the Terryland River Valley which is bounded to the north, south and east by outcrops of carboniferous limestone and glacial till. Historical mapping shows that part of the valley was a lake bed and/or prone to flooding until land reclamation works began in the 1850s as part of the Famine Relief Scheme (Hunt, 1991).

4.4.3.2 Solid Geology

In general the solid geology within the scheme study area comprises Carboniferous limestone to the east of the N59 which uncomfortably overlies Devonian and Ordovician intrusive igneous rocks which outcrop in the west. The formations are described in **Table 4.4.2** and are presented on **Figure 4.4.3**.

Figure 4.4.3 is based on the Geological Survey of Ireland information with some modifications based on the desk study information. The geological boundary has been reconfigured in the vicinity of the Quincentenary Bridge based on the results of the boreholes records for the bridge foundations which suggest the presence of metamorphic bedrocks exist underneath the river in the crossing location.

Table 4.4.2 Rock formations within the scheme study area

Geological period	Bedrock Unit	Formation	Description
Carboniferous	Dinantian Pure Bedded Limestone	Visean Limestone (undifferentiated)	Undifferentiated limestone succession.
Early-middle Devonian	Granites and other Igneous Intrusive Rocks	Murvey Granite	Fine grained, aphyric, felsic granite, contains almandine – spessartine-bearing aphlites.
		Errisbeg Townland Granite	Coarse grained, pink, phenocrystic K-feldspar granite, phenocrysts up to 40mm in longest dimension.
		Porphyritic-Megacrystic Granite	Coarse Grained, pink, phenocrystic K-feldspar granite, commonly foliated, phenocrysts up to 80mm in longest dimension.
		Fine grained Foliated Granite	
		Quartz Porphyry and Felsite	Phenocrysts of quartz and plagioclase, and sometimes K-feldspar, in a fine or glassy matrix.
Ordovician	Granites and other Igneous Intrusive Rocks	Metagrabbo and orthogneiss suite (undifferentiated)	Undifferentiated metagabbro and related lithologies (mg), quartz diorite gneiss (Qd) and granite K-feldspar gneisses (Qg).

Carboniferous

Visean limestone is present in the east of the scheme study area. The undifferenciated limestone bedrock is pale to medium grey, bedded, bioclastic, fossiliferous, and coarse to medium grained limestone. It is generally not argillaceous (clayey) containing few shale beds and consists of almost completely pure limestone ($CaCO_3$). Bedding becomes thinner with depth.

The limestone is highly karstified and karst features including conduits, springs, turloughs and swallow holes are common. Detailed investigation results presented in the N6 GCOB EIS in 2006 indicate a weak to well-developed zone of epikarst extends up to 5.9 meters in thickness along the path of the 2006 GCOB Scheme.

Epikarst describes the highly weathered bedrock between the overburden and the competent unweathered bedrock. Intense karstification, typically at joints, has led to deeper weathering below the epikarst resulting in dissolution features which can become infilled with sediment.

There are no recorded faults within the limestone in the scheme study area. The depth to rock along the 2006 GCOB Scheme varies from rock exposed at the surface to a depth to bedrock greater than 27 meters. This depth to bedrock was measured during detailed site investigations undertaken for the EIS during the 2006 GCOB Scheme.

The unconfined compression strength of the limestone was measured during the 2006 GCOB Scheme and also a number of ground investigations across the east of

the scheme study area. The data suggests that a significant proportion of the rock is classified as strong to very strong using BS 5930:1999. This suggests that mechanical excavation alone may not be productive and blasting using explosives or expansion grout may be required to efficiently remove limestone rock. The use of explosives in limestone areas with a potential for karst features needs to be carefully managed.

The main geotechnical constraint with respect to the limestone comprises the karst features. Karst features present areas of weakness which can collapse when loaded and areas or variable ground conditions where material which has filled collapsed karst features may have different geotechnical properties to the surrounding limestone.

Devonian

Early to middle Devonian bedrock is present in the west of the scheme study area. The rock units consist of granites which are part of the Galway Granite Batholith.

The granite is generally described as fine to coarse grained pale grey or pink granite. Intrusive investigations within the scheme study area revealed strong pink and grey medium to coarse grained granite, strong light grey fine-grained crystalline andesite, strong pink grey diorite and strong green grey rhyolite. Exposed granite in quarries is noted to be green grey and purple, coarse grained and contain widely to very widely spaced discontinuities.

Discontinuities are generally described as smooth, although occasionally smooth to rough, and planar to undulating, although occasionally stepped. The orientations of the discontinuities are generally random.

The granite contains pale cream coarsely crystalline veins which consist mainly of quartz. Talc and serpentine veins are also present and prone to erosion.

The granite bedrock contains a number of notable faults. The more significant fault is the Bearna fault which is in a North Northwest- South Southeast direction.

The contact between the limestone and granite is well defined. At the contact point the granite is described as strong green grey and grey.

The depth to bedrock is generally less than 3.0 meters although it varies from 0.5 meters to 13.6 meters. It is likely that blasting or chemical splitting of the granite would be necessary to excavate large volumes of rock. Two boreholes were drilled to 30metres depth at Rahoon as part of this constraints study to investigate the variations in the rock with depth.

The results suggest that the rock would be classified as strong to very strong although some of the unconfined compression results failed at lower stresses. This may be due to the presence of incipient failure planes in the test specimens.

It is considered that are no significant geotechnical constraints associated with the granite.

Ordovician

A small area of Ordovician metagrabbo and orthogneiss is present west of the River Corrib in the centre of the site. The gabbroic rocks are mostly hornblende gabbros or hornblende gabbronorites which are of igneous origin, although some are of

metamorphic origin. A significant part of the formation is inverted as a result of folding.

The orthogneisses is usually rich in quartz and consist of quartz-diorite, tonalite, granodiorite and granite, and alkali granite. It is likely that blasting or chemical splitting of the Ordovician rocks would be necessary to excavate large volumes of rock.

It is considered that are no significant geotechnical constraints associated with the Ordovician rocks.

Summary

The bedrock geology itself presents no constraints for any potential options within the scheme study area. However, where limestone is present care should be taken as there is a potential for karst features to be encountered. Karst features are discussed further in **Section 4.5 Hydrogeology**.

4.4.3.3 Soils and Superficial Deposits

Soils

The soils in the western side of the study area consist of a mix of peaty podzols, blanket peat, lithosols / regosols and surface water gleys. Made ground is encountered in urban areas. Alluvium deposits and fen peat is encountered along the River Corrib and the Terryland River. The soils in the east of the study area consist predominantly of grey brown podzolics, lithosols peat and renzinas / lithosols.

The subsoils in the study area generally consist of material derived from the underlying bedrock. Therefore, the subsoils in the east of the scheme study area consist of till derived from limestone and in the west the tills are derived from granite bedrock. Occasional granite erratics have been observed in limestone regions in the east. The Environmental Protection Agency (EPA) and Teagasc have produced soils and subsoils maps for Ireland. These maps are presented in **Figures 4.4.4** and **4.4.5** respectively for the scheme study area.

In the central part of the scheme study area, in the vicinity of Galway City, the soils are primarily composed of Made Ground and have no agricultural value. In the wider study area the composition of the soils generally reflects the underlying bedrock parent material. As part of the recharge mapping project the Geological Survey of Ireland (GSI) has assessed the soil drainage properties and this has been incorporated into the importance ranking presented in **Table 4.4.3**.

Table 4.4.3 Importance ranking of soil within the scheme study area

Soil type	Description	Constraints Importance Ranking
Made Ground	Assorted sand, gravel, rubble and organic materials	Medium
AminDW	Deep well drained mineral soils derived from mainly non-calcareous parent materials	High
AlluvMIN	Mineral alluvium	Medium

Soil type	Description	Constraints Importance Ranking
AminPD	Deep poorly drained mineral derived from mainly non-calcareous parent materials	Medium
AminSRPT	Shallow, lithosolic or podzolic type soils potentially with peaty topsoil. Predominantly shallow soils derived from non-calcareous rock or gravels with/without peaty surface horizon	Medium
AminSW	Shallow well drained mineral Derived from mainly non-calcareous parent materials	Very high
BktPt	Blanket peat	High
BminDW	Deep well drained mineral Derived from mainly calcareous parent materials	High
BminPDPT	Poorly drained mineral soils with peaty topsoil Derived from mainly calcareous parent materials	Low
BminSRPT	Shallow, lithosolic or podzolic type soils potentially with peaty topsoil Predominantly shallow soils derived from calcareous rock or gravels with/without peaty surface horizon	Low
BminSW	Shallow well drained mineral Derived from mainly calcareous parent materials	Medium

Superficial deposits

Superficial deposits comprise the unconsolidated geological deposits below the soils which cover the solid geology. The superficial deposits comprise peat, alluvial deposits and glacial deposits and are shown on **Figure 4.4.5**.

Peat covers the area at the southern shores of Lough Corrib and a number of peat bogs are present throughout the scheme study area, particularly in the west, as shown on **Figure 4.4.5.**

Alluvial deposits are present along the banks of the River Corrib.

A buried glaciated channel was encountered in the vicinity of upper reaches of the River Corrib during previous investigations. In the vicinity of the Terryland River, both alluvial and calcareous deposits are likely to be present. The glaciated channel and the alluvial and calcareous deposits may have geotechnical constraints associated with them which will be discussed further below under the heading of Soft/compressible ground.

Made Ground is present extensively in urban areas.

The subsoil thickness is variable; there are considerable portions of the scheme study area where rock is very close or is exposed at the surface.

The superficial deposits themself present no constraints for any potential options within the scheme study area. However, where peat and alluvial deposits are present care should be taken to quanity the deposits present in order to develop engineering design and construction solutions.

Soft/compressible ground

There are soft compressible deposits in the scheme study area as shown on **Figure 4.4.6**. Some of the geotechnical challenges associated with these deposits have been described in a number of technical papers and thesis (e.g. Flood and Eising, 1987, Rodgers and Naughton, 2003, Peters et al., 2012 and others).

There are areas of fens and bogs which provide very poor foundation conditions and are identified in **Figures 4.3.7** and **4.3.8**. These areas typically have a high water table and the soft, compressible materials are difficult to construct on.

There are lake silts, calcareous soils and peat located along the River Corrib, the Terryland River Valley and the Seamus Mulvoy Road. The ground conditions typically consist of a peat over calcareous silt over grey lake silts over glacial till and bedrock. The peat has high moisture and voids content and is prone to significant primary and long term settlements when loaded by embankments. The calcareous silt was formed by calcium rich water seeping upwards from the underlying limestone through lake muds. The deposition of the lake muds and the calcareous soils raised the bed of the lake high enough to support reeds, which in turn resulted in the formation of reed or fen peat (Long and Rodgers, 1995). The soil structure is weakly cemented and a significant loss of strength can occur upon disturbance. The thickness and organic content of the lake silts is variable. These soils are characterised by their low strength and permeability. The presence of these soil deposits would probably require special construction measures such as ground improvement/treatment or a structural solutions such as a piled raft or a piled embankment.

The buried channel discussed above under the heading of Quaternary and Agricultural Soils is infilled with glacial material. Foundations in these materials may need to be deeper and more complex than in adjacent areas where bedrock is shallow. Mitigation measures could involve supporting the temporary works on temporary pile foundations or using floating cranes in the river.

Areas of Made Ground are typically areas associated with the major urban developments. These are also considered as geological constraints as they can be sources of contamination or may be loosely compacted and of varying engineering properties.

Soft/compressible ground itself presents no constraints for any potential options within the scheme study area. However, where present care should be taken to establish the footprint and extent in order to develop engineering design and construction solutions.

Karst solution features

The Carboniferous limestone occurring in the constraints study area is known to contain karst solution features. The hydrogeology of karst features is dealt with in **Section 4.5 Hydrogeology**.

The key aspect under consideration in this section is the potential for karst features to have a significant influence on the topography, ground surface and stability of the ground. The eastern part of the study area is underlain by clean limestone where karstification has occurred. A range of solution features were found within the study area. These include:

- weathered rock;
- dolines (enclosed depressions);
- caves;
- estavelles;
- springs;
- wells;
- swallow holes; and
- turloughs.

Limestone pavement has been identified in a number of locations across the scheme study area. These and other known karst features are shown in **Figures 4.4.7** and **4.4.8** and are summarised in **Table 4.4.4**. Some karst features have been identified outside the scheme study area due to the potential interaction between different karst features but have not been included in this table.

In general karst soils and geology features encountered are ranked as low or medium importance. One karst feature ID K89, a cave identified on the GSI karst database, is ranked as high importance. This site is listed in the SEA Environmental Report of Galway City Development Plan as a County Geological Site and may be recommended for geological National Heritage Area designation in the future.

Table 4.4.4 Karst Features and Limestone Pavement within the Scheme Study Area

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K1	Enclosed Depression	Lidar, Bing Maps	Low
K2	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water line	Medium
K3	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K4	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K5	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K6	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K7	Spring	Field Survey	Medium
K9	Spring	Field Survey	Medium
K10	Enclosed Depression	Field Survey	Low
K11	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K12	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K14	Spring	Lidar, OSI Water line	Medium
K15	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K17	Spring	Field Survey	Medium
K18	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K19	Spring	Lidar, OSI Water line	Medium
K20	Turlough	Scott Cawley Ecologists Surveys	Medium
K21	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K25	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water line	Medium
K31	Turlough	Scott Cawley Ecologists Surveys	Medium
K37	Enclosed Depression	Field Survey	Low
K39	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K40	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K44	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K45	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water line	Medium
K49	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K50	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K51	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K54	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K57	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K59	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K61	Enclosed Depression	Field Survey	Low
K62	Enclosed Depression	Field Survey	Low
K64	Enclosed Depression	Field Survey	Low

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K65	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K66	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K67	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K69	Enclosed Depression	Field Survey	Low
K70	Enclosed Depression	Field Survey	Low
K71	Enclosed Depression	Field Survey	Low
K72	Turlough	Scott Cawley Ecologists Surveys	Medium
K73	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K74	Turlough	Ecologists survey, Lidar, Bing Maps, Google Maps, Aerial Photography	Medium
K75	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K76	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K77	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K81	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K82	Enclosed Depression	Field Survey	Low
K83	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K85	Enclosed Depression	Field Survey	Low
K86	Estavelle	EIS N6 Galway City Outer Bypass Vol 2 2006	Medium
K87	Spring Swallow Hole	GSI Database: Well survey carried out by Bride Naughton GSI 1972, Lidar, Bing Maps, Google Maps, Aerial Photography	Medium
K88	Enclosed Depression	Field Survey	Low
K89	Cave	GSI Database: Six inch map	High
K90	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K92	Well	Field Survey	Medium
K94	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K95	Swallow Hole	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K96	Spring Swallow Hole	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K97	Turlough	Lidar, Bing Maps, Google Maps, Aerial Photography	Medium
K98	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K99	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water line	Medium
K100	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K104	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K112	Enclosed Depression	Field Survey	Low
K122	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K124	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K126	Spring	Field Survey	Medium
K129	Spring	Field Survey	Medium
K130	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K131	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K132	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography	Medium
K134	Superficial solution features	GSI Database	Medium
K135	Enclosed Depression	Field Survey	Low
K136	Spring	Lidar, Bing Maps, Google Maps, Aerial Photography, OSI Water line	Medium
K140	Spring	Field Survey	Medium
K147	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K151	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K152	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K154	Enclosed Depression	GSI Database: Well survey carried out by Bride Naughton GSI 1972 and Lidar	Low
K158	Spring	OSI Water line map	Medium
K159	Enclosed Depression	GSI database; Well survey carried out by Bride Naughton GSI 1972 and Lidar	Low

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K160	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K161	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K163	Enclosed Depression	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Low
K164	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K165	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K166	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K168	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K169	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K170	Well	Field Survey	Medium
K172	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K173	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K174	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K175	Enclosed Depression	Field Survey	Low
K176	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K178	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K179	Enclosed Depression	Field Survey	Low
K180	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K181	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K184	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K189	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K190	Spring	GSI Database: Well survey	Medium
K192	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Medium
K193	Enclosed Depression	Field Survey	Low

ID code	Karst Feature	Information Source	Constraints Importance Ranking
K198	Enclosed Depression	GSI Database: Well survey carried out by Bride Naughton GSI 1972.	Low
K199	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K201	Enclosed Depression	Field Survey	Low
K202	Enclosed Depression	Field Survey	Low
K203	Enclosed Depression	Field Survey	Low
K204	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K205	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K206	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K207	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K208	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K209	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K210	Spring	GSI Database: Well survey carried out by Bride Naughton GSI 1972. Lidar	Medium
K211	Superficial solution features	GSI database	Medium
K212	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K213	Enclosed Depression	Field Survey	Low
K214	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K215	Enclosed Depression	Field Survey	Low
K216	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K218	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low
K222	Superficial solution features	GSI Database	Medium
K223	Enclosed Depression	Lidar, Bing Maps, Google Maps, Aerial Photography	Low

Slope Stability

The GSI has developed a database of historical landsides in Ireland. This database has been consulted and none of the recorded events lie within the study area.

There are known instances of embankment failures constructed in the Terryland River Valley.

These failures are due to the presence of very soft soils described previously.

Areas containing slopes are located at the areas of higher elevation at Corcullen and Tonabrocky. Uncontrolled disturbance of such upland bogs can lead to slope failure and landslides. These slopes require further investigation during the options stage to mitigate against potential landslides.

In order to assess the stability of potential rock cuttings, it is important to identify the orientation of present discontinuities, their condition and also the extent of weathering present during the detailed site investigation.

The Carboniferous limestone rock may be susceptible to cutting instability because of the complex geological structure. Cutting stability within the limestone rocks shall also have to be carefully considered due their potential for karst weathering.

Mining Areas

There are no recorded mines located within the study area that would cause a concern with regard to ground stability.

4.4.3.4 Man-made features

Economic geology

The economic geological features pits and quarries in the scheme study area have been subdivided into the following categories:

- Disused Quarries of which there are a total of 34 recorded;
- Active Quarries of which there is one recorded; and
- Potential Quarry of which there are none recorded.

The majority of the disused quarries are concentrated in the city centre which were limited in volume. A number of quarries identified within the scheme study area are shown in **Figure 4.4.9** and summarised in **Table 4.4.5**. There is a large active quarry at the Roadstone Quarry, Twomileditch and a large inactive quarry Lackagh Quarry at Menlough.

Investigations are required to determine the exact location of these quarries and what the nature of the backfill materials is

Table 4.4.5 Quarries within the scheme study area

ID	Type	Description	Constraints Importance Ranking
HQ01	Pit	Small historic quarry/pit	Low
HQ02	Quarry	Small historic quarry/pit	Low
HQ03	Pit	Small historic quarry/pit	Low

ID	Type	Description	Constraints Importance Ranking
HQ04	Pit	Small historic quarry/pit	Low
HQ05	Quarry	Small historic quarry/pit	Low
HQ06	Quarry	Small historic quarry/pit	Low
HQ07	Quarry	Small historic quarry/pit	Low
HQ08	Quarry	Small historic quarry/pit	Low
HQ09	Quarry	Small historic quarry/pit	Low
HQ10	Quarry	Small historic quarry/pit	Low
HQ11	Pit	Small historic quarry/pit	Low
HQ12	Pit	Small historic quarry/pit	Low
HQ13	Pit	Small historic quarry/pit	Low
HQ14	Quarry	Small historic quarry/pit	Low
HQ15	Quarry	Small historic quarry/pit	Low
HQ16	Quarry	Small historic quarry/pit	Low
HQ17	Quarry	Small historic quarry/pit	Low
HQ18	Quarry	Small historic quarry/pit	Low
HQ19	Quarry	Small historic quarry/pit	Low
HQ20	Quarry	Small historic quarry/pit	Low
HQ21	Pit	Small historic quarry/pit	Low
HQ22	Quarry	Small historic quarry/pit	Low
HQ23	Pit	Small historic quarry/pit	Low
HQ24	Quarry	Small historic quarry/pit	Low
HQ25	Quarry	Small historic quarry/pit	Low
HQ26	Pit	Small historic quarry/pit	Low
HQ27	Pit	Small historic quarry/pit	Low
HQ28	Quarry	Small historic quarry/pit	Low
HQ29	Pit	Small historic quarry/pit	Low
HQ30	Pit	Small historic quarry/pit	Low
HQ31	Pit	Small historic quarry/pit	Low
HQ32	Pit	Small historic quarry/pit	Low
HQ33	Quarry	Small historic quarry/pit	Low
HQ34	Quarry	Small historic quarry/pit	Low
Q01	Non-Active Quarry: Lackagh Quarries Menlough	Large quarry	Medium
Q02	Active Quarry: Roadstone Quarry, Twomileditch	Large existing quarry	Very High

The GSI Aggregate Potential Mapping tool does not identify any aggregate resources within the scheme study area. The Roadstone Quarry Twomileditch is a major supplier of aggregates for the construction industry in Galway.

Mineral resources in Ireland mapped by the GSI are available. Locations within the scheme study area where mineral resources are present are shown in **Figure 4.4.9**. The importance of these mineral resources are summarised in **Table 4.4.6**. A number of locations contain more than one mineral resource. A unique ID is allocated for each mineral resource at each location.

Table 4.4.6 Mineral resources within the scheme study area

ID	Mineral Resource	Constraints Importance Ranking
MR01	Iron	Low
MR02	Molybdenum	Low
MR03	Copper	Low
MR04	Iron	Low
MR05	Copper	Low
MR06	Iron	Low
MR07	Copper	Low
MR08	Iron	Low
MR09	Molybdenum	Low
MR10	Iron	Low
MR11	Molybdenum	Low
MR12	Copper	Low
MR13	Copper	Low
MR14	Iron	Low
MR15	Fluorspar	Low
MR16	Copper	Low
MR17	Granite	Medium
MR18	Fluorspar	Low
MR19	Granite	Low
MR20	Dimension stone	Low
MR21	Limestone (in general)	Low
MR22	Limestone (in general)	Low
MR23	Granite	Low
MR24	Limestone (in general)	Low
MR25	Sand and gravel	Low
MR26	Granite	Low
MR27	Copper	Low
MR28	Granite	Medium
MR29	Granite	Low
MR30	Dimension stone	Low
MR31	Limestone (in general)	Low
MR32	Dimension stone	Very High
MR33	Limestone (in general)	Very High

Landfills and contaminated sites

In 1996 the EPA began licensing certain activities in the waste sector. These include landfills, transfer stations, hazardous waste disposal and other significant waste disposal and recovery activities. These are potential geological constraints as they may act as areas of contamination.

Two waste licences were issued in the scheme study area as outlined in **Table 4.4.7** and presented in **Figure 4.4.10**. Further details on waste constraints are detailed in **Section 4.16 Waste.**

Table 4.4.7 Waste licenced facilities within the scheme study area

ID	Licence Holder	Type of Facility	Licence Status	Constraints Importance ranking
WL1	Galway City Council	Waste transfer station	Licenced	low
WL2	Galway City Council	Carrowbrowne – composting facility and closed landfill facility	Licenced	low

It has been determined from the EPA website (dated 18 September 2014) that there are no known historical (or 'legacy') landfills within the study area. Historic quarries listed in **Table 4.4.5** can also be potential locations of contaminated land as they are sometimes backfilled by dumping waste.

Licensed industrial and agricultural facilities

Industrial sites may be the source of locally contaminated land due to site activities. However, these sites operate with the EPA Industrial Emissions (IE) licence framework and due to the regulated nature of their activities, the risk of contamination is low. The IE licenced sites within the scheme study area are listed in **Table 4.4.8** and are shown on **Figure 4.4.10**.

Similarly, sites which have been granted a waste water discharge licence may be a source of contamination, however, these sites are also licenced by the EPA and as such the risk of contamination is low. No sites have been granted a waste water discharge licence within the scheme study area.

Table 4.4.8 IE licenced facilities within the scheme study area

ID	Licence Holder	Licence Status	Constraints Importance Ranking
IP01	Heiton Buckley Limited	Licenced	Low
IP02	Thermo King Ireland Limited	Licenced	Low
IP03	Boston Scientific Ireland Limited	Licenced	Low
IP04	Irish Finishing Technologies Limited	Surrendered	Low
IP05	Medtronic Vascular Galway Limited	Licenced	Low
IP06	Ingersoll-Rand International Limited	Applied	Low

ID	Licence Holder	Licence Status	Constraints Importance Ranking
IP07	Nellcor Puritan Bennett Ireland Ltd	Ceased	Low

Geological Heritage

A database of geological heritage sites is maintained by the GSI. It is important to note that not all geological heritage sites are a constraint to any potential options within the scheme study area. In fact exposure caused by road cuttings can often enhance the value of the geological heritage site and allow a greater number of people to appreciate the geology.

The Bearna Drumlin Swarm is a County Geological Site (CGS) which may be recommended for geological Natural Heritage Area designation in the future.

Karst feature, ID K89, is also listed in Galway City Development Plan as a County Geological Site, however, for this scheme the impact of this feature has been assessed as a karst constraint.

Locations of geological heritage are presented in **Figure 4.4.11** and summarised in **Table 4.4.9**.

Table 4.4.9 Areas of Geological Heritage

ID	Site Name	Principle characteristic	Constraints Importance Ranking
GHA01	Roadstone Quarry on Tuam Road	Heritage/large existing quarry. Limestone quarry producing aggregates, agricultural ground limestone and concrete.	Very High
GHA02	Merlin Park Quarry	Heritage/large historic quarry. A quarry exposure of Galway Black Marble in the Upper Visean Limestone. Brachiopod fossils have been recorded, in some shell beds. The quarry was once main source of Galway Black Marble to the stone trade.	Very High
GHA03	Mushroom rock: Menlough	Rare geological feature; This stone, and others in the vicinity, have been interpreted as marking the former lake margins of Lough Boora.	Very High
GHA04	Bearna Drumlin Swarm	Rare geological feature; A cluster of drumlins around Bearna record ice flow south-westwards into Galway Bay and show limestone carried onto granite bedrock. The internal structure shows till deposition over largely undeformed proglacial sediments and records ice sheet readvance.	Very High
GHA05	Bearna Drumlin Swarm	Rare geological feature; A cluster of drumlins around Bearna record ice flow south-westwards into Galway Bay and show limestone carried onto granite bedrock. The internal structure shows till deposition over largely undeformed proglacial sediments and records ice sheet readvance.	Very High

4.4.4 Summary

This section of the constraints study has identified the geological constraints for the scheme study area. These geological constrains have been assessed in terms of importance so that they can be ranked for the screening of potential options. The constraints are shown on **Figures 4.4.1** to **4.4.11**.

A number of the geological constraints are discrete elements such as geological heritage, quarries, waste licence sites, etc. Other constrains (e.g. soft ground, solid geology, karstic features) are more widespread and local variations will exist.

The principal constraints are the presence of soft ground and the potential for karst features. The variations in rock and soil properties will be further investigated subsequent design stages of the scheme.

4.4.5 References

British Standard Institute. (2010). *Code of practice for site investigations. BS 5930:1999+A2:2010*

Flood, P. and Eising, J. (1987). *'The use of vertical drains in the construction of the Galway Eastern Approach Road',* Proc.9th European Conference on Soil Mechanics and Foundation Engineering, Dublin, 31 August – 3 September.

Hunt, P. (1991). *Analysis of soft soil deposits at a location on the Eastern Approach Road, Galway, M.Eng.Sc. thesis*, National University of Ireland, Galway.

Long, M.M. and Rodgers, M. (1995). *'Geotechnical behaviour of very soft calcareous soils in Ireland',* Proc. XI European conference on soil mechanics, Copenhagen, pp. 8-103 to 8-108.

National Road Authority. (2009). *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*.

Peters, M., Wilkins, A and O'Brien, A. (2012). *'Role of geotechnical temporary works on infrastruicture construction in Ireland', Proc. Geotechnics on Irish Roads, 2000 – 2010: A decade of achievement*, Geotechnical Society of Ireland. Pp.110 to 136.

Rodgers, M. and Naughton, P. (2003). *'Insitu and laboratory testing of a soft soil deposit on the west coast of Ireland'*. Proc. Int. Workshop on Geotechnics of Soft Soils – Theory and Practice. Vermeer, Schweiger, Karstunen and Cudny (eds.). 17-19 September 2003.

4.5 Hydrogeology

4.5.1 Introduction

This section identifies the hydrogeological constraints identified within the scheme study area for the N6 Galway City Transport Project, as shown on **Figures 4.5.1** to **4.5.7**.

Section 4.5.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.5.3** describes the hydrogeological constraints within the scheme study area. A summary is presented in **Section 4.5.4** and references are listed in **Section 4.5.5**.

4.5.2 Methodology and Sources of Information

4.5.2.1 Methodology

This assessment was prepared taking cognisance of the requirements of the NRA *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA 2009'*. The hydrogeology constraints study was compiled in conjunction with, and in mind of, data acquired by other disciplines in particular the Soils and Geology, Ecology and Hydrology constraint studies.

The NRA guidelines provide criteria for ranking the importance of the identified hydrogeological constraints and these criteria are presented in **Table 4.5.1**.

Table 4.5.1 Criteria for rating the importance of identified features (based on NRA Guidelines (2009) Box 4.1: Criteria for Rating Site Attributes)

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale.	Groundwater supports river, wetland or surface water body ecosystem protected by EU legislation e.g. cSAC or SPA status.
Very High	Attribute has a high quality or value on a regional or national scale	Regionally Important Aquifer with multiple well fields. Groundwater supports river, wetland or surface water body ecosystem protected by national legislation – e.g. NHA status. Regionally important potable water source supplying >2500 homes. Inner source protection area for regionally important water source.
High	Attribute has a high quality or value on a local scale	Regionally Important Aquifer. Groundwater provides large proportion of baseflow to local rivers. Locally important potable water source supplying >1000 homes. Outer source protection area for regionally important water source. Inner source protection area for locally important water source.

Importance	Criteria	Typical Example
Medium	Attribute has a medium quality or value on a local scale	Locally Important Aquifer Potable water source supplying >50 homes. Outer source protection area for locally important water source.
Low	Attribute has a low quality or value on a local scale	Poor Bedrock Aquifer. Potable water source supplying <50 homes.

Consistent with the approach presented in the NRA guidance, the assessment is undertaken using the criteria for importance ranking and this will be used inform the assessment of the potential impacts of the route options detailed in **Section 6.5.3** and **Section 7.6.3**.

The assessment is based on the results of a desk study and fieldwork survey. The desk study includes a hydrogeological assessment of the following criteria:

- Aquifer type and classification;
- Aquifer vulnerability;
- Hydroecology;
- Groundwater Resources; and
- Karst landforms.

The desk study was followed by a detailed field survey of the identified karst features in and adjacent to the scheme study area and this was undertaken during October and November 2014. Information recorded during the field survey included a description of the feature, location (x, y coordinates), elevation, presence of water, water quality parameters (electrical conductivity, temperature and pH), flow where possible and photographs. Full details of this field survey are included in **Appendix A.4.4**.

4.5.2.2 Sources of Information

This constraints study collated and reviewed the following sources of information to identify hydrogeological constraints within the scheme study area:

- Current and historical Ordnance Survey maps available for the scheme study area (1:2,500 and 1:10,560 scales);
- Aerial photography (2012) of the scheme study area;
- Geological maps of the site area produced by the Geological Survey of Ireland (www.dcenr.gov.ie):
  - Bedrock Geology 1:100,000;
  - Bedrock Boreholes;
  - Karst Features;
  - Groundwater Aquifers;
  - National Draft Generalised Bedrock map (Groundwater Rock units);
  - National Vulnerability; and
  - National Groundwater Recharge.
- Lidar elevation survey carried out by the Office of Public Works and provided by Galway County Council;

- Results from karst field surveys carried out in October and November 2014.
- Constraints reports from the previous N6 Galway City Outer Bypass Scheme (GCOB):
  - Galway City Outer Bypass R336 Western Approach Scheme Constraints Study Report 2000; and
  - N6 Galway City Outer Bypass Constraints Study Report.
- N6 Galway City Outer Bypass Environmental Impact Statement (2006).

4.5.3 Existing Environment

The following section presents the existing environment and identifies the hydrogeological features within the scheme study area.

4.5.3.1 Aquifer Classification and Groundwater Bodies

The Geological Survey of Ireland (GSI) has devised a system for classifying the aquifers in Ireland based on the hydrogeological characteristics, size and productivity of the groundwater resource. The three main classifications are Regionally Important Aquifers (RI), Locally Important Aquifers (LI) and Poor Aquifers (P). Each of these types of aquifer is further subdivided and has a specific range of criteria such as the transmissivity (m^2/day), productivity, yield and potential for springs associated with it. The GSI also provides a delineation of extents for groundwater bodies within each aquifer.

Regionally Important Aquifers can be sub-divided into Karstified Bedrock with either diffuse (Rkd) or conduit (Rkc) flow, fissured bedrock (Rf) or extensive sand and gravel (Rg). By the very nature of Regionally Important Aquifers and their importance for groundwater resources, there may be significant impacts on the aquifer by any potential options in such an area. Examples of impacts which may occur are the disruption of groundwater flow paths during earthworks, derogation of water supplies if dewatering is necessary, disruption of base flow to groundwater fed rivers or fens, or contamination of the aquifer through accidental spillage and removal of the overburden which protects the aquifer.

Locally Important Aquifers are sub-divided into those that are generally moderately productive (Lm), those that are moderately productive only in local zones (Ll), and smaller sand and gravel aquifers (Lg). The term ‘Locally Important Aquifers which are karstified (Lk)’ is sometimes used; however, this is not an official classification. There is also potential to have an impact on the environment if any potential option is located on a Locally Important Aquifer, however the impacts may be limited to a localised area. In these aquifers there is the potential for contamination and the derogation of local water supplies and springs through changing groundwater flow paths during earthworks and dewatering.

Poor Aquifers are classed as either generally unproductive except for local zones (Pl) or generally unproductive (Pu). Poor Aquifers generally provide little groundwater for water supply or for baseflow to surface water bodies, however they are sometimes used for local supply for individual houses/farms. While the impact on the environment of locating any potential option on a Poor Aquifer will be significantly less than that on a Regionally Important Aquifer, it still requires consideration and mitigation against impacts during the design and construction stages.

The aquifer classification and groundwater bodies within the scheme study area is shown in **Figures 4.5.1, 4.5.2** and **4.5.3** and is summarised in **Table 4.5.2**. The granite and orthogneissbedrock to the west is a Poor Aquifer where the bedrock is generally unproductive except for local zones (Pl). The limestone bedrock to the east is a Regionally Important Karstified Aquifer which is dominated by conduit flow (Rkc).

Table 4.5.2 Aquifer Classification and Groundwater Bodies within the Scheme Study Area

Aquifer Classification	Rock Formation	Groundwater Bodies	Constraints Importance Ranking
Rkc	Visean limestone	Galway East Clarinbridge Care-River Corrib Ross Lake Lough Corrib Fen	High
Pl	Murvey Granite Errisbeg Townland Granite Porphyritic-Megacrystic Granite Fine grained foliated granite Quartz porphyry and Felsite Metagrabbo and orthogneiss suite undifferentiated	Galway West Maam Clonbur Spiddal	Low

4.5.3.2 Aquifer Vulnerability

Vulnerability of a groundwater body is the term used to describe the intrinsic geological and hydrogeological characteristics which determine the ease with which a groundwater body may be contaminated by human activities. The vulnerability is determined by the travel time and quantity of contaminants and the attenuation capacity of the overlying deposits. These vulnerability determining parameters are based on the thickness of the unsaturated zone, permeability of overlying soils and the type of recharge (point or diffuse) in the area. For example bedrock with a thick, low permeability overburden is less vulnerable than bedrock with a thin high permeability, gravel overburden.

The classification guidelines, as published by the GSI, are given in **Table 4.5.3** which demonstrates that bedrock groundwater is most at risk in areas where subsoils are thin or absent and where karst features such as swallow holes are present. This is due to the ability of potential contaminants to reach the aquifer following a low travel time and with little or no contaminant attenuation due to the thin or absent overburden.

Table 4.5.3 GSI Vulnerability Rating Matrix

Vulnerability Rating	Hydrogeological Conditions				
	Subsoil Permeability (Type) and Thickness			Unsaturated Zone	Karst Features
	High permeability (sand/gravel)	Moderate permeability (e.g. Sandy subsoil)	Low permeability (e.g. Clayey subsoil, clay, peat)	Sand/gravel aquifers only)	(<30m radius)
Extreme (E)	0 – 3.0m	0 – 3.0m	0 – 3.0m	0 – 3.0m	-
High (H)	>3.0m	3.0 – 10.0m	3.0 – 5.0m	>3.0m	N/A
Moderate (M)	N/A	>10.0m	5.0-10.0m	N/A	N/A
Low (L)	N/A	N/A	>10.0m	N/A	N/A

Notes: (1) N/A = not applicable
(2) Precise permeability values cannot be given at present.
(3) Release point of contaminants is assumed to be 1-2 meters below ground surface.

Groundwater vulnerability maps have been produced for the country by the GSI. **Figure 4.5.4** shows the aquifer vulnerability within the study area. As discussed in **Section 4.4 Soils and Geology** the subsoil thickness is variable with considerable portions of the scheme study area where rock is exposed at the surface. As a result, the aquifer vulnerability is classified as extreme or where rock is at or near surface or karst.

Potential impacts on the aquifer includes release of contamination through accidental spillage or mobilisation due to the disturbance of the overburden.

In urban areas, made ground is present and the aquifer vulnerability is classified as high. Pockets of medium and low vulnerability is located near Lough Atalia and Lough Corrib where the subsoil is peat or alluvium.

4.5.3.3 Hydroecology

Groundwater dependant habitats may be impacted by any potential option through accidental contamination, localised flooding or the alteration of base-flow supplies to fens and marshlands causing the area to dry out.

Water dependant habitats are listed in **Table 4.5.4** and presented for the western section of the scheme study area in **Figures 4.5.5** and the eastern section of the scheme study area in **Figure 4.5.6**. These habitats are further discussed in **Section 4.3 (Ecology**).

Table 4.5.4 Water Dependant Ecological Features in scheme study area

Site ID	Feature Name	Characteristics	Constraints Importance
Lough Corrib cSAC, EC28, EC29, EC30	Lough Corrib, Glenlo Abbey Hotel and Riverbank, Kentfield/NUI Galway Recreational Facilities	Wetland habitats including alluvial woodland, swamp wet grassland, bog and fen. Sensitive to water quality influences/water levels	Extremely High

Lough Corrib cSAC, EC31	Lough Corrib, Dangan Wetland	Wetland habitats including bog and fen. Sensitive to water quality influences/water levels	Extremely High
Lough Corrib cSAC, EC34, EC37	Lough Corrib, Menlo South to Jordan's Island, Coolagh South	Wetland habitats including grassland and woodland. Sensitive to water quality influences/water levels	Very High
Lough Corrib cSAC, EC33	Lough Corrib, Coolanillaun wetland	Wetland complex. Sensitive to water quality influences/water levels	Very High
EC11, EC12, EC13	Heath/Bog	Heath/bog complex. Sensitive to water quality influences and potentially water levels	High
EC14	Heath	Heath complex. Potentially sensitive to water quality influences/water levels	Low-High
EC15, EC16	Heath	Heath complex. Potentially sensitive to water quality influences/water levels	Low-High
EC16, EC17	Heath	Heath/bog complex. Sensitive to water quality influences and potentially water levels	Low-High
EC18	Heath	Heath complex. Potentially sensitive to water quality influences/water levels	Low- Moderate
EC19, EC20	Heath	Heath/bog complex. Sensitive to water quality influences and potentially water levels	Low - high
EC22	Moycullen Bogs	Heath/bog complex. Sensitive to water quality influences/water levels	Low - high
EC24	Heath	Heath complex. Potentially sensitive to water quality influences/water levels	Low – moderate
EC25	Moycullen Bogs	Heath/bog complex. Sensitive to water quality influences/water levels	Low – high
EC35	Turlough	Turlough site. Sensitive to water quality influences/water levels	High
EC36	Turlough	Turlough site. Sensitive to water quality influences/water levels	High
EC37	Turlough	Turlough site. Sensitive to water quality influences/water levels	High
EC38	Turlough	Turlough site. Sensitive to water quality influences/water levels	High
EC39	Ballindooley Lough	Wetland complex of fen, swamp, and wet grassland. Sensitive to water quality influences/water levels	High
EC41	Marsh/grassland/ karst	Marsh, wet grassland and karst features. Sensitive to water quality influences/water levels	Low - high

As detailed in **Table 4.5.4** those ecological habitats of the highest importance are Ballindooley Lough, Coolagh Lakes, Coolanillaun Wetland and Terryland River.

4.5.3.4 Groundwater Resources

Groundwater resources describe any large spring, well or boreholes which are used for as a groundwater abstraction source by domestic, agricultural, commercial, industrial, local authority or group water scheme users. Groundwater abstractions have the potential to be impacted by options. Lowering of the groundwater table may reduce the supply available. Accidental spillages or releases of contaminants may impact the water quality.

Source Protection Zones (SPZ) reports have been produced by the GSI and the EPA. The reports aim to guide development planning and regulation to provide protection to groundwater sources. To date no SPZ reports have been produced for locations within the scheme study area.

Wells, boreholes and springs used for supply within the scheme study area are summarised in **Table 4.5.5** and are identified in **Figure 4.5.7**. The wells are catalogued in terms of well accuracy which refers to the siting of the well from the location, within 50m, 100m etc.

Table 4.5.5 Groundwater Supplies

ID	Site Name	Abstraction Type	Abstraction Use	Constraints Importance Ranking
W1000-01	Coolagh	Spring	Agri & domestic use	Low
W1000-02	Ballybrit	Borehole	Domestic use only	Low
W1000-03	Ballyloughaun	Unknown	Other	Low
W1000-04	Garraun South	Borehole	Agri & domestic use	Low
W500-01	Murrogh	Unknown	Agri & domestic use	Low
W100-01	Mervue	Borehole	Other	Low
W100-02	Mervue	Dug well	Other	Low
W100-03	Castlegar	Borehole	Other	Low
W100-04	Castlegar	Borehole	Other	Low
W100-05	Castlegar	Borehole	Other	Low
W100-06	Castlegar	Borehole	Other	Low
W50-01	Clybaun GWS	Borehole	Group Scheme	Medium
W50-02	Murrogh House Well	Dug well	Agri & domestic use	Low
W50-03	Lough Atalia	Borehole	Unknown	Low
W50-04	Lough Atalia Rd. E.I.S.	Borehole	Other	Low
W50-05	Lough Atalia	Borehole	Unknown	Low
W50-06	Lough Atalia	Borehole	Unknown	Low
W50-07	Lough Atalia	Borehole	Unknown	Low
W50-08	Merlin	Borehole	Unknown	Low
W50-09	Rahoon	Borehole	Domestic use only	Low
W50-10	Ballybrit	Borehole	Unknown	Low
W50-11	Ballinfoyle	Borehole	Unknown	Low
W50-12	Commercial property	Borehole	Bottled water	High

4.5.3.5 Karst

Karstic areas are those where the rock present is readily dissolved by water (relative to other rock types). Distinctive karstic features are formed along preferential groundwater flow paths such as fractures, fissures or joints. Karstic aquifers are the most common source of bedrock groundwater in Ireland. In these, groundwater flow is dominated by fissure flow, leading to potentially high yields and the aquifers can extend over large areas.

A desk based and field based study in the eastern study area underlain by limestone has identified karst features including springs, turloughs, enclosed depressions and swallow holes. **Appendix A.4.4 Karst Study Report,** comprises the findings of the karst study. This list of karst features is not exclusive and other sources of information such as landowner consultation may identify additional features.

The karst features are summarised in **Table 4.5.6** and presented in **Figure 4.5.2.** The karst features are the same as those discussed in **Section 4.4 (Soils and Geology)** where they are dealt with in terms of topography, ground surface and stability. This section deals with the hydrogeology of karst and the potential impacts on the environment from any potential option near karst features. The karst features are ranked in terms of their location within ecologically designated habitats as outlined in the NRA guidelines summarised in **Table 4.5.1**. Features are designated as extremely high where located within an internationally designated area (i.e. cSAC). The underlying limestone aquifer is a regionally important aquifer and therefore all other features not within ecologically designated areas are considered to be classified as high importance.

Table 4.5.6 Karst Features in the study scheme area

Feature ID	Feature type	Designated ecological habitat within which feature is located	Constraints importance ranking (based on Table 4.5.1)
K1	Enclosed Depression	n/a	High
K2	Spring	n/a	High
K3	Enclosed Depression	n/a	High
K4	Enclosed Depression	n/a	High
K5	Enclosed Depression	n/a	High
K6	Enclosed Depression	n/a	High
K7	Spring	n/a	High
K9	Spring	n/a	High
K10	Enclosed Depression	n/a	High
K11	Enclosed Depression	n/a	High
K12	Enclosed Depression	n/a	High
K14	Spring	n/a	High
K15	Enclosed Depression	Lough Corrib SAC, pNHA, SPA	Extremely High
K17	Spring	Lough Corrib SAC, pNHA, SPA	Extremely High
K18	Enclosed Depression	n/a	High

Feature ID	Feature type	Designated ecological habitat within which feature is located	Constraints importance ranking (based on Table 4.5.1)
K19	Spring	n/a	High
K20	Turlough	n/a	High
K21	Enclosed Depression	n/a	High
K25	Spring	Lough Corrib SAC	Extremely High
K31	Turlough	n/a	High
K37	Enclosed Depression	Lough Corrib SAC	Extremely High
K39	Enclosed Depression	n/a	High
K40	Enclosed Depression	Lough Corrib cSAC	Extremely High
K44	Enclosed Depression	n/a	High
K45	Spring	n/a	High
K49	Enclosed Depression	Lough Corrib SAC	Extremely High
K50	Enclosed Depression	Lough Corrib SAC	Extremely High
K51	Enclosed Depression	Lough Corrib SAC	Extremely High
K54	Enclosed Depression	Lough Corrib SAC	Extremely High
K57	Enclosed Depression	Lough Corrib SAC	Extremely High
K59	Enclosed Depression	Lough Corrib SAC	Extremely High
K61	Enclosed Depression	Lough Corrib SAC	Extremely High
K62	Enclosed Depression	Lough Corrib SAC	Extremely High
K64	Enclosed Depression	Lough Corrib SAC	Extremely High
K65	Enclosed Depression	n/a	High
K66	Enclosed Depression	Lough Corrib SAC	Extremely High
K67	Enclosed Depression	n/a	High
K69	Enclosed Depression	Lough Corrib SAC	Extremely High
K70	Enclosed Depression	n/a	High
K71	Enclosed Depression	Lough Corrib SAC	Extremely High
K72	Turlough	n/a	High
K73	Enclosed Depression	n/a	High
K74	Turlough	n/a	High
K75	Enclosed Depression	n/a	High
K76	Enclosed Depression	n/a	High
K77	Spring	n/a	High
K81	Spring	n/a	High
K82	Enclosed Depression	n/a	High
K83	Enclosed Depression	n/a	High
K85	Enclosed Depression	n/a	High
K86	Estavelle	n/a	High

Feature ID	Feature type	Designated ecological habitat within which feature is located	Constraints importance ranking (based on Table 4.5.1)
K87	Spring Swallow Hole	n/a	High
K88	Enclosed Depression	n/a	High
K89	Cave	n/a	High
K90	Spring	n/a	High
K92	Well	n/a	High
K94	Enclosed Depression	n/a	High
K95	Swallow Hole	n/a	High
K96	Spring Swallow Hole	n/a	High
K97	Enclosed Depression	n/a	High
K98	Enclosed Depression	n/a	High
K99	Spring	n/a	High
K100	Enclosed Depression	n/a	High
K104	Enclosed Depression	n/a	High
K112	Enclosed Depression	n/a	High
K122	Enclosed Depression	n/a	High
K124	Enclosed Depression	n/a	High
K126	Spring	n/a	High
K129	Spring	n/a	High
K130	Enclosed Depression	n/a	High
K131	Enclosed Depression	n/a	High
K132	Spring	n/a	High
K134	Superficial solution features	n/a	High
K135	Enclosed Depression	n/a	High
K136	Spring	n/a	High
K140	Spring	n/a	High
K147	Spring	n/a	High
K151	Enclosed Depression	n/a	High
K152	Enclosed Depression	n/a	High
K154	Enclosed Depression	n/a	High
K158	Spring	n/a	High
K159	Enclosed Depression	n/a	High
K160	Spring	n/a	High
K161	Spring	n/a	High
K163	Enclosed Depression	n/a	High
K164	Enclosed Depression	n/a	High
K165	Enclosed Depression	n/a	High

Feature ID	Feature type	Designated ecological habitat within which feature is located	Constraints importance ranking (based on Table 4.5.1)
K166	Spring	n/a	High
K168	Enclosed Depression	n/a	High
K169	Enclosed Depression	n/a	High
K170	Well	n/a	High
K172	Enclosed Depression	n/a	High
K173	Spring	n/a	High
K174	Enclosed Depression	n/a	High
K175	Enclosed Depression	n/a	High
K176	Spring	n/a	High
K178	Spring	n/a	High
K179	Enclosed Depression	n/a	High
K180	Spring	n/a	High
K181	Spring	n/a	High
K184	Spring	n/a	High
K189	Spring	n/a	High
K190	Spring	n/a	High
K192	Spring	n/a	High
K193	Enclosed Depression	n/a	High
K198	Enclosed Depression	n/a	High
K199	Enclosed Depression	n/a	High
K201	Enclosed Depression	n/a	High
K202	Enclosed Depression	n/a	High
K203	Enclosed Depression	n/a	High
K204	Enclosed Depression	n/a	High
K205	Enclosed Depression	n/a	High
K206	Enclosed Depression	n/a	High
K207	Enclosed Depression	n/a	High
K208	Enclosed Depression	n/a	High
K209	Enclosed Depression	n/a	High
K210	Spring	n/a	High
K211	Superficial solution features	n/a	High
K212	Enclosed Depression	n/a	High
K213	Enclosed Depression	n/a	High
K214	Enclosed Depression	n/a	High
K215	Enclosed Depression	n/a	High
K216	Enclosed Depression	n/a	High

Feature ID	Feature type	Designated ecological habitat within which feature is located	Constraints importance ranking (based on Table 4.5.1)
K218	Enclosed Depression	n/a	High
K222	Superficial solution features	n/a	High
K223	Enclosed Depression	n/a	High

4.5.4 Summary

This section has identified the hydrogeological constraints for the scheme study area by assessing:

- aquifer type;
- the vulnerability of groundwater;
- the presence of water dependant terrestrial ecosystems; and
- quantifying groundwater as a resource.

These hydrogeological attributes have been assessed in terms of importance so that they can be ranked for the screening of potential options.

The hydrogeology contrasts significantly between the western and eastern sections of the scheme study area, with the western section comprising of a poor aquifer and the eastern section comprising a regionally important karst aquifer. This distinction raises different constraints for the two areas. The hydroecology in the west is associated with the perching of waters in peatlands whilst in the west the hydroecology is groundwater dependant being fed by karst pathways.

A number of ground water abstraction wells area assessed as having a high constraint such as W50-11 and W50-12 which are supplies for industry.

Refer to **Figures 4.5.1** and **4.5.2** which summarises the hydrogeological constraints for the scheme study area.

4.5.5 References

Ordance Survey Ireland. (2015) *Current and historical maps,* available; http://maps.osi.ie/publicviewer/#V1,591271,743300,0,10, accessed 23/3/2015

Geological Survey of Ireland. (2014) *Bedrock Geology 1:100,000, Bedrock Boreholes, Karst Features, Groundwater Aquifers, National Draft Generalised Bedrock map (Groundwater Rock units), National Vulnerability and National Groundwater Recharge maps,* available; www.dcenr.gov.ie, accessed 23/3/2015

Department of the Environment and Local Government (DELG), (1999) The Environmental Protection Agency (EPA) and the Geological Survey of Ireland (GSI) Protection Schemes Guidelines, available; http://www.gsi.ie/Programmes/Groundwater/Projects/Protection+Schemes+Guidelines.htm#summary, accessed 23/3/2015

4.6 Hydrology

4.6.1 Introduction

This section identifies the hydrological constraints identified within the scheme study area for the N6 Galway City Transport Project, as shown on **Figures 4.6.1** to **4.6.3**.

Section 4.6.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.6.3** describes the hydrological constraints within the scheme study area. A summary is presented in **Section 4.6.4** and references are listed in **Section 4.6.5**.

The hydrology constraints applicable to the scheme study area can be summarised under the following headings:

- Surface Waters
  - River and stream crossings (large and small);
  - Lakes (permanent and seasonal); and
  - Coastal Waters.
- Floodplains and Flood Risk
  - Fluvial;
  - Coastal and estuarine;
  - Pluvial;
  - Groundwater (seasonal lakes);
  - Flood Defences; and
  - Arterial Drainage Schemes.
- Hydroecology Sites
  - Natura 2000 sites;
  - Surface water related habitats;
  - Salmonid Waters (River Corrib part of Lough Corrib cSAC);
  - Coastal Lagoon (Lough Atalia);
  - Wetland Systems; and
  - Blanket bogs.
- Surface Waters Abstractions

4.6.2 Methodology and Sources of Information

This assessment was prepared taking cognisance of the requirements of the NRA guidance for the preparation of route selection reports for geology, hydrology and hydrogeology ('Environmental Impact Assessment of National Road Schemes – Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes, NRA 2009').

The guidelines provide useful criteria for ranking the Importance of the identified hydrological constraints and these criteria are presented in **Table 4.6.1**.

Table 4.6.1 Criteria for rating the Importance of identified features[14]

Importance	Criteria	Typical Example
Extremely High	Attribute has a high quality or value on an international scale	River, wetland or surface water body ecosystem protected by EU legislation e.g. 'European sites' designated under the Habitats Regulations or 'Salmonid waters' designated pursuant to the European Communities (Quality of Salmonid Waters) Regulations, 1988.
Very High	Attribute has a high quality or value on a regional or national scale	River, wetland or surface water body ecosystem protected by national legislation – NHA status Regionally important potable water source supplying >2500 homes Quality Class A (Biotic Index Q4, Q5) Flood plain protecting more than 50 residential or commercial properties from flooding Nationally important amenity site for wide range of leisure activities
High	Attribute has a high quality or value on a local scale	Salmon fishery Locally important potable water source supplying >1000 homes Quality Class B (Biotic Index Q3-4) Flood plain protecting between 5 and 50 residential or commercial properties from flooding Locally important amenity site for wide range of leisure activities
Medium	Attribute has a medium quality or value on a local scale	Coarse fishery Local potable water source supplying >50 homes Quality Class C (Biotic Index Q3, Q2- 3) Flood plain protecting between 1 and 5 residential or commercial properties from flooding
Low	Attribute has a low quality or value on a local scale	Locally important amenity site for small range of leisure activities Local potable water source supplying

This desk study collated and reviewed the following sources of information to identify hydrological constraints within the scheme study area:

- Current and historical Ordnance Survey maps available for the study area (1:2,500 and 1:10,560 scales);
- Aerial photography of the scheme study area;
- OPW Arterial Drainage Mapping for Corrib-Clare Arterial Drainage scheme;
- CFRAM Draft Mapping and CFRAM Hydrology and Hydraulics Reports for the scheme study area (web address);
- OPW CFRAM lidar and topographical data for scheme study area;
- OPW Hydrometric Data for River and Coastal Gauges;
- EPA hydro tool for River Flow Duration data;

[14] Based on NRA Guidelines (2009); Box 4.1: Criteria for Rating Site Attributes

- EPA Water Quality Monitoring Data;
- Inland Fisheries Ireland;
- Western River Basin Reports;
- Galway County Council County development Plan;
- Galway City Development Plan;
- Galway Port Tidal Data;
- Constraints reports from the previous Galway City Outer Bypass Scheme:
  - Galway City Outer Bypass Western Approach R336 Link Road Scheme Constraints Study Report 2000; and
  - N6 Galway City Outer Bypass Constraints Study Report.
- N6 Galway City Outer Bypass EIS Volume 2 (2006).

4.6.3 Existing Environment

4.6.3.1 Watercourses

The scheme study area falls within hydrometric areas 29, 30 and 31 (29 Galway Bay Southeast Catchment, 30 The Corrib Catchment, 31 The Galway Bay North). The scheme study area measures a total area of 69km^2 of which 26km^2 is located within the Corrib hydrometric area, 30km^2 (43%) is in the Galway Bay North Hydrometric area and 13km^2 (19%) is in the Galway Bay Southeast hydrometric Area.

There are 11 drainage catchments/sub-catchments within the scheme study area as shown on **Figure 4.6.1**. These drainage catchments are labelled from West to East as follows:

1. Sruthán Na Libeirti;
2. Trusky Stream;
3. Bearna Stream;
4. Knocknacarra Stream;
5. Galway City Coastal;
6. River Corrib Catchment incl. and the Terryland River Valley;
7. Lough Atalia;
8. Doughiska;
9. Roscam;
10. Curragreen; and
11. Glenascaul.

The River Corrib represents the largest watercourse within the scheme study area having a catchment area of some 3,135 km^2 to Salmon Weir in Galway City. The Office of Public Works (OPW) regulate water levels in the River Corrib and Lough Corrib through gated control at the Salmon Weirs. The regulation level range for the lake is set at 28ft to 30ft Poolbeg (5.8 to 6.4m OD Malin) for navigation and flooding control. Gates are opened and closed by the OPW depending on existing

and forecasted rainfall conditions. The canals and mill races through the city are fed by the River Corrib upstream of the Salmon Weir and outfall into the Corrib Estuary.

The Eglington canal is prone to siltation as the flow through this is restricted by lock gates, weirs and turbines.

Given the cSAC and salmonid status of the River Corrib it is considered to be of international status with an Extremely High attribute value. The remaining watercourses encountered within the scheme study area are minor watercourses all of which are less than 10km^2 in catchment area.

1. Sruthan Na Libeirti (1.5 km^2);
2. Trusky Stream (3.3 km^2);
3. Bearna Stream (9.14 km^2);
4. Knocknacarra Stream (4.4 km^2);
5. Distillery Stream (3.5 km^2); and
6. Terryland River (6.9 km^2).

The majority of the above streams have highly urbanised catchments and are not hydrologically very sensitive. The Sruthan Na Libeirti Stream and the Trusky Streams do not directly discharge to the Galway Bay cSAC Complex, outfalling to the Sea near Bearna. The remaining streams will outfall to the Galway Bay Complex cSAC.

Terryland River Valley is a low lying river valley area that is supplied by the River Corrib via the Terryland River. From the intake at Terryland it flows to Castlegar where it disappears underground to the sea via swallow holes at Poulavourleen west of Castlegar Village. The water level in the lower Terryland River is influenced by the tide and displays a tidal curve. The outfall for the Terryland River has not been proved and it may discharge to deeper waters in Galway Bay, there are suggestions that the swallow hole discharges to Lough Atalia or to the springs near Renmore but such linkage has not been proven (refer to Galway Harbour Study).

Of the above streams the Bearna Stream would be considered to be of locally high importance with the other streams, Sruthan na Liberti, Trusky and Knocknacarra Streams of medium importance.

4.6.3.2 Coastal Waters

The scheme study area and all of the drainage catchments encountered eventually outfall to inner Galway Bay from Bearna Quay east to inner Oranmore Bay. Inner Galway Bay is a designated cSAC (000268 – Galway Bay Complex) and an SPA (004031 – Inner Galway Bay SPA)

Estuarine water of the River Corrib, mudflats within Oranmore Bay, Bathing waters of Silver Strand, Salthill and Ballylaughaun Beach, Claddagh Basin, Lough Atalia Coastal Lagoon, Bearna Quay.

These coastal waters given their status are considered to have an extremely high attribute value and would potentially be locally sensitive to water quality impacts and at risk of being impacted by possible options during construction and operation phases. In terms of hydrological regime flows, velocities and water depth and

fluctuation and physic-chemistry (salinity, temp etc.) there is little ability for options development to affect the hydrological functioning of the Coastal Waters and the Galway Bay Complex cSAC.

4.6.3.3 Lakes and Standing Waters

This section considers the permanent and seasonal lakes (turloughs) and groundwater dependent turloughs. A more detailed description is presented in the hydrogeology section (**Section 4.5**). It is important to note that for the seasonal lakes / turloughs, the surface water hydrology can play a significant role in defining the hydrological regime within the waterbody and defining the water chemistry. These features within the scheme study area have localised catchment from which a substantial overland inflow contribution during flood conditions can occur. The permanent lakes encountered within the scheme study area are Ballindooley Lough, Coolagh Lakes and Lough Atalia.

Ballindooley Lough

Ballindooley Lough which is considered part of the Terryland system has no surface outflow stream and rises and falls with the groundwater table which is generally seasonal. The summer low level in the Lough is measured at 8.5 to 8.6m OD and the winter high flood level is generally less than 9.5m OD. The Lough has a total area of 30.4ha at the 9.5m OD contour. The permanent Lough area (i.e. at summer drought levels) is approximately 5ha and the surrounding bank level within the Lough flood area is 9.1 OD and relatively flat to its boundary where the topography steepens sharply (i.e. the Lough represents an enclosed depression with the lands rising sharply around its perimeter). Consequently there is little difference in the extent of land that floods each winter. The total live storage within the Lough between 8.5 and 9.5m OD water levels is calculated to be approximately 149,900m^3. There are some karst features towards the north of the lake.

The likely catchment area contributing to this lake is 2.2km^2 based on the topography there may also be some karstic inflows from a wider area. The outflow rate is unknown as it drains via groundwater and annually. The drainage path is unknown and may drain towards the River Corrib but most likely towards the Terryland Stream.

This lough would be considered to be of High Local attribute value. It is sensitive to changes to the hydrological regime in terms of water balance resulting in changes to water depth and water level fluctuation. This may occur through encroachment or through potential interference to the natural inflows to the lough or via the groundwater outflow from the lough. It is also sensitive to water quality impact.

Coolagh Lakes

Coolagh Lakes is part of the River Corrib Catchment System with the lake level within Coolagh Lakes significantly influenced by the River Corrib Level and the control imposed by the OPW at the Galway City Salmon Weirs Barrage (regulation 5.8 to 6.4m OD which is achieved approximately 85% of the time). The highest recorded flood level at Dangan Slip occurred on the 28 November 2009 at 6.76m OD Malin. This lake has a small local catchment area of *c.* 2.5km^2 being primarily fed from runoff and groundwater flow from the surrounding limestone catchment to the north and east of the lakes. Calcareous fen habitat has been identified around the fringes of the lake. This habitat is priority Annex I habitat and would potentially

be sensitive to changes to the hydrogeology connections with the surrounding limestone bedrock and also to the River Corrib Water level and water quality. Coolagh Lakes are part of the Lough Corrib cSAC and is considered to be of international importance. The Coolagh Lakes are connected by a 200m long reedy channel to the River Corrib located 250m upstream of Jordan's Island. The flood area in the vicinity of the Coolagh Lakes is very extensive measuring some 40ha in area at the historical maximum flood level of 6.7m OD and varying significantly from 4.5ha to 25.5ha for the River Corrib regulation band levels of between 5.8m to 6.4m OD. This suggests a very shallow lake system that dries and wets with fluctuations in the River Corrib.

Lough Atalia

Lough Atalia is a tidal Lough of some 39ha in area, located to the northeast of Galway Docks in Galway City. The lough is connected to the sea via a 430m long inlet channel with a railway bridge crossing at its north end, the Galway Harbour Enterprise Park roadbridge crossing towards its southern seaward end and a low stone boulder weir located across a wide section of the channel towards the north end. The surrounding catchment area to the lough is of the order of 2.2km^2 and is an urbanised catchment with approximately 30 to 40% paved area.

The bedrock geology of the catchment and the majority of the lough is a Visean pure bedded limestone, which is classified as regionally important karstic (conduit flow) bedrock aquifer. The southern end of the lough near the railway bridge is classified as a Metagabbro and Orthogenesis bedrock which is a metamorphic rock derived from igneous rock. This represents a hard and impervious rock formation whereas the Visean Limestone is softer and prone to weathering and solution. The bedrock underlying the docks and the proposed harbour extension area is also shown to be Metagabbro and Orthogenesis bedrock.

The bathymetry of Lough Atalia reveals generally a shallow bay except for a deep pocket towards the southern end of the lough inside the inlet channel. This deep pocket is coincides with the interface between the igneous and limestone bedrock formations, with the softer limestone bedrock being eroded over time by the locally high velocities inflowing to the lough and the igneous rock being much more resistant to erosion.

The salinity in Lough Atalia has been shown to vary significantly with the tidal range and the River Corrib flow rate. Recorded salinities within the lough varied from 1 up to 29 psu over a range of sampling dates in 2012 and 2013 (Galway Harbour Study). The lough is relatively shallow and is practically completely flushed in a single spring tide. Little saline inflow occurs on neap tides.

Image 4.6.1 Aerial View of Galway Docks, Claddagh Basin and Lough Atalia

4.6.3.4 Flood Risk Areas

A detailed catchment flood risk and management (CFRAM) study is being carried out by the OPW and is currently available in draft format in respect to flood mapping and flood hydrology. Refer to Figures 4.6.3. This CFRAM study examined the fluvial flooding in the River Corrib and its tributary the Terryland River providing flood level predictions. It also examined coastal flooding in the estuary and shorelines areas of the city. The following tables present the CFRAM flood level predictions for 10, 100 and 1000 year fluvial events at a number of relevant locations along the River Corrib.

Table 4.6.2 CFRAM Flood Level Predictions for relevant locations on the River Corrib (m OD)

Location	10 year	100year	1000year
Salmon Weirs	6.13	6.44	6.93
Quincentenary Br.	6.31	6.67	7.24
Coolagh	6.72	7.15	7.85
Dangan	6.87	7.32	8.02
Menlough	7.00	7.45	8.26
Lough Corrib outlet	7.02	7.51	8.28

Table 4.6.3 CFRAM Flood Level Predictions for relevant locations along the Terryland River

Location	10 year	100year	1000year
d/s Terryland Water Works	3.73	4.25	6.14
Headford Road	3.37	3.8	6.06
Liosbaun Business Park	3.09	3.56	5.52
N6 road	3.03	3.51	5.50
Swallowholes at Castlegar	2.9	3.34	4.73

The Distillery Stream which receives the majority of the storm water from the Dangan, Rahoon and Shantalla areas flows through the university concourse was also investigated and flood estimates are presented below.

The flood risk in the Distillery Stream to the university is both from the urban storm flow outfalls and from the River Corrib. A number of mitigation measures have been implemented to protect against flooding through the construction of Penstock gates that can open and close to divert flow away from the stream into the River Corrib.

Table 4.6.4 CFRAM Flood Level Predictions for relevant locations along the Distillery Stream at NUIG (m OD)

Location	10 year	100year	1000year
Kingfisher Club	6.09	6.44	7.36
u/s of Eglington Canal	3.91	4.76	6.8

The other watercourses namely, the Knocknacarra Stream, the Bearna Stream, the Trusky Stream and the Sruthan Na Libeirti Stream were not investigated as part of the CFRAM study. These are minor water courses with poorly maintained and defined channels and in the case of the Knocknacarra Stream large culverted sections. These streams present a flood risk which is reasonably local to their over banks or upstream of culverted sections and which can be easily accommodated or remedied. The Trusky Stream through Bearna has being identified as overtopping its small road culvert on the R336 and putting a number of properties at flood risk.

To the east of the scheme study area, surface drainage features are minimal with high degree of karstification and reliance on groundwater flow. A pluvial flood risk applies to the Doughiska area however, storm pipes have been laid through Merlin Park University Hospital Galway grounds to drain this area. The Glenascaul/Deerpark area to the east of the scheme study area is subject to pluvial and groundwater flooding. Details of groundwater and pluvial flood risk, obtained from the Office Public Works Preliminary Flood Risk Assessment and Management Plans, are shown on **Figure 4.6.2** and **4.6.3.**

4.6.3.5 Surface Water Abstraction

The Terryland Water Works abstraction serving 40,000 population equivalent (PE) (approximately 300m^3/hr at 180 l/person/day) is taken from an inlet channel off the Jordan's Island eastern River Corrib channel approximately 200 metres upstream of Quincentenary Bridge. This is an import source of potable water supply to Galway City and environs and is sensitive to pollution, the River Corrib Water level and the flow distribution around Jordan's Island. Its source protection area would extends up into and include Lough Corrib.

4.6.3.6 Hydroecology

Water dependant habitats may be impacted by a road option through accidental contamination, localised flooding through stormwater drainage or through the alteration of the natural base-flow water supplies to fens and marshlands triggering a change to the hydrological regime or causing the area to dry out. In areas where the a road option passes close to or within an ecologically sensitive habitat, mitigation measures should be put in place to ensure the impact to the hydrological

regime in terms of water level fluctuation, water depth and water quality (pH, Nutrients, etc.) within the habitat is minimal.

The water dependant habitats which may be impacted by changes in hydrological regime and water quality are included in **Table 4.5.4 Section 4.5 Hydrogeology**. These habitats are discussed in more detail in **Section 4.3 Ecology** and shown in **Figure 4.5.5** and **4.5.6.**

4.6.4 Summary

The hydrological constraints to the N6 Galway Road Project are associated primarily with the River Corrib which is part of the Lough Corrib cSAC, a sensitive fishery and amenity river and a major drinking water abstraction source for Galway City. The River Corrib flows and water levels are controlled by the OPW at the Salmon Weirs as part of arterial drainage and flood defence scheme.

There are a number of minor stream crossings to the west of the River Corrib with the more sensitive of these being the Bearna Stream whose downstream estuarine reach is within the Galway Bay Complex cSAC. On the east side of the River Corrib, which is in the limestone terrain, there are very few surface water features present, with recharge percolating away to groundwater through the generally free draining till and limestone bedrock. The more sensitive surface water features to the east of the river are the Coolagh Lakes which are part of the Lough Corrib cSAC, Ballindooley Lough which is a groundwater controlled lake system and the Terryland Stream. Annex I Water dependent habitat and Wet heath habitat is present to the west of the River Corrib with sections of the Moycullen Bog Complex NHA within the scheme study area. Dewatering of such habitat is considered to represent a significant constraint, as is water pollution to the River Corrib and the Coolagh Lakes. There area number of flood risk/floodplain areas identified within the scheme study area associated with fluvial, groundwater (Turlough flooding) and pluvial flooding and these carry medium to very high attribute value.

Table 4.6.5 below shows a summary of all of the hydrology constraints within the study area. The constraints are identified as hydrological attributes and their relative attribute importance is identified based on the NRA guidelines for assessment of hydrology on national road schemes.

Table 4.6.5 Hydrological Attributes and Attribute Importance

Hydrological Attribute	Attribute Importance
River Corrib	Extremely High
Sruthan Na Libeirti	Medium
Trusky Stream	Medium
Bearna Stream	High
Knocknacarra Stream	Medium
Distillery Stream	Low
Terryland River	Medium
Galway Bay Coastal Waters	Extremely High
Ballindooley Lough	High
Coolagh Lakes	Extremely High

Hydrological Attribute	Attribute Importance
Lough Atalia	Extremely High
River Corrib Floodplain	Very High
Sruthan Na Libeirti Floodplain	Medium
Trusky Stream Floodplain	High
Bearna Stream Floodplain	High
Knocknacarra Stream Floodplain	High
Distillery Stream Floodplain	Medium
Terryland River Floodplain	High
Doughiska Pluvial Floodplain	High
Terryland Water Works Potable Water Extraction	Very High
Hydrologically Sensitive Ecological Attribute	Refer to **Section 4.3**

4.6.5 References

Arthure J.B. (1960) *"Construction of a Sluice Barrage on the River Corrib at Galway"* IEI

Office of Public Works. (1987) *Hydraulic and Hydrologic Investigation of Lough Corrib Flow Regime and of Gate Manipulation Policy at Gawly Sluice Barrage*

Office of Puplic Works Catchment Flood Risk Assessment and Management. *Western Basin Corrib Catchment* – Inception Report

Office of Public Works. Preliminary Flood Risk Assessment Mapping for County Galway

Office of Pupblic WorksCatchment Flood Risk Assessment Management. *Flood Extent and Flood Zone Mapping* – Corrib Catchment Galway City

Tobin. (1999) *Terryland River Valley Drainage Scheme* for Galway Corporation

Hydro Environmental Ltd. (Oct 2011) *Strategic Flood Risk Assessment Study of National University of Ireland Galway Campus*

Galway Harbour Extension Environmental Impact Statement. – (2014) *Chapter 8 Water*

Office of Public Works. *Flood Studies update* web Portal http://opw.hydronet.com/

Office of Public Works. *Network of live gauged Water level data* http://waterlevel.ie/

Office of Public Works. *Floodmaps.ie Historical archived flood events* web site http://floodmaps.ie/

Environmental Protection Agency. *Hydrotool web site for estimating low flow and flow duration in gauged and ungauged Irish rivers and streams* http://watermaps.wfdireland.ie/HydroTool/

N6 Galway Outer Bypass – *Constraints Study 2006*

N6 Galway Outer Bypass – *Route Selection Study 2006*

N6 Galway Outer Bypass – *EIS Reports 2008*

Environmental Protection Agency (2015) *Water Quality in Ireland 2010-2012*

Western River Basin Management Plan 2009-2015

Water Maps - Mapping Information System to support River Basin Management Plans http://www.wfdireland.ie/maps.html

Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes (2008)

4.7 Landscape and Visual

4.7.1 Introduction

This section describes the landscape and visual constraints identified within the scheme study area for the N6 Galway City Transport Project.

This constraints study examined the existing landscape and highlights landscape and visual features of sensitivity that may influence the development of feasible route options.

The landscape and visual environment is comprised of both natural and built elements including topography, water bodies, vegetation, wildlife habitats, open spaces, developed lands, buildings and structures and views to and from such elements. The landscape and visual constraints are presented on **Figures 4.7.1** and **4.7.2**.

Section 4.7.2 describes the methodologies and sources of information that were used to carry out this constraints study. **Section 4.7.3** describes the landscape and visual constraints within the scheme study area. A summary is presented in **Section 4.7.4** and references are listed in **Section 4.7.4**.

4.7.2 Methodology and Sources of Information

Landscape assessment is concerned with the alteration to the physical landscape which may give rise to changes in its character, how it is experienced and the ascribed value of the landscape. Visual impact assessment is concerned with changes that arise in the overall effect on visual amenity.

The approach sought to highlight landscape and visual constraints through undertaking site visits and on-ground reviews, and in having regard to the following principal sources of information:

- Ardaun Local Area Plan (Pre-Draft Stage);
- Bearna Local Area Plan 2007-2017 and Associated Maps;
- Galway City Development Plan 2011-2017 and Associated Maps;
- Galway County Development Plan 2015-2021 (including Landscape and Landscape Character Assessment for County Galway) and Associated Maps;
- National Inventory of Architectural Heritage;
- Ordinance Survey Mapping and Aerial Photography;
- Online Local Information; and
- Other Environmental Aspects of the Study, *e.g.* Flora and Fauna and Cultural Heritage.

4.7.3 Existing Environment

4.7.3.1 Overview

Galway City is situated on the River Corrib – a short *c*.6km of river linking Lough Corrib in the north to Galway Bay in the south. The historic city and the city core is centred on the southern end (mouth) of the river but the city has also extended significantly both east towards Oranmore and west towards Bearna. Development has also extended along the corridors of the various national, regional and local roads that radiate out east, north and west from the city centre, where it is increasingly subsuming the village settlements of Coolagh-Briarhill, Castlegar, Coolagh-Menlo and Menlough.

The landscape within the city and north along the River Corrib corridor is low-lying generally being lower that 30m above ordnance datum (AOD). Within the extended city, the landscape rises gradually to the east to *c*.70m AOD at Briar Hill where the local high point is topped by a reservoir. To the northeast, the landscape undulates gently westward over shallow valleys at between *c*.20 to 30m AOD and across low ridges (up to *c*.60m+ AOD) to the River Corrib/Lough Corrib. The ridges at Ballygarraun/Pollkeen and Ballindooley are topped with large hard rock limestone quarries and exposed Limestone pavement and stone walls are a feature of the wider area from Ballindooley through to Menlough.

The ruin of Menlo Castle and its associated grounds provide an attractive landmark feature on the east side of the river close to where it exits Lough Corrib. Menlough Village, also located on the east bank of the river, has an attractive and historic network of narrow rural roads with a dense network of residential properties on standalone sites.

The River Corrib north of the defined city is a broad attractive watercourse set within a mixed landscape of grassland and marginal grassland, scrub plantings, sports areas (*e.g.* NUIG Recreational Facilities and Glenlo Abbey Golf Course) and areas wetland/marsh – especially at the northern reach of the river approaching Lough Corrib. The entire valley is low-lying – usually below 10m AOD.

West of the river corridor, the landscape rises to the northwest where a local high point at Tonabrocky (111m AOD) is marked with telecommunication masts. From Tonabrocky the landscape falls gradually southwards to the coastal corridor extending to either side of Bearna Village.

A large lake, Lough Inch, is located *c*.1.5km northwest of Bearna Village. Large areas of bogs/peatlands are located west/northwest of Bearna, including around Lough Inch and at Tonabrocky Bog further north.

Extensive residential development is a particular feature along the R336 Regional Road and along other local roads of the wider area surrounding Bearna Village.

Extensive residential, community and mixed developments is also a feature along the N59 corridor extending northwest from the city. This includes industrial parks and small sports grounds, as well as the major developments such as NUIG Recreational Facilities at Dangan and a golf course at Glenlo Abbey Hotel.

In conclusion, the scheme study area spans the developed city centre of Galway; its outer suburbs and its rural hinterland. The area is sandwiched between Galway Bay to the south and Lough Corrib to the north and divided east and west by the north

south riparian landscape corridor of the River Corrib, which links the lake to the coast.

As such, the main landscape constraints in the scheme study area revolve around the diversity of ecological/landscape and cultural areas, comprising a matrix of open grassland, Limestone pavement, marsh, wetland, river corridor/lake edge, scrub/tree plantings, sports grounds (including Galway Racecourse and NUIG) and open spaces. These landscape constraints have a strong correlation to areas of ecological importance, which add to overall landscape diversity and interest. In this regard the River Corrib corridor is considered to be of the highest significance.

The main visual constraints revolve around residential, community and social amenities dispersed across urban, suburban and linear areas as well as rural villages located within the scheme study area. Visual constraints also apply to features of archaeological, architectural and cultural heritage, *e.g*. Menlo Castle, Bushy Park House, *etc*., as described under **Section 4.11 Archaeological, Architectural and Cultural Heritage** of this report.

4.7.3.2 Landscape and Visual Constraints

Landscape and Visual Constraints are considered under:

Landscapes: *i.e*. trees, woodlands, natural landscapes; designated or protected landscapes; parks, open spaces, sports, recreational and amenity areas; etc. ; and

Visual Receptors: *i.e*. residential and community land uses and properties; designated views and prospects; scenic walks; cultural features, etc.

The majority of the scheme study area is located within the boundary of Galway City Planning Authority, and most of these aspects are highlighted within the Galway City Development Plan 2011-2017 and associated land use maps. Likewise other landscape and visual aspects, including landscape character assessment, are provided in Galway County Development Plan 2015-2021.

Landscape Character & Landscape Character Areas

The landscape character assessment of County Galway indicates that the majority of the southern, central and western portion of the scheme study area is located within Landscape Character Area (LCA) 9: *Inverin to Galway City Coastline, which covers the southwestern portion of the study area in and around Bearna and City Coastline (*refer Figure 1: Baseplan of Landscape and Landscape Character Assessment for County Galway).

Thereafter, and running clockwise from the Bearna/Galway Coastline (LCA 9 – above):

- The north-western portion of the scheme study area (from Lough Inch through Tonabrocky to the immediate east of the N59) is located at the eastern end of LCA 12: *South foothills of east Connemara Mountains (west of Salthill to Rossaveel)*;
- The northern portion of the scheme study area running from the city north along the River Corrib to Lough Corrib and from east of the N59 to west of the N84 is located in LCA 11: *Lough Corrib and environs;*

- The north-eastern portion of the scheme study area from west of the N84 to the N17 is located at the very southern end of LCA 5: *Northeast Galway (Tuam environs);*
- The eastern portion of the scheme study area from the N17 to the M6 is located at the very western end of LCA 3: *East Central Galway (Athenry, Ballinasloe to Portuma); and*
- Finally the south-eastern portion of the scheme study area from the M6 to Galway Bay is located at the very north-western end of LCA 13: *East Galway Bay (Oranmore to Kinvara Bay and inland to N18 Road).*

The Lough Corrib landscape character area (LCA 11), which covers the northern end of the scheme study area north of the developed city, is the most significant, being described as...

...'*wide dramatic expanse of water including many islands supporting deciduous woodland. The land surrounding the southern section is flat, open grassland. The landscape of the Lough and its surrounds is highly scenic and includes many facilities for visitors*.' (**Section 2.13 of Landscape and Landscape Character Assessment for County Galway**).

Landscape Value and Sensitivity

The landscape value and landscape sensitivity of the different landscape character areas (LCA) within the scheme study area is set out in **Table 4.5.1.**

Table 4.5.1 Landscape Character: Value and Sensitivity

Landscape Character Area	Landscape Value Area	Landscape Sensitivity
LCA 3	Low	Class 1-Low with pockets of Class 2-Moderate
LCA 5	Low	Class 1-Low with pockets of Class 2-Moderate
LCA 9	High	Class 3-High with pockets of Class 4-Special
LCA 11	Outstanding	Class 5-Unique with pockets of classes 3-Moderate and 4-Special
LCA 12	Medium	Approximately half class 4-Special and half Class 3-Moderate
LCA 13	High	Class 3-High with a coastal edge of Class 4-Special

Much of the scheme study area – in particular along the coast (LCA 9 & 13) and between the city and Lough Corrib – is of High or Outstanding Landscape Value and of Special or Unique Landscape Value.

The western portion of the scheme study area (LCA 12), i.e. north of Bearna, is described as Medium Value and Moderate Sensitivity (Class 2); while the eastern portion of the scheme study area (LCA 3 & 5) is of Low Value and Low Sensitivity (Class 1 – with pockets of Class 2-Moderate).

*(*Refer to 'Landscape Value Rating' Figure and 'Landscape Sensitivity Rating' Figure 3 of Landscape and Landscape Character Assessment for County Galway).

Parks and Green Network

There is a broad range of areas of recreation and amenity open spaces and parks in the city. These areas are strongly associated with each other and form a combined natural resource within the city.

Some of these assets extend outside of the city area and into the county area, *e.g.* River Corrib greenway proposals.

The Galway City Parks and Green Network are set out in **Table 4.7.2.**

Table 4.7.2 Galway City: Parks and Green Network

Open Space Type	Location
Three City Parks	Bearna Woods/Lough Rusheen. Merlin Park Woods. Terryland Forest Park.
Neighbourhood Parks	Mixed sized parks located adjacent to residential areas *e.g.* Renmore Park, Mervue, McGrath's Field (Knocknacarra), Ballinfoyle Park, South Park and Shantalla Neighbourhood Park.
City Centre Parks	Central city locations including Kennedy Park, Millennium Children's Park, Riverside Walk, Fr. Burke Park, Celia Griffin Memorial Park and Woodquay.
Enclosed Marine/ Wetland and Coastal areas	Silverstrand to Roscam including Lough Rusheen, Lough Atalia, Ballyloughane Beach.
Rivers and Waterways	River Corrib and canal systems.
Civic Spaces	Eyre Square, Fishmarket Square, Shop Street/Quay Street, Courthouse Square, Woodquay, The Small Crane.
Greenways	Greenways including coastal, river, canal and woodland walk and cycle ways.
Residential Open Space	Open space in residential areas occurs throughout the city.
Commercial and Industrial Open Spaces	Throughout the city including IDA lands. Areas offering general amenity value often with landscape planting within the grounds of commercial or industrial developments.
Institutional Open Space	Throughout the city including NUIG and GMIT grounds and Merlin Park University Hospital grounds.
Cemeteries	Throughout the city including St. James Cemetery and Rahoon Cemetery.
Recreational and Amenity Zoned Lands	Located at the fringes of the City including Galway Racecourse, Dangan Woods, Roscam Woods and lands at Kingston.
Agricultural and High Amenity lands	Throughout the city including land at Menlo Castle and woods and lands at Roscam.

Greenways and Public Rights of Way

Greenways are '*circulation routes reserved exclusively for non-motorised journeys, developed in an integrated manner, which enhances both the environment and quality of life of the surrounding area*' (Declaration towards a European Greenway Network, 2000).

Within the city, existing and proposed greenways, such as the riverside walk, form connections between urban areas and the natural hinterland linking habitats. They are also proposed as links, between residential and community services, in particular existing and future school sites.

In the City Development Plan **Policy 4.3:** Greenways and Public Rights of Way seeks to further develop the network including links outside of the city area, ***e.g.*** to Bearna, along the coast and along the River Corrib, as follows:

- Continue to develop and improve the greenway network in the city, providing alternative accessible circulation routes for pedestrians and cyclists, for the enjoyment and recreational use by the entire community.
- Develop a strategic citywide coastal greenway from east to west linking with riverside walkways having due regard to nature conservation considerations.
- Investigate the potential of linked greenways from the city into the county area in particular to Bearna, Oranmore and Tonabrocky.

Natural Heritage and Biodiversity

Natural and semi-natural habitats located in the city include the coastline, waterways, urban woodlands, wet meadows, lakes, grassland, limestone pavement and blanket bog. Other natural features such as views and prospects of amenity value, trees and features of geological interest also contribute to this resource. Refer also to **Section 4.3 Ecology**

This resource includes a wide range of Natural Heritage Areas (pNHAs/NHAs); Sites of Geological Importance; Local Biodiversity Areas; as well as Other Areas/Features of Local Importance in the City. These include key landscape areas such as Doughiska, Merlin Park Woods, Galway Racecourse, Terryland Forest Park and Coopers Cave, Ballindooley/Castlegar Wetlands, Menlough to Coolagh Hill Calcareous Habitats, Angliham and Lackagh Quarries, River Corrib and adjoining wetlands, Ballagh – Barnacranny Hill, Cappagh – Ballymoneen Bog, and Rusheen Bay – Bearna Woods – Illaunafamona Habitats.

Coastal Areas, Canals and Waterways

The coast, Lough Corrib, rivers and canals are important natural resources in the city, providing long-term benefits for both people and wildlife.

The river and its banks, canal system and the coastline, by virtue of their linear and continuous nature, are valuable wildlife corridors linking with the natural hinterland. Outside of the city centre, the banks of the River Corrib are semi-natural in character and development is restricted in order to protect water quality and the semi-natural character of the river.

Galway's coastal area is an important tourist and recreational amenity.

Along the coastline, land use zoning reflects the international ecological importance of the bay, its high visual amenity and the dynamic nature of coastal flooding and erosion processes.

In the City Development Plan, **Policy 4.5** Coastal Area, Canals and Waterways seeks to protect, conserve, develop and enhance these aspects.

Urban Woodlands, Trees and Hedgerows

Trees, urban woodlands, and hedgerows provide ecological links within the wider landscape and need to be valued and protected. Other woodlands including parks such as, Merlin Park Woods, Terryland Forest Park and Bearna Woods/Lough Rusheen Park, are important amenities in the city.

In the City Development Plan, **Policy 4.6** Urban Woodlands and Trees seeks to protect, integrate, manage and promote such areas and features within the city.

Views of Special Amenity Value and Interest

In general, these views are of the coastal areas, River Corrib, Lough Corrib and panoramic views of the surrounding rural countryside and skyline. However, the City Plan acknowledges that views are not static and can be changed by both natural and human activity.

Protected views within the city can be classified into panoramic views and linear views (refer **Table 4.7.3**). The former allows expansive views over landscape while the latter are views towards a particular landscape, observed from a particular roadway.

In the City Plan, Policy 4.8 refers to Views of Special Amenity Value and Interest and seeks to protect such and control of inappropriate development.

Table 4.7.3 Galway City Views of Scenic Amenity Value and Interest

View No.	Description
Panoramic Views	
V.1	Panoramic views of the city and the River Corrib from Circular Road.
V.2	Views from Dyke Road and Coolagh Road encompassing the River Corrib and Coolagh Fen.
V.3	Seascape views of Lough Atalia from Lough Atalia Road, College Road, Dublin Road and Lakeshore Drive.
V.4	Seascape views of Galway Bay from Grattan Road, Seapoint, the Salthill Promenade and the Coast Road to the western boundary of the golf course.
V.5	Seascape views encompassing Lough Rusheen including section of Blake's Hill, sections of Knocknacarra Road, sections of Bearna Road from Knocknacarra to city boundary and including the road to Silverstrand Beach.
V.6	Panoramic views of the city and the Terryland Valley from parts of the Castlegar-Ballindooley Road.
V.7	Views encompassing Lough Corrib from parts of the Quarry Road and Monument Road.
V.8	Seascape views of Galway Bay from the old Dublin Road to the City boundary.
V.9	Views toward the sea at Roscam.
Linear Views	

View No.	Description
V.10	Views from Galway-Moycullen Road (N59) of the River Corrib.
V.11	Views from Waterside of the River Corrib.
V.12	Seascape views of Galway Bay from Kingston Road.
V.13	Seascape views of Galway Bay at Ballyloughane from south of the railway bridge.
V.14	Views northwards encompassing the River Corrib and adjoining lands from Quincentenary Bridge.
V.15	Views towards Galway Bay from Hawthorn Drive, Renmore.
V.16	Views from Quincentenary Bridge Road southwards over Terryland Forest Park and River Corrib.
V.17	Seascape views from Military Walk, Renmore.
V.18	Views towards River Corrib from junction of St. Bridget's Place with St. Bridget's Terrace.
V.19	Views encompassing Ballindooley Lough from parts of the Headford Road.

Likewise a number of **Focal Points and Views** are identified for protection in the **County Development Plan** (Section 9.12 and Map FPV1), and also in the Landscape Character Assessment for the County. The following Focal Points/Views are within the scheme study area.

70 – View of the River Corrib from the N59

71 – View of the headland Illainafamona

72 – View of the sea from north of Bearna

73 – View of Lough Inch from the surrounding Third Class Roads

74 – View of North Clare Coast

Other Land uses and Visual Receptors

Other landscapes includes the general background landscape which comprises a diverse mix of agricultural lands, bogs, peatlands, areas of scrub, wetlands, rivers, smaller waterbodies and quarries.

Residential development either in the form of residential estates, linear roadside development or as standalone properties represent the most prominent and significant visual sensitivity within the scheme study area. Such development is widespread within the City and extends into outer suburbs and along national, regional and local roads throughout the scheme study area.

The scheme study area also contains a number of smaller rural villages, including historic settlements such as Bearna, (which has grown significantly into its hinterland), Menlough, Coolagh, Ardaun, *etc*.

In addition, to the landscape elements listed previously, views to and from such areas, including to and from features of natural and/or cultural interest, *e.g.* Menlo Castle are also significant visual receptors.

4.7.4 Summary

The key landscape constraints in the scheme study area revolve around the diversity of ecological/landscape and cultural areas, comprising a matrix of open grassland, Limestone pavement, marsh, wetland, river corridor/lake edge, scrub/tree plantings, sports grounds (including Galway Racecourse and NUIG) and open spaces.

These landscape constraints have a strong correlation to areas of ecological importance, which add to the overall landscape diversity and interest. In this regard the River Corrib corridor is considered to be of the highest significance.

The key visual constraints revolve around residential properties and areas, as well as community and social amenities dispersed across the wide range of urban, suburban and rural areas within the scheme study area. Visual constraints also apply to features of cultural heritage, *e.g.* Menlo Castle, and also to views to and from the range of landscape features.

4.7.5 References

(2014) *Ardaun Local Area Plan (Pre-Draft Stage)*

Bearna Local Area Plan 2007-2017

Environmental Protection Agency. (2002) *Guidelines on the information to be contained in EIS.*

Environmental Protection Agency. (2003) *Advice Notes on current practice in the preparation of EIS*.

Galway City Development Plan 2011-2017

Galway County Development Plan 2015-2021

National Inventory of Architectural Heritage (NIAH)

National RoadsAuthority. (2010) *National Roads Project Management Guidelines.*

Ordinance Survey Mapping and Aerial Photography.

4.8 Artificial Constraints

Artificial Constraints are those which are forming part of the built environment, namely Land Use and Planning Context which is detailed in **Section 4.9 Land Use and Planning Context**, Engineering which is detailed in **Section 4.10 Engineering**, Archaeology, Architectural and Cultural Heritage which is detailed in **Section 4.11 Archaeology, Architectural and Cultural Heritage**, Material Assets – Agriculture which is detailed in **Section 4.12 Material Assets – Agriculture** and Material Assets – Non- Agriculture which is detailed in **Section 4.13 Material Assets – Non- Agriculture,** Air Quality and Climate which is detailed in **Section 4.14 Air Quality and Climate,** Noise and Vibration which is detailed in **Section 4.15 Noise and Vibration,** and Human Beings which is detailed in **Section 4.16 Human Beings**.

4.9 Land Use and Planning Context

4.9.1 Introduction

This section describes the land use and planning constraints within the scheme study area for the N6 Galway City Transport Project. These constraints are presented on **Figures 4.9.1** to **4.9.5.**

Section 4.9.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.9.3** describes the existing land use and planning constraints and **Section 4.9.4** describes the proposed developments identified within the scheme study area, **Section 4.9.5** describes the aspirations for Galway City, **Section 4.9.6** Urban Design Principles of Galway City, and Section **4.6.7** Aspirations for Galway County. A summary is presented in **Section 4.9.8** and references are listed in **Section 4.9.9**.

4.9.2 Methodology and Sources of Information

Methodology

Planning in County Galway and Galway City is guided by local, regional and national planning guidelines, policies and plans. These were examined as part of this Constraints Study.

Sources of Information

The planning guidelines, policies and plans which were examined as part of the development of the N6 Galway City Transport Project and the constraints identified therein are as follows:

- Galway City Development Plan (2011 – 2017):
- Galway Metropolitan Smarter Travel Areas Action Plan (2010 – 2015);
- Galway City and Environs Walking and Cycling Strategy (2010);
- Galway Public Transport Feasibility Study (2010);
- Galway Strategic Bus Study (2007);
- Recreation and Amenity Study (2008);

- Galway County Council Major Emergency Plan (2013 – 2014);
- National Transport Authority 5 Year Plan (2012);
- Galway County Development Plan (2015 - 2021):
- Ardaun/Garran Concept Study (2007);
- Ardaun Local Area Plan Pre-draft Issues Paper (2014)
- Bearna Local Area Plan (2007 – 2017);
- Galway Transportation and Planning Study (2002);
- Sustainable Rural Housing Guidelines for Planning Authorities (2005);
- Gaeltacht Local Area Plan (2008);
- Guidelines for Planning Authorities on Sustainable Residential Development in Urban Areas (2009);
- Design Manual for Urban Roads and Streets (2014);
- Galway Chamber, Traffic and Travel Trends in Galway City; and
- Department of the Environment, Community and Local Government, Planning Policy Statement (2015).

In addition to the guidance documents noted above, institutions and industrial centres within the city and county have planned developments which were consulted. These include:

- Galway Port Development Plan (2013);
- National University of Ireland, Galway Masterplan (2008);
- National University of Ireland, Galway Strategic Plan (2009 - 2014);
- National University of Ireland, Galway Strategic Plan (2015 - 2020);
- Galway Mayo Institute of Technology;
- Industrial Development Authority (IDA) Masterplan - Parkmore East;
- Galway Shopping Centre Masterplan/Framework Plan;
- Knocknacarra District Centre Masterplan/Framework Plan;
- University Hospital Galway Planned Developments; and
- Merlin Park University Hospital Galway.

4.9.3 Existing Land Use and Planning

4.9.3.1 Historical Significance & Development of Galway

Settlements have been recorded at the location of Galway City since 1124 with the formation of a fort called “Dun Bhun na Ghaillimhe”.

In the intervening period control of the city shifted between the Irish, the British and the Normans. This led to the development of a city rich in historical and cultural heritage with a “*strong medieval architectural and archaeological legacy*”. All of which combines to give Galway City its unique cultural and historical identity.

4.9.3.2 Population and Travel Patterns

An analysis of Census 2011 data yields the following:

- Galway City has a population of approximately 75,500, an increase of 4.3% since the 2006 census;
- Galway County (including Galway City) has a population of approximately 250,000, an increase of 8.2% since the 2006 census;
- The population of Galway County which is west of the River Corrib is approximately 77,000;
- The population of Galway City west of the River Corrib is approximately 39,625;
- The population outside the city is relatively dispersed;
- The population density outside the city and the environs is relatively low;
- The number of workers travelling into Galway City and its suburbs is approximately 20,500, an increase of 8.6% since the 2006 census. The number of people at work in Galway City and suburbs is 41,402;
- The combined student population (between primary, post primary and tertiary) is approximately 25,000;
- Travel by car is the choice of the majority in County Galway; and
- The car was the main transport mode for people commuting into Galway City (90%).

Commuting patterns, from existing residential development to centres of employment, were examined in order to establish trip patterns in the Galway Public Transport Feasibility Study (2010). It found that there are many relatively unique trips which are not replicated over a twenty four hour period, and which are reflective of the dispersed land use patterns with dispersed residential and workplace destinations of Galway City and County.

4.9.4 Proposed Developments

There are numerous planned and proposed infrastructural, residential, commercial, institutional and industrial developments in Galway City and County. These projects are set within the context of the Galway City and Galway county land use zoning objectives maps, which form part of the respective Development Plans.The project stages range from concept/feasibility stage through to implementation and construction. These developments are graphically presented in **Figures 4.9.1** to **4.9.4**.

Figure 4.9.4 graphically presents all of the planning applications made since 2013 to both Galway City and County Council that lie within the scheme study area.

Figure 4.9.5 illustrates planned future cycling and pedestrian networks.

4.9.5 Aspirations for Galway City

The Galway City Development Plan 2011-2017 sets out the aspirations for Galway City within its lifetime and the near future. As noted in the foreword to the plan, it

aims to "*set out a coordinated and integrated spatial framework for the continued development of this attractive and vibrant City in a sustainable and inclusive manner*". With reference to local, regional, national and European policies the plan sets out the main strategies for:

- Housing, including for city expansion to east Galway to lands at Ardaun;
- Transportation;
- Natural Heritage, Recreation and Amenity;
- Enterprise and Employment;
- Community and Culture;
- Built Heritage and Urban Design; and
- Environment and Infrastructure.

The strategic goals of the plan are as follows:

- Promote balanced and sustainable economic development that will enable Galway City to fulfil its role as a National Gateway and a Regional Centre, providing sufficient employment opportunities and appropriate services;
- Use the role of the Gateway to harness the strengths and maximise the economic development of the region;
- Provide for a built and natural environment that is of high quality and that contributes to providing a good quality of life for residents and visitors and affords sustainable transportation opportunities;
- Promote social inclusion in accordance with the National Anti-Poverty Strategy 2007 and the National Action Plan for Social Inclusion 2007-2016 and aim to reduce and ultimately eliminate poverty levels in accordance with national targets;
- Facilitate the achievement of the goals contained in the Galway City Development Board (GCDB) Strategy Gaillimh Beo agus Briomhar (GCDB) 2002-2012; and
- Promote the reduction of greenhouse gas emissions through proactive measures in line with EU commitments to tackle climate change.

4.9.6 Urban Design Principles of Galway City

Due to the potentially intrusive nature of any option which would include the update of the existing road infrastructure, it was necessary to interrogate the Galway City Development Plan and the associated reference documents in order to develop a framework which could be used to guide the optioneering process. Of particular importance was the need to consider the urban design philosophy followed during the preparation of the City Development Plan.

It is noted within the Development Plan that the following principles are critical in the consideration of the urban design of Galway City:

- Character;
- Legibility;
- Ease of Movement;

- Quality of the Public Realm;
- Continuity and Enclosure; and
- Diversity and Adaptability.

The principles above are to be examined and incorporated into the development and assessment of options to ensure that major new upgrades would be integrated into the city structure and that new schemes would emphasise, retain or enhance the city's identity.

4.9.7 Aspirations for Galway County

The Galway County Council Development Plan (2015-2021) sets out the aspirations for Galway County within its lifetime and the near future. As noted in the background to the plan, it aims to "*sets out an overall strategy for the proper planning and sustainable development of the functional area of Galway County Council*". With reference to local, regional, national and European policies the plan sets out the main strategies for the County in the areas of:

- Spatial Strategy, Core & Settlement Strategy, including for development of lands at Ardaun as part of the City and County development strategy;
- Urban & Rural Housing;
- Economic Tourism & Retail Development;
- Roads & Transporation;
- Water, Wastewater, Waste Management & Extractive Industry;
- Energy/Renewable Energies & Communications Technology;
- Climate Change & Flooding;
- Heritage, Landscape & Environmental Management;
- Cultural, Social & Community Development; and
- Agriculture, Fishing, Marine Resources & Forestry.

The Plan further sets out vision for the County which is to "*enhance the quality of life of the people of Galway and maintain the County as a uniquely attractive place in which to live, work, invest and visit, harnessing the potential of the County's competitive advantages in a sustainable and environmentally sensitive manner*."

The strategic aims of the Plan are set out at 1.7 of the Plan and in summary include:

1. Promote regional development and growth through harnessing the competitive advantages of County Galway;
2. Afford suitable protection to the environment;
3. Recognise the importance of living landscapes while ensuring they are managed in a sustainable and appropriate manner;
4. Seek balanced urban and rural development;
5. Encourage and support the development of inclusive communities;
6. Ensure integrated development;

7. Promote sustainable mobility;
8. Promote An Ghaeltacht as an Irish speaking community;
9. Facilitate the development of infrastructural projects which will underpin sustainable development;
10. Enhance and protect the built heritage and natural environment; and
11. Integrate climate change consideration in planning and delivering work programmes.

The principle of sustainable development is a major component of the plan which is reflected in the Plan's policies and objectives.

4.9.8 Summary

The scheme study area for the N6 Galway City Transport Project includes a mixture of urban and suburban regions in addition to agricultural lands, and key future lands planned to be delivered as part of city and county policy, at Ardaun. The scheme study area includes urban residential zones, education centres, retail zones, employment zones, and high amenity areas, the aims and objectives of which must be fully considered and incorporated into the development of options for the transport project.

During the development of the options for the transport project, consideration shall be given to protecting planning objectives contained within the Development Plans for the area, to ensure that the Vision for Galway City and County is achieved, in tandem with and through the delivery of, the proposed Galway City Transport Project.

4.9.9 References

Census. (2011)

POWCAR. (Census 2011)

Galway City Council Development Plan. (2011 – 2017)

Galway Metropolitan Smarter Travel Areas Action Plan. (2010 – 2015)

Galway City and Environs Walking and Cycling Strategy. (2010)

Galway Public Transport Feasibility Study. (2010)

Galway Strategic Bus Study. (2007)

Recreation and Amenity Study. (2008)

Galway County Council Major Emergency Plan. (2013 – 2014)

Ardaun/Garran Concept Study. (2007)

Ardaun Local Area Plan Pre-Draft Issues Paper. (2014)

Bearna Local Area Plan. (2007 – 2017)

Galway Transportation and Planning Study. (2002)

Sustainable Rural Housing Guidelines for Planning Authorities. (2005)

Gaeltacht Local Area Plan. (2008) Guidelines for Planning Authorities on Sustainable Residential Development in Urban Areas (2009)

Urban Design Manual. (2009)

Design Manual for Urban Roads and Streets. (2014)

Galway Chamber, *Traffic and Travel Trends in Galway City*

Department of the Environment, Community and Local Government. (2015) *Planning Policy Statement*

National Transport Authority. 5 Year Plan (Galway City) *(*2012) - *Framework Plan for Investment*

Galway County Council Development Plan. (2009 – 2015, 2015 - 2021)

Link & Place. (2008) – *A Guide to Street Planning & Design*

Galway Port Development Plan. (2013)

National University of Ireland. (2008) *Galway Masterplan*

National University of Ireland. *Galway Strategic Plan* (2009 - 2014)

National University of Ireland. *Galway Strategic Plan* (2015 - 2020)

Galway Mayo Institute of Technology. *Planned Developments*

Industrial Development Authority (IDA). *Masterplan - Parkmore East*

Galway Shopping Centre. *Masterplan/Framework Plan*

Knocknacarra District Centre. *Masterplan/Framework Plan*

University Hospital Galway. *Planned Developments*

Merlin Park University Hospital Galway

4.10 Engineering

4.10.1 Introduction

This section describes the engineering constraints identified within the scheme study area for the N6 Galway City Transport Project.

This section identifies the main engineering and infrastructural constraints which comprise of the natural features (topography and landscape, rivers and the coastal domain) and the main infrastructure (roads, railways, public transport, ports and airports) within the scheme study area. Major utility constraints such as gas, water, electricity and telecommunications are detailed in **Section 4.13 Material Assets - Non-Agriculture**. Proposed developments are detailed in **Section 4.9 Land Use and Planning.**

The objective of this engineering constraints study was to identify all the engineering constraints within the scheme study area in order to inform the development of route options. The existing environment has been analysed under the headings of topography and landscape, rivers and coastal domain, existing road network, traffic, other transport modes and quarries.

Section 4.10.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.36.3** describes the engineering constraints identified within the scheme study area. A summary is presented in **Section 4.10.4** and references are listed in **Section 4.10.5**.

4.10.2 Methodology and Sources of Information

Research for this constraints study was undertaken as a desktop exercise. The following sources of information were consulted in order to identify engineering constraints:

- Ordinance Survey Ireland (OSI);
- Galway Harbour Company;
- Galway City Council;
- Iarnród Éireann;
- Bus Éireann;
- City Direct;
- Office of Public Works (OPW); and
- Irish Aviation Authority.

4.10.3 Existing Environment

4.10.3.1 Topography and Landscape

The western part of the scheme study area consists of gently undulating to hummocky topography in areas overlying granite.

The ground level is lowest at the shores of Lough Corrib and along the coast (10m OD) and rises to the high points at Gortacleva/Tonabrocky (111m OD), Derry Crih

(96m OD) and Corcullen (90m OD). Ridge lines exist at Tonabrocky and Derry Crih which run northwest-southeast.

The topography to the east of the River Corrib is less pronounced than in the west. The area around the River Corrib is relatively flat and rises to the east. The highest point is at Castlegar-Coolagh Hill (65m OD). From this high point the ground surface gently slopes towards Ballindooley Lough and rises again towards Twomileditch (60m OD).

There are floodplains located along both banks of the River Corrib within the scheme study area, from Lough Corrib to the weir located in Galway City. The floodplains include Jordans Island, sports fields and low lying marshy ground. South of Salmon Weir Bridge the only water compatible developments are South Park and the Galway Harbour Enterprise Park.

4.10.3.2 Rivers and Coastal Domain

The largest river in the scheme study area is the River Corrib. The River Corrib drains Lough Corrib and flows south discharging into Galway Bay. Approximately two kilometres from the outflow location, the River Corrib branches off into the Terryland River which typically flows east and discharges into two swallow holes.

Lough Corrib constrains the scheme study area to the north as the River Corrib is only six kilometres in length. Lough Corrib is the second largest lake in Ireland with a surface area of 178km^2. Numerous smaller streams are located west of the River Corrib to the boundary of the scheme study area and are shown on **Figure 4.10.1**. The majority of these streams drain south directly into Galway Bay or the River Corrib. To the east, the area is notably absent of surface water drainage, suggesting that the karstic landscape results in surface water seeping downwards, the nature of the geology in this area is described further in **Section 4.4 Soils and Geology**.

Galway City has numerous canals. These canals were built as part of major engineering works that was carried out on the River Corrib in the 19th century.

Galway City has a coastline of approximately 13.5km that stretches from Blackrock in the west to Roscam Point in the east, whilst outside of the scheme study area it is immediately adjacent. The area around Claddagh Point and the Docklands are influenced by tidal flooding and also by the River Corrib which discharges to Galway Bay.

4.10.3.3 Existing Road Network

There are national, regional and local roads contained within the scheme study area. The four national roads are the N59, the N84, the N17 and the N6.There is an extensive local road network present in addition to numerous regional roads including the R336, R337, R338, R339, R446, R863, R864 and R866. Refer to **Figure 4.10.1**

The N59 enters on the northwest side of the scheme study area and runs parallel to the River Corrib until it terminates at the Browne Roundabout. The N59 extends from Sligo to Galway City and is 298km in length.

The route forms part of the Atlantic Road Corridor connecting Gateways Sligo and Galway through Westport, Clifden, Oughterard and Moycullen. The portion of the road within the scheme study area is composed of single carriageway. The N59 is the only national road that provides access to the west of County Galway, in particular the Connemara area and the western tourist route.

The N84 enters the scheme study area from the north and terminates at the Kirwan Roundabout. The N84 is a national secondary road which connects Castlebar, Mayo with Galway City and is 73km in length. The portion of the road within the scheme study area is composed of single carriageway. The N84 provides access to Galway City for west Mayo and north Galway.

The N17 enters on the northeast side of the scheme study area and terminates at the junction with the N6 at Castlegar. The N17 is a national primary road which connects Collooney, Sligo to Galway City and is 123km in length. The portion of the road within the scheme study area is composed of single carriageway. The route of the N17 runs through or adjacent to several major towns and places including Claregalway, Tuam, Milltown, Ballindine, Claremorris, Knock, Kilkelly, Charlestown and Tobercurry .The N17 is the main commuter route between Tuam and Galway which also provides the primary route to Knock Airport from Galway City.

The N6 enters the scheme study area to the east and terminates at the at-grade Kirwan Roundabout. The N6 is a national primary road which connects the M6 motorway to Galway City and the Quincentenary Bridge. The R338 continues from the Kirwan Roundabout as a two lane single carriageway road of varying width, including bus lanes on certain sections, to the R336 Coast Road, thus completing a circumferential route around Galway City to the north. The portion of the N6 within the scheme study area is composed of dual carriageway with eight at-grade junctions along its length which cater for the N59, N84, N17, R865, R339 and M6 connections.

The existing regional and rural roads are of varying quality and contain few dedicated facilities for pedestrians and other vulnerable road users apart from through villages and towns.

Closer to the city the area becomes suburban and urban and is comprised of residential, commercial and industrial zones. There are a number of local and regional roads within the scheme study area which can be used as alternative routes. These routes act as ‘rat runs’ for motorists wishing to quickly access various parts of the city during peak period flows.

4.10.3.4 Road Safety Charactistics of Existing Road Network

Current and future traffic volumes

A full traffic modelling study of the scheme study area has been carried out, refer to Chapter 3 for more details of the traffic constraints.

Accident data

A study undertaken by the Road Safety Authority into different collisions in the cities in the Republic of Ireland, including Galway, has shown that the number of fatalities and serious injuries generally declined in the period from 1997 to 2006.

The study notes that almost half of all fatalities in the period from 1997 to 2006 in Galway City were pedestrians. The majority of these fatalities occurred at junctions.

Table 4.10.1 below shows the distribution of collisions in the scheme study area for the period from 1996 to 2012. This data was obtained from the Road Safety Authority. The period 1997 to 2006 in this dataset correlates with the report from the Road Safety Authority into road safety in Galway City. This data however, highlights that there has been a slight increase in the number and severity of all collision types since 2006.

Table 4.10.1 Collision Data Galway City and Environs 1996 – 2012

Year	Killed	Seriously Injured	Minor Injury
1996	6	29	118
1997	7	16	91
1998	6	17	118
1999	2	22	104
2000	2	11	83
2001	4	8	58
2002	1	11	80
2003	2	5	63
2004	4	5	67
2005	4	8	56
2006	1	4	96
2007	5	7	21
2008	3	0	149
2009	1	10	168
2010	0	8	130
2011	1	6	114
2012	2	15	154
Total	51	182	1670

4.10.3.5 Other Transport Modes

Railways

Galway railway station, Ceannt Station, is a two platform station located in the centre of Galway City beside Eyre Square. It is currently the terminus for the Dublin to Galway intercity service, the Limerick to Galway and Athenry to Galway commuter services.

The station opened on the 1 August 1851 and was the western terminus of the Midland Great Western Railway. The railway track from Galway to Clifden was closed by the Great Southern Railways Company in 1935. Historically leaving Galway, this single railway line passed through a tunnel, described by the engineers as a 'cut and cover' which carried Prospect Hill roadway over the railway, then through the outskirts of the city to the River Corrib. The river was crossed by a viaduct with three spans, each of 150 feet, and a lifting span of twenty-one feet, to allow for navigation of the river. Once over the bridge, the line ran along the west side of the river and the western shore of Lough Corrib to Moycullen Station. Once the route was closed the tracks were removed from the line and sold to a German scrap company.

The current railway line runs east from Ceannt Station along the southern boundary of the scheme study area. There are nine to ten services daily from Galway to Dublin as well as eight services daily from Galway to Limerick. There are a similar number of services for the return journeys.

Road based public transport

Bus Éireann currently operates eight city services and four regional services within the scheme study area as shown in **Table 4.10.2**. City Direct Ltd. also operates three bus service routes which cater for Knocknacarra and Bearna as shown in **Table 4.10.3**. The location of these bus routes are depicted on **Figure 4.10.2**

Table 4.10.2 Bus Éireann – Galway City and County bus services

Route No.	Service Type	Destination
401	City service	Eyre Square – Salthill
402	City service	Seacrest – Eyre Square – Merlin Park
403	City service	Eyre Square – Castlepark
404	City service	Eyre Square – Newcastle
405	City service	Rahoon – Eyre Square – Ballybane
407	City service	Eyre Square – Bóthar an Chóiste
409	City service	Eyre Square – Parkmore Industrial Estate
410	City service	Eyre Square – Oranmore
350	Regional service	Bus Station – Dublin Road (GMIT)
424	Regional service	Bus Station – Bearna
425/425A	Regional service	Bus Station – Castlegar (Crossroad)
434	Regional service	Galway – Rosshill Cross (Coast Rd)

Table 4.10.3 City Direct Ltd. – bus services

Route No.	Destination
411	Eyre Square –Cappagh Road
412	Eyre Square – Western Distributor Road
414	Eyre Square – Bearna

GoBus operate 15 daily services from Galway to Dublin airport with 13 to 14 services also serving Dublin City, Route 720. There are a similar quantity of services on the return journeys.

Citylink operate eight direct daily services from Galway to Dublin Airport. A further 12 services facilitate both the airport and Dublin City centre, and an additional three services serve Dublin City centre only. There are a similar number of services for the return journey.

Citylink also operate a number of daily intercity and town services from Galway to, Limerick, Cork and Cork Airport (five no.), Clifden (five no.), Killarney (two no.) and Ballinasloe and Athlone (seven no.) via a commuter route which terminates at Dublin Airport.

Galway City Council operates a Christmas park and ride service which in 2014 ran from the 29 November to the 24 December. The service operates from the Galway Racecourse to the Coach Station in the city centre every 15 minutes.

City Direct Ltd. operates a park and ride facility on behalf of NUIG, providing a shuttle bus operating to and from the college. The 500 space car park is located north of the Corrib Village on Upper Newcastle Road.

NUIG, Galway City Council, HP Galway, Galway University Hospital and other workplaces in Galway have a car share scheme in place and are registered partner organisations with the National Transport Authority's car sharing scheme which is a Smarter Travel Workplace Initiative.

There are numerous taxi and hackney companies based in Galway City, Bearna and Oranmore which operate within the scheme study area.

Ports

Galway Port is the most central port on the west coast of Ireland and is located in the sheltered eastern corner of Galway Bay. The port has a history dating back to the 10th century. Galway City has historically drawn its wealth from the sea; both from fishing and from extensive trade with France, Spain and the West Indies. Currently the port is operated by the Galway Harbour Company.

The port of Galway is situated on the River Corrib and due to the fact that it is a gated port it is subject to the vagaries of rising and ebbing tides. The port is restricted by the size of the current sea channel and therefore cannot facilitate vessels with capacity above 6,000 tonnes. Neither the current channel nor the existing port gates, quays and berths allow for cruise liners to dock at the quayside. Cruise liners currently have to anchor offshore. Eight cruise ships called to Galway in 2014 and there were eight scheduled visits for 2015.

The core business of the Port is in the importation of oil, bitumen, steel and general cargo. The oil capacity of the New Terminal/Topaz (Galway) Terminal is 50,995m^3. Galway Harbour has discharge underground pipeline facilities for

petroleum products and for bitumen. These two commodities accounts for 80% of the current cargo throughput.

Folan Quay presently handles the discharge of oil tankers of 4,500dwt (dead weight tonnage) directly to two tank farms via underground pipelines. One pipeline is connected to the Leeside Terminal and is owned by Topaz/Chevron. The other underground pipeline from Dun Aengus Quay North is owned by the Galway Harbour Company and connects the quay with the newly constructed oil storage facility located at the harbour enterprise park. This facility was commissioned in 2009.

Dun Aengus Quay North handles both refined petroleum products and bitumen. Tanker sizes at this quay being handled are in the region of 6,000 dwt. bitumen ships are handling 5,500dwt to 6,000dwt at this quay.

A planning application to redevelop the port was submitted in 2010. The proposed New Port of Galway consists of 23.89ha of land reclamation. The development will extend 935m out to sea providing 660m of quay berth to –12m Chart Datum (C.D.) depth serviced by a –8m C.D. channel depth. The development itself will consist of berthing facilities for general cargo vessels, oil tankers, passenger vessels, fishing vessels and container vessels. A western marina will be formed providing 216 amenity berths. The development will also contain roll-on/roll-off facilities and berths for naval/research vessels. Breakwaters will be constructed as part of the proposed development to provide requisite shelter and craft stability while berthed.

Airport

Galway airport is located in Carnmore which is located to the east of the scheme study area. The runway is 1,289m in length and 30m in width. The airport was closed on the 31 October 2011 when Aer Arann ceased commercial operations. A number of destinations were previously served by Galway Airport which included Bristol, Cardiff, Cork, Dublin, Edinburgh, Leeds Bradford, London Luton, Lorient, Manchester, Newcastle, Belfast City, Birmingham, Southampton and more. Galway City and County Council purchased the airport in 2013. An 11 month licence has been obtained by Carnmore Aviation Ltd to operate the airport. The Galway Flying Club currently operates from the Galway airport. A feasibility study is to be undertaken on the airports future use by the local authorities.

Walking routes

There is an extensive network of footpaths adjacent to the road networks within the city centre. While some of the facilities do not meet current recommended guidelines, especially for vulnerable road users, the network provides for alternative modes of transport. In addition, there are numerous walking routes located within the scheme study area which provides an amenity for passive recreation as well as an alternative form of travel, such as:

- Bearna Woods;
- Cappagh Park Pitches;
- Silverstrand;
- Salthill Promenade;
- South Park/Claddagh;
- NUIG river walk;

- Terryland Forest Park;
- Crestwood Park;
- Lough Atalia;
- Galway Racecourse;
- Ballyloughane Strand;
- Mervue Slí na Sláinte; and
- Merlin Woods.

4.10.3.6 Quarries

There are numerous quarries located within the scheme study area, as shown on **Figure 4.4.9**, of which the Shantalla quarry, Lackagh quarry, Merlin Park quarry and Roadstone quarry are the most noteworthy. There are many smaller historic quarries located throughout the study area such as the quarries located at Taylors Hill, Salthill, Terryland, Mervue, Twomileditch and Laghtavarna.

Shantalla quarry was first opened in 1889 by the Galway Marble Works company. Shantalla granite was used in the construction industry throughout Galway City and County and can be seen in the wall shafts of the Claddagh Church. At its peak the quarry produced 1000 tonnes of worked stone per week. The quarry went into decline shortly after 1911 and eventually closed.

Lackagh quarry is located in Menlough and was mined by Lackagh Quarry Group Limited for limestone. Decorative stone was produced from the mined limestone. The company was dissolved in 1999 and the quarry is currently inactive.

Roadstone quarry is located in Twomileditch and is the only active quarry within the study area. Roadstone Ltd. operates the limestone quarry and has an approximate landholding of 65.9ha. The quarry was assigned the quarry reference number QY7 and is a pre 1964 quarry.

Merlin Park quarry is a black marble quarry located east of the city. The quarry was opened in 1814. The quarry carries historical significance as the Galway Cathedral and Stormont Castle in Belfast both feature marble from the quarry. The marble of Merlin Park quarry occurred in considerable masses with a straight fracture, on thin strata of plastic clay or argillaceous paste. The solid blocks often weighed more than four tonnes that measured from 5.5 to 6.1 meters in length and from 2.4 to 3.05 meters in width, and were frequently raised, particularly at Anglingham quarry.

4.10.4 Summary

The purpose of this section is to provide analysis of the engineering constraints located within the scheme study area in order to inform the development of options for the scheme.

It was found that there is a substantial restriction between Lough Corrib and Galway Bay which provides a limited space for an additional crossing point of the River Corrib once the built infrastructure of Galway City is included. The western part of the scheme study area consists of gently undulating to hummocky topography in areas overlying granite. The topography to the east of the River Corrib is less pronounced than in the west, the area around the River Corrib is relatively flat and

then rises to the east. The existing road network of Galway City is an important transportation link, both in terms of public transport and private vehicle usage, between west and east Galway as well as between Galway City and other cities. The current pedestrian facilities within the scheme study area are insufficient which is clear from the increase in pedestrian accidents in recent years. The existing railway and port create large infrastructure constraints along the southern boundary of the scheme study area while the airport east of the scheme study area also causes a restriction. There is one active quarry, an inactive quarry and numerous disused quarries within the scheme study area.

4.10.5 References

(2010). *O'Reilly -v- Galway City Council. [2010] IEHC 97 (2010).*Available: http://ie.vlex.com/vid/reilly-v-galway-city-council-195441595. Last accessed 18th November 2014.

(2013). *The Irish Ecclesiastical Record* (Vol. 7). London: Forgotten Books. P218-219. (Original work published 1900)

(2013). *Galway airport site to be bought by councils.* Available: http://www.breakingnews.ie/ireland/galway-airport-site-to-be-bought-by-councils-612213.html. Last accessed 19 November 2014.

Ayres, B. *Irish railways.* Available: http://www.railbrit.co.uk/Ireland/Irish_railways.pdf. Last accessed 24 November 2014.

Bernd Biege. *Galway Airport.* Available: http://goireland.about.com/od/travelingtoireland/qt/galway_airport.htm. Last accessed 19 November 2014.

Bus Éireann. *Galway City Network Map.* Available: http://www.buseireann.ie/pdf/1360855228-Galway-City.pdf. Last accessed 26 November 2014.

Bus Éireann. *Galway County Timetable.* Available: http://www.buseireann.ie/inner.php?id=247#Galway. Last accessed 26 November 2014.

Bus Timetables. Available: http://www.citydirectgalway.ie/. Last accessed 25 November 2014.

City Direct. *Bus Timetables.* Available: http://www.citydirectgalway.ie/. Last accessed 24 November 2014.

Discover Ireland. *GALWAY AIRPORT.* Available: http://www.discoveringireland.com/galway-airport/. Last accessed 19 November 2014.

Galway City Council. (2014). *Park and Ride Gets Underway on Saturday, November 29th - €3 Per Car.* Available: http://www.galwaycity.ie/news/135/59/Park-and-Ride-Gets-Underway-on-Saturday-November-29th---3-Per-Car/. Last accessed 26 November 2014.

Galway City Council. *Galway City Water Supply Scheme: Menlo Extension/Augmentation.* Available:http://www.water.galwaycity.ie/gcc/WSIPProjects/MenloExtensionAugmentation.aspx. Last accessed 28 November 2014.

Galway City Council. *Park and ride.* Available: http://www.galwaycity.ie/park-and-ride-2/park-and-ride/#1. Last accessed 24 November 2014.

Galway City Council. *Public Walk Ways.* Available: http://search.galwaycity.ie/AllServices/ParksandRecreation/PublicWalkWays/. Last accessed 25 November 2014.

Galway Harbour Company. Available: http://www.galwayharbour.com/index.php. Last accessed 24 November 2014.

Galway Harbour Company. *Galway Port Development Plan.*Available: http://www.galwayharbour.com/10215_GHC_interactive.pdf. Last accessed 24 November 2014.

Go Bus. *Go Bus Timetable.* Available: http://www.gobus.ie/. Last accessed 24 November 2014.

Hardiman, J (1820). *The history of the town and county of the town of Galway from the earliest period to the present time, embellished with several engravings and a copious appendix.* Dublin: W. Folds and Sons. P288

Henry, W. (2013). *Shantalla – Quarry, House & Pieta.* Available: http://www.galwayindependent.com/20130710/news/shantalla-quarry-house-pieta-S20844.html. Last accessed 18 November 2014.

Irish Aviation Authority. (2013). *Integrated Aeronautical Information Package.* Available: http://www.iaa.ie/safe_reg/iaip/Published%20Files/AIP%20Files/AD/EI_AD_2_EICM_EN.pdf. Last accessed 19 November 2014.

Irish Heart Foundation. *Slí na Sláinte - Mervue.* Available: http://www.irishheart.ie/iopen24/pub/slinaslainte/maps/mervue.pdf. Last accessed 25 November 2014.

Irish Rail. Available: http://www.irishrail.ie/. Last accessed 24 November 2014.

Kernan Andrews. (2014). *Negotiations may lead to Galway Airport re-opening.* Available: http://www.advertiser.ie/galway/article/70647/negotiations-may-lead-to-galway-airport-re-opening. Last accessed 19t November 2014.

Lewis, S (1837). *A Topographical Dictionary of Ireland*. London: S. LEWIS & Co. Galway Town Geology.

National Roads Design Office Roscommon. (2014). *N59 Clifden to Mamm Cross porposed road development – Environmental Impact Statement. Volume 1 Non Technical Summary.* Available: http://www.galway.ie/N59-Clifden-to-Maam-Cross-EIS-and-NIS/N59%20CMC%20EIS%20Vol%2001%20Non%20Technical%20Summary.pdf. Last accessed 21 November 2014

Office of Public Works (2014). *Western CFRAM Unit of management 30 Galway City AFA - Draft modelling report*.P1.

Sarah McCabe. (2014). *Galway Airport to reopen for corporate jets and flight training.* Available: http://www.independent.ie/business/irish/galway-airport-to-reopen-for-corporate-jets-and-flight-training-30460580.html. Last accessed 19 November 2014.

The Central and Regional Fisheries Board (2008). *Sampling Fish for the Water Framework Directive – Lakes 2008. Lough Corrib*. P3.

Villiers-Tuthill, K. *The Connemara Railway 1895-1935.* Available: http://www.historyireland.com/20th-century-contemporary-history/the-connemara-railway-1895-1935/. Last accessed 24t November 2014.

Workplace Groups. Available: http://www.carsharing.ie/workplaces. Last accessed 26t November 2014.

4.11 Archaeological, Architectural and Cultural Heritage

4.11.1 Introduction

This section describes the archaeological, architectural and cultural heritage constraints identified within the scheme study area for the N6 Galway City Transport Project.

This assessment includes all recorded archaeological, architecture and cultural heritage sites and areas of archaeological or architectural potential within the scheme study area, Archaeological, architectural and cultural heritage constraints are presented in **Figure 4.11.1** and **4.11.2**

Section 4.11.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.11.3** describes the archaeological, architectural and cultural heritage constraints within the scheme study area.

A summary is presented in **Section 4.11.4** and references are listed in **Section 4.11.5**.

4.11.2 Methodology and Sources of Information

The study has been carried out in accordance with the *NRA Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes and Guidelines for the Assessment Architectural Heritage Impacts of National Road Schemes' 2005.*

Research for this constraints study was undertaken as a desktop exercise. The following sources were consulted in order to identify archaeological, built heritage and cultural heritage constraints:

- Record of Monuments and Places (RMP) for County Galway;
- Sites and Monuments Record (SMR) for Galway;
- Monuments in State Care Database;
- Preservation Orders;
- Register of Historic Monuments;
- Cartographic and written sources relating to the scheme study area;
- Galway City Development Plan 2011–2017;
- Galway County Development Plan 2015-2021;
- Excavations Bulletin (1970–2014);
- Historic Ordnance Survey mapping (1838, 1913);
- N6 Galway City Outer Bypass EIS (2006) (including geophysical survey); and
- National Inventory of Architectural Heritage (NIAH): Architectural & Garden Survey, County Galway

Once all archaeological heritage (RMP/SMR) and built heritage (protected structures and NIAH structures) sites had been identified during the initial research, the sites were plotted onto a map of the study area (Refer **Figure 4.11.1** and **4.11.6** In addition, further constraints, which may not be subject to statutory protection, but should none the less be considered as cultural heritage constraints, were also added. These included sites of archaeological potential identified within the landscapes, such as watercourses and during the Environmental Impact Assessment for the N6 Galway City Outer Bypass, 2006; a railway line and buildings of architectural merit (cultural heritage). In addition all areas of designed landscapes or demesnes, which often include the site or ruins of a former country house, were identified and mapped (designed landscapes).

In addition to the desktop assessment, it was decided to carry out detailed geophysical survey of the interior of Galway Racecourse in order to gain a more thorough understanding of the key archaeological constraints located within the racecourse. A copy of this geophysical survey report is included in **Appendix A.4.5 Geophysics at Ballybrit**. The archaeological constraints in and around the racecourse grounds consist of a deserted medieval settlement, tower house, enclosure, ringfort and an undated house. All of the sites are recorded monuments and further protected with Preservation Orders (see **Table 4.11.2**).

4.11.3 Existing Environment

The scheme study area is characterised by Galway City and its surrounding suburban and rural environment. The area consists of a mix of dense residential development surrounding the city centre and an outlying rural landscape mostly utilised for pastoral farming with some marginal landscape also present. There are a total of 95 townlands within the scheme study area, which are located within four parishes and two baronies (**Table 4.11.1**). The cultural heritage resource is characterised by numerous recorded monuments from various periods, recorded buildings and a substantial amount of designed landscapes dating to the 19th century.

Table 4.11.1 Townlands, Parishes and Baronies located within the Scheme Study Area

Barony	Parish	No. of Townlands	Townland Names
Dunkellin	Oranmore	8	Ardaun, Ballintemple, Breanloughaun, Cartron, Coolagh, Garraun North, Garraun South, Roscam,
Galway	Oranmore	14	Ballindooley, Ballygarraun, Brockagh, Carrowbrowne, Cloonacaunern, Coolanillaun, Curragrean, Doughiska, Kilroghter, Menlough, Merlin Park, Murrough, Pollkeen, Tonacurragh
Galway	Rahoon	61	Acres, Aille, Ahaglugger, Attitomasrevagh, Ballagh, Ballard East, Ballard West, Ballymoneen East, Ballymoneen West, Ballyburke, Ballynahown East, Bearna, Barnacranny, Boleybeg East, Boleynasruhaun, Brownville, Bushypark, Cappagh, Cappanaveagh, Cloghscoltia, Cloghatisky, Cloonagower, Clybaun, Dangan Lower, Dangan Upper, Drumeast,

Barony	Parish	No. of Townlands	Townland Names
			Freeport,.Na Foraí Maola Thoir, Na Foraí Maola Thiar, Gortacleva, Gortnalecka, Keeraun, Kentfield, Kilcorkey, Killeen, Kimmeenmore, Knockaunnacarragh, Knocknacarra, Lacklea, Lenabower, Lenaboy, Lenarevagh, Letteragh, Loughinch, Mincloon, Newcastle, Newvillage, Oranhill, Pollnarooma East, Pollnarooma West, Rahoon, Rusheen, Seapoint, Shanballyduff, Shangort, Shantallow, Tievegariff, Tonabrocky, Townparks, Trusky East, Trusky West
Galway	St Nicholas	12	Ballinfoyle, Ballybane Beg, Ballybane More, Ballybrit, Cappanabornia, Castlegar, Glenanail, Parkmore, Rahylin Glebe, Renmore, Terryland, Wellpark,
Total		95	

4.11.3.1 Archaeological Heritage (AH)

A total of 163 RMP/SMR sites or groups of sites have been identified within the constraints area and are listed below in **Table 4.11.2** and **Table 4.11.3**. Some of the sites contain multiple constraints, such as AH 103, which surrounds Galway City and contains 63 individual sub-constraints. Of the 163 sites falling within the constraints area, two are listed as National Monuments (AH 139 (Castle, Merlin Park) and the medieval town defences within AH 103) and should be considered as key constraints. A further four sites are protected with Preservation Orders (AH 24-27) and are also key constraints. Of the 163 sites, 29 have been reclassified as 'redundant records'. However, they have been included within the assessment, as in the past sites that have been made redundant, have later been found to be archaeological in nature.

A national monument receives statutory protection and is described as 'a monument or the remains of a monument the preservation of which is a matter of national importance by reason of the historical, architectural, traditional, artistic or archaeological interest attaching thereto' (National Monuments Act, 1930, Section 2) (**Table 4.11.2).**

Preservation Orders and/or Temporary Preservation Orders (**Table 4.11.2)**, can be assigned to a site or sites that are deemed to be in danger of injury or destruction. These are allocated under the 1930 Act. Preservation Orders make any interference with the site illegal. Temporary Preservation Orders can be attached under the 1954 Ammendment. These perform the same function as a Preservation Order but have a time limit of six months, after which the situation must be reviewed. Work may only be undertaken on or in the vicinity of sites under Preservation Orders with the written consent, and at the discretion, of the Minister (DoAHG)

Section 5 of the National Monuments Act (1987 amendment) provides that the state will establish and maintain a Register of Historic Monuments (a precursor to the RMP). Of the 163 sites, 22 are also recorded within the Register of Historic Monuments (**Table 4.11.3)**. Inclusion within the RHM does not afford an

archaeological site any more statutory protection than those registered as RMP sites (see below).

Section 12 (1) of the National Monuments Act (1994 amendment) provides that the Minister for Arts, Heritage, Gaeltacht and the Islands (now the Minister for Arts, Heritage and the Gaeltacht) shall establish and maintain a record of monuments and places (RMP) where it is known that such monuments exist. The record comprises of a list of monuments and relevant places and supporting mapping showing each monument and relevant place in respect of each county in the State. Sites recorded on the Record of Monuments and Places all receive statutory protection under the National Monuments Act (**Table 4.11.3**).

There are 27 structures/sites that are included within the RMP and Record of Protected Structures (RPS), which are subject to statutory protection under both the National Monuments Act and Planning and Development Act.

Table 4.11.2 National Monuments or Sites with Preservation Orders

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 24	GA082-012002	Settlement deserted – medieval	BALLYBRIT	533408, 727539	Preservation Order, RHM, RMP
AH 25	GA082-012001	Castle – tower house (Also BH 6)	BALLYBRIT	533458, 727552	Preservation Order, RHM, RMP
AH 26	GA082-014	Enclosure	BALLYBRIT	533553, 727410	Preservation Order, RMP
AH 27	GA082-013/001	Ringfort – rath House – indeterminate date	BALLYBRIT	533617, 727445	Preservation Order, RHM, RMP
AH 139	GA094-023/001	Castle – tower house, Sheela-na-gig (Also BH 78)	MERLINPARK	533436, 725971	National Monument, RMP
AH 103	GA094-100001-	Town defences	TOWNPARKS	529828, 725278	National monument, RMP

Table 4.11.3 Archaeological Sites recorded within the SMR/RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 1	GA093-009	Redundant record	NA FORAÍ MAOLA THIAR	521369, 723085	N/a
AH 2	GA093-005	Redundant record	CAPPAGH (Galway By.)	524099, 725518	N/a
AH 3	GA093-004	Quarry	CAPPAGH (Galway By.)	524636, 725890	SMR
AH 4	GA082-051	Designed landscape feature	KILLEEN (Ballintemple ED)	526381, 728665	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 5	GA082-104	Enclosure	DANGAN LOWER	527553, 728432	RMP
AH 6	GA082-061	Burial ground	MENLOUGH	528172, 728320	RMP
AH 7	GA082-063	Designed landscape feature	MENLOUGH	528294, 728219	SMR
AH 8	GA082-062	Designed landscape feature	MENLOUGH	528353, 728292	SMR
AH 9	GA082-070	Gatehouse (Also BH 3)	MENLOUGH	528488, 728319	RMP
AH 10	GA082-100	Cairn – clearance cairn	MENLOUGH	528524, 728043	SMR
AH 11	GA082-064001	House – 17th century Castle, unclassified (Also BH 2)	MENLOUGH	528426, 727902	RMP
AH 12	GA082-002	Castle – tower house (Also BH 36)	BALLINDOOLEY	531465, 729177	RMP, RHM
AH 13	GA082-076	Quarry	AN POLL CAOIN	533857, 729194	SMR
AH 14	GA094-055	Megalithic structure (Also BH 43)	RAHOON	528046, 725019	RMP
AH 15	GA082-001	Redundant record	BALLAGH	526309, 727229	N/a
AH 16	GA082-039	Children's burial ground	DANGAN LOWER	527477, 727663	RMP
AH 17	GA082-032	Redundant record	DANGAN LOWER	527633, 728032	N/a
AH 18	GA082-031	Enclosure	COOLAGH (Galway By.)	530400, 728335	SMR
AH 19	GA082-095	Ringfort – unclassified	COOLAGH (Galway By.)	530430, 728411	SMR
AH 20	GA082-003	Quarry	BALLINDOOLEY	531052, 728705	SMR
AH 21	GA082-004	Redundant record	BALLINDOOLEY	531226, 728743	N/a
AH 22	GA082-025	Crannog	CASTLEGAR (Galway By.)	531576, 728748	RMP
AH 23	GA082-023	Chapel (site of) (Also BH 93)	CASTLEGAR (Galway By.)	532032, 728561	RMP
AH 28	GA082-043, 001,	Fulacht fia	DOUGHISKA	534665, 726686	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
	002, 003, 004				
AH 29	GA082-092	Redundant record	BALLINFOYLE	530852, 727686	N/a
AH 30	GA082-045	Quarry	GLENANAIL	531553, 727364	SMR
AH 31	GA082-046	Redundant record	GLENANAIL	531751, 727440	N/a
AH 32	GA082-017	Earthwork	BALLYBRIT	533372, 727238	SMR
AH 33	GA082-015	Designed landscape feature	BALLYBRIT	533285, 727160	SMR
AH 34	GA082-036	Building	DANGAN LOWER	528306, 727759	RMP
AH 35	GA093-021	Fulacht fia	CAPPAGH (Clonmacnowen By.)	524872, 724835	RMP
AH 36	GA082-077	Bullaun stone	RAHOON	526436, 726354	RMP
AH 37	GA082-040	Redundant record	DANGAN LOWER	527785, 727171	N/a
AH 38	GA082-041	Well	DANGAN LOWER	528099, 727215	SMR
AH 39	GA082-085	Designed landscape feature	DANGAN LOWER	528359, 727432	RMP
AH 40	GA082-038	Designed landscape feature	DANGAN LOWER	528396, 727499	RMP
AH 41	GA082-037	Designed landscape – summer house (Also BH 13)	DANGAN LOWER	528506, 727645	RMP
AH 42	GA082-033	Barrow – unclassified	DANGAN LOWER	528091, 727261	RMP
AH 43	GA082-071	Ringfort – unclassified	NEWCASTLE (Rahoon Par.)	528812, 727137	RMP
AH 44	GA082-034	Ringfort – unclassified (Also BH 14)	DANGAN LOWER	528366, 727281	RMP RHM
AH 45	GA082-078	Quarry	TERRYLAND	529604, 727049	SMR
AH 46	GA082-082	Burial ground (Also BH 15)	TERRYLAND	529877, 726878	RMP
AH 47	GA082-007	Quarry	BALLINFOYLE	530130, 726898	SMR
AH 48	GA082-008	Quarry	BALLINFOYLE	530687, 726862	SMR

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 49	GA082-009	Redundant record	BALLINFOYLE	530835, 726959	N/a
AH 50	GA082-006	Quarry	BALLINFOYLE	530959, 727120	SMR
AH 51	GA082-005	Quarry	BALLINFOYLE	531080, 727297	SMR
AH 52	GA082-096	Mass-rock	COOLAGH (Galway By.)	530056, 727341	RMP
AH 53	GA082-093	Kiln – lime (Also BH 97)	COOLAGH (Galway By.)	529974, 727445	SMR
AH 54	GA082-094	Architectural fragment (Also BH 96)	COOLAGH (Galway By.)	529803, 727631	RMP
AH 55	GA094-111	Ringfort – unclassified	RAHOON	527119, 725072	RMP
AH 56	GA094-047	House – indeterminate date (Also BH 16)	RAHOON	527201, 725378	SMR
AH 57	GA094-048	Ritual site – holy well	RAHOON	527356, 725407	RMP
AH 58	GA094-121	Enclosure	RAHOON	527416, 725334	RMP
AH 59	GA094-049/001/002	Church, Graveyard, Ecclesiastical enclosure	RAHOON	527486, 725318	RMP
AH 60	GA094-038	Church	NEWCASTLE (Rahoon Par.)	529252, 726187	RMP
AH 61	GA082-081	House – 18th/19th century	TERRYLAND	529342, 726307	RMP
AH 62	GA082-080001/002	Castle – unclassified, House – 17th century (Also BH 20)	TERRYLAND	529339, 726389	RMP
AH 63	GA082-083	Bastioned fort	TOWNPARKS (St. Nicholas Par.)	530476, 726309	RMP
AH 64	GA094-056	Designed landscape feature	RAHOON	527027, 725269	RMP
AH 65	GA082-047001/002	House – 18th/19th century, Chapel (Also BH 1)	KENTFIELD	526797, 728325	RMP
AH 66	GA093-023	Ringfort – cashel	TROSCAIGH THIAR	522703, 723156	SMR

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 67	GA093-023001	Field system	TROSCAIGH THIAR	522754, 723170	SMR
AH 68	GA093-016	Church	NEWVILLAGE (Galway By.)	522298, 722668	RMP
AH 69	GA093-010	Settlement cluster	AN CHÉIBH	523112, 722944	SMR
AH 70	GA093-020	Graveyard	RINN NA MARA	523115, 722867	RMP
AH 71	GA093-006	Cenotaph (also BH 29)	AN CHLOCH SCOILTE	522783, 724875	RMP
AH 72	GA093-015	Church	CNOC NA CATHRACH	524358, 723442	SMR
AH 73	GA093-003001-3	Holy well, Church, Graveyard (Also BH 24)	BEARNA (Gaillimh)/ CNOC NA CATHRACH	524477, 723467	RMP/SMR
AH 74	GA082-021	Castle – tower house (Also BH 72)	CASTLEGAR (Galway By.)	531889, 728046	RMP
AH 75	GA093-002	Castle – unclassified (BH 27)	BEARNA (Gaillimh)	524845, 723630	RMP
AH 76	GA093-019	Designed landscape feature	AN ROISÍN	525407, 723780	RMP
AH 77	GA093-018	Designed landscape feature	AN ROISÍN	525801, 723886	RMP
AH 78	GA093-022	Redundant record	BALLYMONEEN WEST	525680, 724215	N/a
AH 79	GA093-013	Water mill – horizontal-wheeled (Also BH 56)	KNOCKNACARRA	526101, 723960	RMP
AH 80	GA094-019	Ringfort – unclassified(Also BH 55)	KNOCKNACARRA	526487, 724231	RMP
AH 81	GA094-015	Ringfort – unclassified	CAPPANAVEAGH	528006, 723919	RMP
AH 82	GA094-016	House – 18th/19th century	CAPPANAVEAGH	527862, 724160	SMR
AH 83	GA094-021	Burial ground (Within BH 63)	LENABOY	528276, 724222	SMR
AH 84	GA094-083	Burial ground	TIEVEGARRIFF	527858, 724432	RMP
AH 85	GA094-041	Stone circle	POLLNAROOMA EAST	527482, 724538	RMP
AH 86	GA094-050	Designed landscape feature	RAHOON	527355, 724754	SMR

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 87	GA094-051	Well	RAHOON	527438, 724842	SMR
AH 88	GA094-054	Watchtower	RAHOON	527647, 724779	RMP
AH 89	GA094-073	House – 18th/19th century	TIEVEGARRIFF	527905, 724696	SMR
AH 90	GA094-134001/2	Redundant record	TIEVEGARRIFF	528030, 724750	N/a
AH 91	GA094-017	House – 18th/19th century	CLOGHATISKY	528316, 724779	RMP
AH 92	GA094-094	Ritual site – holy well	TOWNPARKS (Rahoon Par. – Galway City)	528778, 724556	RMP
AH 93	GA094-084	Designed landscape feature	TOWNPARKS (Rahoon Par. – Galway City)	528928, 724548	RMP
AH 94	GA094-088	Redundant record	TOWNPARKS (Rahoon Par. – Galway City)	528806, 725199	N/a
AH 95	GA094-082	Designed landscape – folly	SHANTALLOW (Galway By.)	528589, 725214	RMP
AH 96	GA094-076	Quarry	SHANTALLOW (Galway By.)	528331, 725145	SMR
AH 97	GA094-077	Redundant record	SHANTALLOW (Galway By.)	528469, 725226	N/a
AH 98	GA094-079	House – 18th/19th century	SHANTALLOW (Galway By.)	528474, 725273	SMR
AH 99	GA094-081	Earthwork	SHANTALLOW (Galway By.)	528386, 725369	RMP
AH 100	GA094-080	Earthwork	SHANTALLOW (Galway By.)	528501, 725383	RMP
AH 101	GA094-052	Enclosure	RAHOON	527646, 725666	RMP
AH 102	GA094-053	Souterrain	RAHOON – precise location unknown	Unknown	SMR
AH 103 (12 entries in RHM)	GA094-091	Religious house – Dominican friars	TOWNPARKS	529514, 724740	RMP
	GA094-099001-	Graveyard	TOWNPARKS	530173, 725084	RMP
	GA094-099002-	Bastioned fort	TOWNPARKS	530174, 725083	RMP
	GA094-099003-	Religious house – Augustinian friars	TOWNPARKS	530173, 725084	RMP
	GA094-100	Historic town	TOWNPARKS	529828, 725278	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
	GA094-102	Religious house – Franciscan friars	TOWNPARKS	529665, 725549	RMP
	GA094-104	Mill – unclassified	TOWNPARKS	529404, 725195	RMP
	GA094-106	Religious house – Franciscan nuns (Poor Clares)	TOWNPARKS	529333, 725462	RMP
	GA094-091002-	Chapel	TOWNPARKS	529514, 724740	RMP
	GA094-091001-	Graveyard	TOWNPARKS	529495, 724750	RMP
	GA094-092	Settlement cluster	TOWNPARKS	529561, 724675	SMR
	GA094-104002-	Mill – unclassified	TOWNPARKS	529532, 725098	RMP
	GA094-102001-	Church	TOWNPARKS	529695, 725512	RMP
	GA094-102002-	Graveyard	TOWNPARKS	529660, 725504	RMP
	GA094-102004-	Wall monument	TOWNPARKS	529688, 725486	RMP
	GA094-102005-	Wall monument	TOWNPARKS	529688, 725486	RMP
	GA094-102006-	Inscribed slab	TOWNPARKS	529688, 725486	RMP
	GA094-102007-	Wall monument	TOWNPARKS	529688, 725486	RMP
	GA094-102008-	Tomb – unclassified	TOWNPARKS	529659, 725506	RMP
	GA094-102009-	Memorial stone	TOWNPARKS	529659, 725507	RMP
	GA094-102010-	Tomb – unclassified	TOWNPARKS	529659, 725507	RMP
	GA094-102011-	Tomb – unclassified	TOWNPARKS	529658, 725506	RMP
	GA094-102012-	Tomb – unclassified	TOWNPARKS	529659, 725506	RMP
	GA094-102013-	Tomb – unclassified	TOWNPARKS	529659, 725506	RMP
	GA094-102014-	Tomb – unclassified	TOWNPARKS	529659, 725506	RMP
	GA094-102015-	Graveslab	TOWNPARKS	529658, 725504	RMP
	GA094-102016-	Graveslab	TOWNPARKS	529655, 725503	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
	GA094-102017-	Graveslab	TOWNPARKS	529658, 725506	RMP
	GA094-102018-	Graveslab	TOWNPARKS	529656, 725506	RMP
	GA094-102019-	Tomb – unclassified	TOWNPARKS	529656, 725506	RMP
	GA094-104001-	Mill – unclassified	TOWNPARKS	529421, 725090	SMR
	GA094-119	Structure	TOWNPARKS	529759, 725530	RMP
	GA094-120	Architectural fragment	TOWNPARKS	529757, 725532	RMP
	GA094-100001-	Town defences	TOWNPARKS	529828, 725278	National monument
	GA094-100043-	Castle – tower house	TOWNPARKS	529816, 725275	RMP
	GA094-100044-	Castle – tower house	TOWNPARKS	529659, 725022	RMP
	GA094-100059-	Quay	TOWNPARKS	529678, 725728	RMP
	GA094-100031-	Bridge	TOWNPARKS	529555, 725125	RMP
	GA094-100032-	Bridge	TOWNPARKS	529456, 724959	RMP
	GA094-100033-	Causeway	TOWNPARKS	529468, 725308	RMP
	GA094-100034-	Bridge	TOWNPARKS	529717, 725397	RMP
	GA094-100035-	Bridge	TOWNPARKS	529791, 725454	RMP
	GA094-100037-	Church	TOWNPARKS	529718, 725238	RMP
	GA094-100038-	Hospital	TOWNPARKS	529767, 725203	RMP
	GA094-100039-	Town hall	TOWNPARKS	529678, 725176	RMP
	GA094-100040-	Town hall	TOWNPARKS	529754, 725224	RMP
	GA094-100041-	Castle – hall-house	TOWNPARKS	529725, 725030	RMP
	GA094-100042-	Castle – tower house	TOWNPARKS	529675, 725302	RMP
	GA094-100047-	Water mill – unclassified	TOWNPARKS	529692, 725428	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
	GA094-100048-	Water mill – unclassified	TOWNPARKS	529713, 725376	RMP
	GA094-100049-	Water mill – unclassified	TOWNPARKS	529636, 725032	RMP
	GA094-100050-	Water mill – unclassified	TOWNPARKS	529606, 725247	RMP
	GA094-100051-	Water mill – unclassified	TOWNPARKS	529540, 725109	RMP
	GA094-100052-	Dovecote	TOWNPARKS	529878, 725129	RMP
	GA094-100053-	Cross – Market cross	TOWNPARKS	529717, 725181	RMP
	GA094-100054-	Cross	TOWNPARKS	529690, 725216	RMP
	GA094-100055-	Ritual site – holy well	TOWNPARKS	529727, 725023	RMP
	GA094-100056-	Weir – regulating	TOWNPARKS	529599, 725380	SMR
	GA094-100057-	Weir – regulating	TOWNPARKS	529581, 725723	SMR
	GA094-100058-	Quay	TOWNPARKS	529665, 724926	RMP
	GA094-131	Redundant record	TOWNPARKS	529356, 725414	N/a
	GA094-132	Redundant record	TOWNPARKS	529554, 724766	N/a
	GA094-138	Architectural feature	TOWNPARKS	529988, 725449	RMP
AH 104	GA094-103001	Mill – unclassified	TOWNPARKS	529559, 725424	RMP
AH 105	GA094-103 GA094-139	Prison Stone sculpture	TOWNPARKS	529479, 725480	RMP
AH 106	GA094-116	Kiln – lime	TOWNPARKS	529469, 725727	SMR
AH 107	GA094-130 GA093-190	Architectural fragment Earthwork	TOWNPARKS	529091, 725731	RMP
AH 108	GA094-089	Redundant record	TOWNPARKS	529276, 725940	N/a
AH 109	GA094-039	Dovecote	TOWNPARKS	529232, 726062	RMP
AH 110	GA094-085	Quarry	TOWNPARKS	529448, 726079	SMR

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 111	GA095-046	Redundant record	GARRAUN SOUTH (Dunkellin By.)	536810, 725919	N/a
AH 112	GA082-079	Redundant record	TERRYLAND	529679, 726548	N/a
AH 113	GA082-106	Redundant record	NEWCASTLE (Rahoon Par.)	529084, 726583	N/a
AH 114	GA082-099	Redundant record	MENLOUGH	529079, 727433	N/a
AH 115	GA082-035	Icehouse (Also BH 32)	DANGAN LOWER	528492, 727103	SMR
AH 116	GA082-060	Pillar stone (present location)	MENLOUGH	528444, 728460	RMP
AH 117	GA082-087 GA082-059	Settlement cluster Redundant record	MENLOUGH	528420, 728523	SMR
AH 118	GA082-066	Enclosure	MENLOUGH	529000, 728506	RMP
AH 119	GA082-065	Leacht cuimhne	MENLOUGH	529001, 728625	RMP
AH 120	GA082-058	Enclosure	MENLOUGH	530034, 729242	RMP
AH 121	GA082-024	Redundant record	CASTLEGAR (Galway By.)	530830, 728089	N/a
AH 122	GA094-129002	Town defences	TOWNPARKS (St. Nicholas Par. – Galway City)	530562, 726255	RMP
AH 123	GA094-128	Leacht	TOWNPARKS (St. Nicholas Par. – Galway City)	530389, 725980	RMP
AH 124	GA094-129	Bastioned fort	TOWNPARKS (St. Nicholas Par. – Galway City)	530680, 726158	RMP
AH 125	GA082-084	Designed landscape – folly	TOWNPARKS (St. Nicholas Par. – Galway City)	530814, 726297	SMR
AH 126	GA094-129001	Bastioned fort	TOWNPARKS (St. Nicholas Par. – Galway City)	530803, 726045	RMP
AH 127	GA094-096	Ritual site – holy well	TOWNPARKS (St. Nicholas Par. – Galway City)	530711, 725715	RMP
AH 128	GA094-097	Ritual site – holy well	TOWNPARKS (St. Nicholas Par. – Galway City)	530661, 725624	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 129	GA094-098	Ritual site – holy well	TOWNPARKS (St. Nicholas Par. – Galway City)	530568, 725472	RMP
AH 130	GA094-117	Field boundary	RENMORE	530969, 725393	SMR
AH 131	GA094-115	Fulacht fia	RENMORE	531059, 725220	RMP RHM
AH 132	GA094-058	Designed landscape – tree-ring (Also BH 89)	RENMORE	531804, 725253	SMR
AH 133	GA094-059	Ringfort – unclassified	RENMORE	531978, 725556	RMP
AH 134	GA094-010/001	Church, graveyard(Also BH 82)	BALLYBANE BEG	532185, 725949	RMP
AH 135	GA082-088	House – 18th/19th century(Also BH 90)	BALLYBANE BEG	531993, 726615	SMR
AH 136	GA082-010/001	Ringfort, souterrain(Also BH 91)	BALLYBANE MORE	532445, 726679	RMP, RHM
AH 137	GA094-024	Designed landscape feature	MERLIN PARK	533775, 725452	SMR
AH 138	GA094-028	House – 18th/19th century	MERLIN PARK	533784, 725645	SMR
AH 140	GA094-122	Enclosure	ROSCAM	534275, 725181	RMP
AH 141	GA094-027	Redundant record	MERLIN PARK	534460, 725262	N/a
AH 142	GA094-026	Redundant record	MERLIN PARK	534570, 725322	N/a
AH 143	GA094-018	Redundant record (Also BH 76)	DOUGHISKA	534678, 725613	N/a
AH 144	GA082-044	Road – road/trackway	DOUGHISKA	534572, 726579	RMP
AH 145	GA082-086	Church	CASTLEGAR (Galway By.)	532462, 727656	SMR
AH 146	GA082-022	Children's burial ground	CASTLEGAR (Galway By.)	352425, 727999	RMP
AH 147	GA082-072	Quarry	PARKMORE (Galway By.)	532874, 727876	SMR
AH 148	GA082-026	Redundant record	CASTLEGAR (Galway By.)	531925, 728369	N/a
AH 149	GA082-105	Crannog (Also BH 70)	BALLINDOOLEY	531591, 729040	RMP

AH No:	SMR No	Class	Townland	ITM Reference (E,N)	Statutory protection
AH 150	GA082-020	Redundant record	CEATHRÚ AN BHRÚNAIGH	531843, 729744	N/a
AH 151	GA082-016	Anomalous stone group	BALLYBRIT	533667, 727931	RMP, RHM
AH 152	GA082-011/001-2	Ringfort – cashel, souterrain, children's burial ground (Also BH 74)	BALLYBRIT	533876, 727767	RMP, RHM
AH 153	GA094-001	Redundant record	ARDAUN	535954, 725959	N/a
AH 154	GA095-043	Redundant record	GARRAUN NORTH (Dunkellin By.)	536119, 726045	N/a
AH 155	GA095-012	Ringfort – cashel	CARTRON (Ballintemple ED)	536510, 725721	RMP RHM
AH 156	GA095-045	Redundant record	GARRAUN SOUTH (Dunkellin By.)	536765, 725864	N/a
AH 157	GA094-030001	Milestone	RENMORE	531572, 726014	RMP
AH 158	GA082-068	Hut site	MENLOUGH	529989, 729535	RMP
AH 159	GA082-057	Enclosure	MENLOUGH	529913, 729576	RMP
AH 160	GA082-069	Hut site	MENLOUGH	529778, 729520	RMP
AH 161	GA082-052	Ringfort	KILLOUGHTER	530711, 729792	RMP
AH 162	GA082-054	Redundant record	KILLOUGHTER	530783, 729699	N/a
AH 163	GA082-018001-3	Castle, 17th C House, Inscribed stone	CARROWBROWNE	531662, 730122	RMP

4.11.3.2 Geophysical Survey

A detailed geophysical survey was carried out in 2014 at Galway Racecourse, Ballybrit as part of the constraints study, (Refer to **Appendix A.4.5 Geophysics at Ballybrit)**. This was undertaken within the interior of the racecourse and to the immediate south of the track, in order to gain a more thorough understanding of the key archaeological constraints located within this area. These consist of a deserted medieval settlement (AH 24), tower house (AH 25), enclosure (AH 26), ringfort and an undated house (AH 27). All of the sites are recorded monuments and further protected with Preservation Orders (see **Table 4.11.2**).

The survey was carried out by Target Archaeological Geophysics on behalf of Irish Archaeological Consultancy Ltd. The survey extended across 13.89ha of land situated *c.*1.8km east of the N17 Tuam Road; immediately north of the N6 and west

of Ballybrit Crescent and Briarhill Business Park. Two survey techniques were utilised during the survey, magnetometry and targeted electromagnetic induction (quadrature) survey.

No responses of definite archaeological character have been recorded from the magnetometer and electromagnetic induction (quadrature) surveys undertaken across the investigation area.

The results from both surveys highlight widespread modern ferrous interference, zones of substantial magnetic disturbance, buried services, responses from recent land use and former cultivation.

Part of an enclosure or field system possibly associated with AH 24 has been recorded in the south-west portion of the survey area (Geophysical Anomaly Ref. M7). Further zones of archaeological potential are suggested by groups of positive linear anomalies and sub-angular responses, weak trends and zones of increased response. The most notable of these occur in Geophysical Anomaly Ref. M3, M4, M5, M7, M8 and M10, and electromagnetic induction (quadrature) anomalies 1, 3, 8 and 10 in EMI1, EMI6 and EMI10.

No responses clearly indicating extramural or buried features associated with large ringfort AH 27 have been identified in the southern region of the survey area. Despite the proliferation of recorded archaeological sites, it is apparent that the development of the survey area as part of a racecourse complex has resulted in significant ground disturbance over recent years. Whilst scattered potential archaeological anomalies have been identified, no large scale archaeological sites are apparent within the survey data. However, it remains possible that archaeological remains do survive within the survey area. These may not possess a geophysical signature or the signature may have been masked by more recent ground disturbances.

The full geophysical survey report is included within **Appendix A.4.5 Geophysics at Ballybrit** of this report.

4.11.3.3 Summary of Previous Archaeological Excavations

A review of the Excavation Bulletin (1970-2014) has revealed that over 90 archaeological excavations have been carried out to date within the centre of Galway City (area defined by the R338 to the west; the N6 to the north and Lough Atalia to the east). The remaining programme of archaeological investigations that have been carried out within the scheme study area are summarised in **Table 4.11.4** below:

Table 4.11.4 Archaeological Fieldwork carried out within the Scheme Study Area

Reference:	Licence No.:	Townland:	Details:
1994:110	94E148	Doughiska	Two burnt mounds, two earthworks, a field system and an ancient road
1995:116	95E99	Doughiska	Burnt mound
2002:0738	02E0793	Doughiska/ Merlin Park	Monitoring
2002:0725	02E0111	Doughiska	Nothing of archaeological significance

Reference:	Licence No.:	Townland:	Details:
2005:591	05E0187	Doughiska	Nothing of archaeological significance
2005:592	A024/1/1	Doughiska	Burnt mounds
2006:789	05E0187ext	Doughiska	Pit
2006:790	E2052	Doughiska	Burnt mounds
2008:540	E3588	Doughiska	Well
2002:0736	02E1364	Merlin Park	Adjacent to tower house (AH 139)
2002:0737	02E0113	Merlin Park	Tower house (AH 139)
2008:516	08E0641	Ballyloughane	Nothing of archaeological significance
1996:026	N/a	Renmore	Enclosure
2005:603	05E0989	Lough Atalia	*Fulacht fiadh*
2002:0729	02E1805	Ballybane More	Monitoring
2000:0369	00E0745	Ballybrit	Nothing of archaeological significance
2001:497	01E0992	Coolagh/ Castlegar/ Ballybrit/ Parkmore/ Cappanabornia/ Glenanail/ Ballybane Beg,	Nothing of archaeological significance
1997:194	97E0341	Castlegar	Adjacent to tower house (AH 74)
1998:237	98E0498	Castlegar	Adjacent to possible souterrain: no archaeological significance
1999:297	99E0012	Newcastle	Nothing of archaeological significance
2002:0749	02E0915	Newcastle	Nothing of archaeological significance
2007:621	07E1116	Newcastle	Nothing of archaeological significance
2008:551	08E0507	Newcastle	Nothing of archaeological significance
2008:552	08E0508	Newcastle	Nothing of archaeological significance
2008:553	08E0618, 08R212	Newcastle	Stray find - halberd
2009:399	09E0217	Newcastle	Nothing of archaeological significance
2009:400	09E377	Newcastle	Nothing of archaeological significance
2010:340	10E0369	Newcastle	Nothing of archaeological significance
2010:341	09E0217ext	Newcastle	Nothing of archaeological significance
2002:0724	02E1327	Dangan Lower	Nothing of archaeological significance
2008:545	08E0558	Dangan Lower	Nothing of archaeological significance
1993:114	93E0078	Rahoon	Nothing of archaeological significance
1997:215	96E0018 97E0060	Rahoon/ Knocknacarra	Nothing of archaeological significance
1994:112	94E068	Knocknacarra	Site of horizontal mill
2001:520	01E0498	Knocknacarra	Monitoring

Reference:	Licence No.:	Townland:	Details:
2004:0669	04E1636	Seapoint, Bearna	Nothing of archaeological significance
2008:519	06E1151ext	Seapoint, Bearna	Graveyard (AH 70)
2008:518	08E0651	Bearna, Knocknacarra	Nothing of archaeological significance
2009:386	08E0387	Seapoint, Bearna	Monitoring

4.11.3.4 Areas of Archaeological Potential

Areas of Archaeological Potential (AAPs) can be defined as parts of the landscape that possess the potential to contain archaeological remains due to the presence of topographic features such as rivers, lakes, turloughs, high defendable ground and bog. Rivers and lakes are a focus for human habitation due to the obvious transport and food resources. They (along with bogs) also have the potential to preserve organic archaeological deposits or artefacts such as wood or leather, which do not usually survive within the alkaline conditions associated with terrestrial archaeology. Wooden track ways dating to the Bronze Age period and later, have been excavated within bog land throughout Ireland. Rivers and lakes may have also played a role in prehistoric ritual, as significant artefacts from the prehistoric periods and into the early medieval period, are often found within river bed deposits. All areas of bog/peat, rivers, stream and bodies of water (both fresh and salt water), and their margins, within the scheme study area should be considered as possessing archaeological potential.

4.11.3.5 Architectural Heritage

A total of 100 structures or groups of structures of architectural heritage significance have been identified within the scheme study area. These are either listed within the Record of Protected Structures (RPS) (Galway City Development Plan 2011-2017/ Galway County Development Plan 2015-2021) or have been identified as part of the architecture survey carried out by the National Inventory of Architectural Heritage (NIAH). The structures are listed in **Table 4.11.5** below and have been identified with the prefix of Built Heritage (BH).

Structures of architectural, cultural, scientific, historical or archaeological interest are protected under the Planning and Development Act, 2000, where the conditions relating to the protection of the architectural heritage are set out in Part IV of this Act. The Act defines a protected structure as '(a) a structure, or (b) a specified part of a structure which is included in a Record of Protected Structures (RPS), and, where that record so indicates, includes any specified feature which is in the attendant grounds of the structure and which would not otherwise be included in this definition.' Protection of the structure or part thereof, includes conservation, preservation, and improvement compatible with maintaining its character and interest'.

Buildings recorded in the RPS can include Recorded Monuments, structures listed in the NIAH or buildings deemed to be of architectural, archaeological or artistic importance by the Minister of Arts, Heritage and the Gaeltacht. It is noted that inclusion within the NIAH survey does not afford statutory protection. However,

the structure may be added to the RPS by the relevant Local Authority in the future. As such the buildings should be considered to be constraints.

There are 29 structures/sites that are included within the RMP and RPS, which are subject to statutory protection under both the National Monuments Act and Planning and Development Act.

The NIAH rating values are: International, National, Regional, Local and Record Only (I, N, R, L, O). Structures which are considered of International, National, and Regional significance are recommended by the Minister to the relevant Local Authority for inclusion in their RPS (NIAH handbook 2011).

International: Structures or sites of sufficient architectural heritage importance to be considered in an international context. These are exceptional structures that can be compared to and contrasted with the finest architectural heritage in other countries.

National: Structures or sites that make a significant contribution to the architectural heritage of Ireland. These are structures and sites that are considered to be of great architectural heritage significance in an Irish context.

Regional: Structures or sites that make a significant contribution to the architectural heritage within their region or area. They also stand in comparison with similar structures or sites in other regions or areas within Ireland. Increasingly, structures that need to be protected include structures or sites that make a significant contribution to the architectural heritage within their own locality. Examples of these would include modest terraces and timber shop fronts.

Local: These are structures or sites of some vintage that make a contribution to the architectural heritage but may not merit being placed in the RPS separately. Such structures may have lost much of their original fabric.

Record Only: These are structures or sites that are not deemed to have sufficient presence or inherent architectural or other importance at the time of recording to warrant a higher rating. It is acknowledged, however, that they might be considered further at a future time.

(National Inventory of Architectural Heritage Handbook, 2011, DoAHG)

Table 4.11.5 RPS and NIAH structures within the Scheme Study Area

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 1	n/a	30408201 30408202	Glenlo Abbey Hotel Church of Ireland Chapel (Also AH 65)	KENTFIELD	526773, 728351	Regional
BH 2	5702	30408220	Menlo Castle (Also AH 11)	MENLOUGH	528432, 727933	Regional
BH 3	5703	30408219	Menlo Castle entrance (Also AH 9)	MENLOUGH	528494, 728315	Regional
BH 4	1501/2	30408204	Church & graveyard	BALLAGH	527306, 727637	Regional
BH 5	1504	30408203	Bushypark House	KENTFIELD	527262, 727826	Regional
BH 6	701	N/a	Tower House (Also AH 25)	BALLYBRIT	533470, 727546	Not specified
BH 7	2901	30408205	Thatched cottage	BARNACRANNY	527512, 727519	Regional
BH 8	2001	N/a	Gate pillars	BARNACRANNY	527619, 727465	Not specified
BH 9	5710	30408216	Thatched cottage	MENLOUGH	528467, 728394	Regional
BH 10	5707	30408217	Thatched cottage	MENLOUGH	528719, 728441	Regional
BH 11	6302	N/a	Thatched Cottage	MINCLOON	525885, 726000	Not specified
BH 12	6301	N/a	Thatched Cottage	MINCLOON	726324, 725908	Not specified
BH 13	3001	N/a	Summer House (Also AH 41)	DANGAN LOWER	528506, 727645	Not specified
BH 14	3003	N/a	Ringfort (Also AH 44)	DANGAN LOWER	528366, 727281	Not specified
BH 15	1801	N/a	Burial ground (Also AH 46)	TERRYLAND	529877, 726878	Not specified
BH 16	8301	N/a	Rahoon House (Also AH 56)	RAHOON	527201, 725378	Not specified
BH 17	8301	30311001	Entrance to Rahoon House	RAHOON	527333, 725451	Regional
BH 18	1001	30311003	Summerdale House	RAHOON	527507, 725152	Regional
BH 19	N/a	30308001	Mill race	NEWCASTLE: (GALWAY BARONY)	529179, 726219	Regional
BH 20	3503	N/a	Castle (Also AH 62)	TERRYLAND	529339, 726389	Not specified

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 21	3501/2	30408208/ 9	Waterworks	TERRYLAND	529477, 726424	Not specified
BH 22	N/a	30409305	Cottage	AHAGLUGGER	523031, 722901	Regional
BH 23	N/a	30409308	Lynch Mausoleum	KNOCKAUNNAC-ARRAGH	524356, 723445	Regional
BH 24	901	N/a	Ritual site - holy well (Also AH 73)	BEARNA	524483, 723457	Not specified
BH 25	904	30409309	Bearna House gate lodge	BEARNA	524655, 723817	Local
BH 26	903	N/a	Bearna House	BEARNA	524775, 723718	Regional
BH 27	902	30409310	Site of Bearna Castle (Also AH 75)	BEARNA	524845, 723630	Not specified
BH 28	1601	N/a	St. Josephs school	CAPPAGH	524668, 726250	Not specified
BH 29	N/a	30409301	Father Griffin Monument (Also AH 71)	AN CLOCH SCOILTE	522779, 724872	Regional
BH 30	1505	N/a	Heffernans cottage	BALLAGH	526872, 727673	Not specified
BH 31	5708	30408213	House	MENLOUGH	528402, 728585	Regional
	5709	30408214	House	MENLOUGH	528421, 728565	Regional
	N/a	30408215	House	MENLOUGH	528375, 728504	Regional
BH 32	3002	N/a	Ice house (Also AH 115)	DANGAN LOWER	528488, 727098	Not specified
BH 33	6902	N/a	No. 49	NEWCASTLE	528840, 726448	Not specified
BH 34	6901	N/a	Former Franciscan College	NEWCASTLE	528876, 726576	Not specified
BH 35	N/a	30408206	College (former nunnery)	NEWCASTLE	528909, 726498	Regional
BH 36	401	N/a	Castle - tower house (Also AH 12)	Ballindooley	531465, 729177	Not specified
BH 37	7001-4	x7	NUIG Campus	NEWCASTLE	529212, 725919	Regional & National

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 38	N/a	30308006	University – nurses homes	TOWNPARKS	528991, 725753	National
BH 39	N/a	30312002	Hansberry House	SHANTALLOW	528505, 725263	Regional
	9202	N/a	57 Shantalla Rd	SHANTALLOW		Not specified
	9203	N/a	58 Shantalla Rd	SHANTALLOW		Not specified
	9201	30312001	59 Shantalla Rd	SHANTALLOW		Regional
BH 40	x38	x60	The Crescent, Sea Road, Raleigh Row, St. Mary's Rd, Shantalla Rd, St. Helen's St, Newcastle Rd	TOWNPARKS	529040, 725047	Regional
BH 41	x25	x22	Salthill Road Lower, Taylor's Hill	TOWNPARKS, KILCORKEY, CLOGHATISKEY	528591, 724761	Regional
BH 42	5501	N/a	No. 5 Maunsell's Rd	SHANTALLOW	528494, 724969	Not specified
BH 43	10111	N/a	Megalithic structure (Also AH 14)	RAHOON	528046, 725019	Not specified
BH 44	10108	30317020 & 30317001	gate lodge, railways, entrance, walls	TIEVEGARRIFF	528003, 724870	Regional
BH 45	10103	30317002	Former nunnery	TIEVEGARRIFF	528111, 724783	Regional
BH 46	N/a	30316003	Rectory	RAHOON	527806, 724832	Regional
BH 47	N/a	30316001	Merville House	RAHOON	527566, 724713	Regional
BH 48	N/a	30320001	School	POLLNAROOMA EAST	527310, 724472	Regional
BH 49	N/a	30323001	Moyveela House	LENABOY	527374, 723651	Regional
BH 50	N/a	30323004 30323005	Public toilets Shelter	LENABOY	527537, 723587	Regional
BH 51	N/a	30323006	Shelter	LENABOY	527528, 723548	Regional
BH 52	N/a	30409405	Bathing area	POLLNAROOMA WEST	527137, 723516	Regional

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 53	1101	30409403	Entrance to Blackrock House	POLLNAROOMA WEST	527053, 723597	Regional
BH 54	1101	30409402	Blackrock House	POLLNAROOMA WEST	527008, 723723	Regional
BH 55	4801	N/a	Ringfort (AH 80)	KNOCKNACARRA	526487, 724231	Not specified
BH 56	4802	N/a	Water mill (AH 79)	KNOCKNACARRA	526101, 723960	Not specified
BH 57	8701	N/a	Gortard	ATTITHOMASRE-VAGH	527598, 723979	Not specified
BH 58	8702	N/a	St. Mary's	ATTITHOMASRE-VAGH	527729, 723955	Not specified
BH 59	N/a	30323003	Band stand	LENABOY	527924, 723738	Regional
BH 60	N/a	30324003	Shelter	LENABOY	527986, 723628	Regional
BH 61	N/a	30324001	Church	LENABOY	528190, 723924	Regional
BH 62	8902	30324002	179 Salt Hill Road Upper	LENABOY	528230, 723832	Regional
BH 63	9003, 4901	30321004/ 5	Entrance gates and burial ground (AH 83) Two houses	LENABOY/ TOWNPARKS	528432, 724193	Regional
BH 64	N/a	30321003	House	TOWNPARKS	528432, 724418	Regional
BH 65	>100	>100	Varies	GALWAY CITY CENTRE	529762, 725238	Regional/ National
BH 66	x6	x5	College Road	TOWNPARKS	530506, 725570	Regional
BH 67	x3	x4	Bohermore Cemetery	TOWNPARKS	530751, 726155	Regional
BH 68	10603	N/a	No. 1 Wellpark Road	WELLPARK	531069, 726289	Not specified
BH 69	502	30302001	Thatched cottage	BALLINFOYLE	530643, 727185	Regional
BH 70	402	N/a	Crannog (Also AH 149)	BALLINDOOLEY	531591, 729040	Not specified
BH 71	1704 N/a	N/a 30408212	Former schoolhouse Monument	CASTLEGAR	532326., 727690	Not specified & regional

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 72	1701	N/a	Castle - tower house (Also AH 74)	CASTLEGAR	531889, 728046	Not specified
BH 73	1703	30408211	House	CASTLEGAR	531835, 728320	Regional
BH 74	702	N/a	Ringfort – cashel, souterrain, children's burial ground (Also AH 152)	BALLYBRIT	533876, 727767	Not specified
BH 75	5903	N/a	Quarry House	DOUGHISKA	534744, 725766	Not specified
BH 76	5904	N/a	Marble works (Also AH 143)	DOUGHISKA	534668, 725675	Not specified
BH 77	8804 8805	N/a	Thatched cottage Gate keepers cottage	ROSCAM	535071, 725180	Not specified
BH 78	5901	N/a	Castle - tower house, Sheela-na-gig (Also AH 139)	MERLIN PARK	533436, 725971	Not specified
BH 79	N/a	30409424	Ross Hill Lodge	ROSSHILL	534606, 725250	Regional
BH 80	N/a	30409423	Railway bridge	ROSSHILL	534226, 725125	Regional
BH 81	6402	30409421	Level crossing	MURROUGH	533202, 725040	Regional
BH 82	6001	N/a	Church, graveyard (Also AH 134)	BALLYBANE BEG	532185, 725949	Not specified
BH 83	N/a	30409418	Club house	BALLYBANE BEG	532291, 725974	Regional
BH 84	N/a	30409411	Barracks	RENMORE	532313, 725798	Regional
BH 85	10601/ 2	30408222/ 3	Galway Mayo Institute of Technology & entrance	(Former friary with chapel) WELLPARK	531570, 726377	Regional
BH 86	N/a	30409419	Bridge	RENMORE	532289, 725043	Regional
BH 87	8405	N/a	School	RENMORE	531541, 725978	Not specified

BH No:	RPS No.	NIAH No.	Classification	Townland	ITM Reference (E,N)	Rating (NIAH)
BH 88	8401/2	30409408-17	Dún Uí Mhaoilíosa Barracks	RENMORE	531370, 725142	Regional
BH 89	8403	N/a	Designed landscape - tree-ring (Also AH 132)	RENMORE	531804, 725253	Not specified
BH 90	6002	N/a	House - 18th/19th century (Also AH 135)	BALLYBANE BEG	531993, 726615	Not specified
BH 91	601	N/a	Ringfort, souterrain (Also AH 136)	BALLYBANE MORE	532445, 726679	Not specified
BH 92	12001	N/a	Thatched cottage	CLYBAUN	526087, 725109	Not specified
BH 93	1702	N/a	Chapel (site of) (Also AH 23)	CASTLEGAR	532032, 728561	Not specified
BH 94	7601	N/a	Two ruined cottages	PARKMORE	532634, 727796	Not specified
BH 95	2402	N/a	Thatched cottage	COOLAGH	529766, 728044	Not specified
BH 96	2401	N/a	Grotto & Architectural fragment (Also AH 54)	COOLAGH (Galway By.)	529803, 727631	Not Specified
BH 97	2701	N/a	Kiln – lime (Also AH 54)	COOLAGH (Galway By.)	529974, 727445	Not specified
BH 98	501	N/a	Kiln - lime	BALLINFOILE	530847, 727757	Not specified
BH 99	3003	N/a	Remains of stone fort	DANGAN LOWER	527914, 728328	Not specified
BH 100	1503	N/a	Thatched cottage	BALLAGH	526993, 727821	Not specified

4.11.3.6 Architectural Conservation Areas (ACAs)

An Architectural Conservation Area is defined as *'A place, area, group of structures or townscape, taking account of building lines and heights, that is of special architectural, historical, archaeological, artistic, cultural, scientific, social or technical interest or that contributes to the appreciation of a protected structure, and whose character it is an objective of a development plan to preserve.'* (Architectural Heritage Protection Guidelines, 40, 2011, DoAHG). Chapter II of Part IV of the Planning and Development Act 2000 states that that all development plans must now include objectives for preserving the character of ACAs. As such ACAs are subject to statutory protection and is a key constraint.

There are two ACAs within the scheme study area. The smallest is ACA 1, which focuses on the centre of Bearna Village and Pier Road. The second ACA is formed by the various areas within Galway City Centre (ACA 2), which are highlighted within the Galway City Development Plan. Both areas are shown on **Figures 4.11.1** and **4.11.6**.

4.11.3.7 Designed Landscapes

The first edition Ordnance Survey map of County Galway (1838) shows the extent of demesne landscapes around Galway City as shaded areas of land. These were established as a naturalised landscaped setting for the large houses of the landed gentry. Later OS mapping (1913) can also indicate demesne extent, although they are not shaded. Not all demesne landscapes are subject to statutory protection. However, where a demesne exists in association with a protected structure (dependant on the preservation of the landscape), protection can be interpreted as extending to the limits of the curtilage and as such falls within the remit of the Planning and Development Act 2000.

A total of 36 designed landscapes have been identified in the scheme study area from the desktop survey. These are described below in **Table 4.11.6**. The NIAH have carried out a desk-based survey of identifiable demesnes within County Galway. Only 18 of the 36 identified are detailed within the survey.

Table 4.11.6 Designed Landscapes within the Scheme Study Area

DL No.:	Townland:	Details:
DL 1	Freeport	Eagle Lodge and demesne. Small structure that appears to be extant located within a small ornamental landscape marked on the early 20th century OS map. Not included within the NIAH garden survey. Today the garden has lost its characteristics due to surrounding residential development.
DL 2	Bearna Cloonagower Gortnalecka Shanballyduff Rusheen Ballymoneen East	Bearna House and demesne. Marked as a substantial demesne on the first edition OS map covering several townlands. NIAH garden survey lists it as 'Main features unrecognisable – peripheral features visible'. Bearna House extant today (BH 26). However, much of the northern part of the demesne has disappeared under residential development. The southern part retains some of its former character.
DL 3	Gortacleva	River View House & demesne (including Albano Cottage). Both River View House and Albano Cottage are marked within a relatively large demesne landscape on the first edition OS map. However, it is not clear as to where the boundary exists between the two properties. By the time of the early 20th century mapping, River View is marked in ruins, although the cottage is still extant. Neither of the two areas are included within the NIAH garden survey. Today the demesne has been impacted on by modern residential structures. One partially occupies the site of River View. A house is located on the site of Albano Cottage, although it appears to be modern in origin.
DL 4	Killeen	New Park House and demesne. The house is marked within a large demesne on the first edition map. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'. The principal structure is extant today and the landscape does retain some of its characteristics.
DL 5	Kentfield	Glenlo Abbey and demesne. The house is named as 'Glenlough' on the first edition OS map and occupies a large demesne landscape. The early 20th century map shows it renamed as Glenlo Abbey. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'.

DL No.:	Townland:	Details:
		Today the principal structure is extant (BH 1) along with ancillary buildings. It is in use as a hotel and half the demesne has been turned over to a golf course. Several residential buildings have also been constructed.
DL 6	Bushypark	Bushy Park House and demesne. Marked on the first edition OS map within a modest demesne. The NIAH garden survey lists it as 'Main features substantially present – peripheral features unrecognisable'. The principal structure is still extant (BH 5). However, most of the demesne features have been subsumed back into the landscape.
DL 7	Barnacranny	Lake View House and demesne. Shown on the first edition OS map but not shaded. The demesne is a small garden, which is marked more clearly on the early 20th century mapping. Not included within the NIAH garden survey. The house is still extant today but the garden has been impacted upon by modern residential development.
DL 8	Dangan Lower	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville. The first edition OS map shows a large demesne landscape containing a number of large structures although the boundaries between them are not clear. Dangan Cottage is shown in the western portion of the landscape with a drive and gate lodge. Dangan Nunnery is shown further to the north, which appears to have an independent drive way with a large recessed entrance flanked by lodges. A building is also shown on the site of Dangan House. By the time of the early 20th century map, Dangan Cottage is shown as being in ruins. Dangan House occupies the eastern part of the demesne and the nunnery to the north has disappeared. A further building (Mary Ville) is shown adjacent to the drive that once served the nunnery. Today Mary Ville and Dangan House are still extant (CH 40, CH 42). The site of the nunnery is recorded as AH 34 and the site of Dangan Cottage CH 41. Although some mature planting has been retained, the landscape has lost much of its former character, having been developed as a sports campus for the most part. The NIAH garden survey only includes an entry for Dangan House (which actually refers to Dangan Cottage). It states virtually no recognisable features remain.
DL 9	Dangan Upper	Ashley Park and demesne. This house is marked within a demesne landscape on the first edition OS map. By the early 20th century mapping, the demesne is smaller in size, although the house is still extant. The NIAH garden survey records it as possessing virtually no recognisable features. Whilst the principal structure remains extant today, the remainder of the landscape has been covered with residential development.
DL 10	Menlough	Menlo Castle and demesne. The castle and accompanying demesne cover a large area adjacent to the River Corrib on the first edition. The demesne to the south-east appears to be formed by more marginal land. However, a number of outbuildings and avenues are clearly marked within the landscape. There are no major changes to note on later editions. The NIAH garden survey records it as 'Main features unrecognisable – peripheral features visible'. Today the principal structure survives in ruins on the site (BH 2) and there has been a small amount of modern development in the northern part of the demesne. For the most part it remains as green fields, although has been subject to division to suit farming requirements.
DL 11	Newcastle	Newcastle Cottage and demesne. Marked on the first edition OS map with a reasonably large principal structure and several out buildings within a demesne landscape. By the time of the early 20th century, the house has been renamed as 'Clanville' and appears to have been remodelled. Not included in the NIAH garden survey. Today the principal structure is no longer extant and the site has been fully developed as part of Galway University Campus. As such all former character has been lost.
DL 12	Newcastle	Rock Lodge and demesne. Rock Lodge is marked within a small demesne on the first edition OS map with a number of small ancillary structures. It is

DL No.:	Townland:	Details:
		present on later OS map editions, but today the principal structure is no longer present and much of the demesne has been impacted upon by modern development. It is not included in the NIAH garden survey.
DL 13	Shantallow	Fort Eyre House and demesne. A large house is shown within a demesne of reasonable size on the first edition OS map. The house is situated on the northern edge of the demesne, adjacent to the road and to the immediate south of DL 28. By the early 20th century the demesne has been reduced in size due to changes in the local road network. Buildings are also apparent adjoining the eastern side of Fort Eyre. Today the principal building (and those adjacent) are still extant (BH 39). However the remainder of the demesne is covered by residential development. The NIAH garden survey records that the site has virtually no recognisable features.
DL 14	Townparks & Kilcorkey	Nile Lodge and demesne. Shown on the first edition as a demesne of reasonable size, with Nile Lodge located in the north-west corner. The principal structure is still present in the early 20th century, although the demesne appears to be smaller in size. Not included in the NIAH garden survey. Today the principal structure has disappeared and the remainder of the demesne has been covered in residential development.
DL 15	Rahoon	Rahoon House and demesne. The house and a large demesne landscape are marked on the first edition OS map. By the time of the early 20th century the demesne is smaller in size and the local road network has been altered. Recorded in the NIAH survey as possessing virtually no recognisable features, the principal structure does survive today (BH 16), but is surrounded by modern residential development. As such, the demesne has almost completely lost its original character.
DL 16	Rahoon	Kingston House and demesne. Clearly marked on the first edition OS map as a house of reasonable size within a demesne landscape. Very few additional features marked within the landscape on this map. The early 20th century shows more outbuildings and demesne features associated with the house. A Christian Brothers burial ground is marked within the grounds. Today the site of the principal structure is occupied by a large cruciform structure and the demesne has been impacted upon by residential development. Some mature boundaries do survive. Recorded within the NIAH survey as possessing virtually no recognisable features.
DL 17	Pollnarooma West	Blackrock House and demesne. The main house is marked within a demesne of reasonable size on the first edition OS map. Several outbuildings are marked to the north of the principal structure. The early 20th century map shows the demesne around Blackrock House is smaller and has been redesigned to accommodate the construction of another large house in the western part of the demesne. This is labelled as 'West Lodge'. Today Blackrock House is still extant (BH 54) but is surrounded by modern residential development. West Lodge is no longer extant and the western part of the demesne lands have been turned over to a golf course. As such, little of the former character survives. The area is not included in the NIAH garden survey.
DL 18	Pollnarooma East	Sea Mount Lodge and demesne. Present on the first edition OS map as a modest property location within a small demesne and immediately west of DL 29. Not included in the NIAH garden survey. The house was still extant in the early 20th century, although the demesne has lost some character. Today the house has been removed and the demesne is entirely covered with residential development.
DL 19	Renmore	Renmore Cottage and demesne. The first edition OS map shows what appears to be a relatively modest structure within an irregular demesne landscape. By the time of the early 20th century, all structures have been removed from this area, although all the boundaries remain tree lined. It is possible that the landscape was incorporated into the demesne associated

DL No.:	Townland:	Details:
		with Renmore House further to the north. Today the area is entirely covered by residential housing.
DL 20	Renmore	Renmore House and demesne. The main house occupies a demesne of reasonable size on the first edition. By the time of the early 20th century, the house is marked as 'Renmore House' and it appears that the demesne has been extended further to the south to incorporate DL 19. The house has been extended, and additional outbuildings and a walled garden built. Today a large part of the demesne has been covered with residential development. The principal structure is still extant (BH 87), although is now used as a school and is surrounded by modern school buildings. Some mature planting survives in the north-west corner. The NIAH garden survey records the area as possessing virtually no recognisable features.
DL 21	Ballybane Beg	Merview House and demesne. Several structures and a walled garden are marked within a large demesne on the first edition map and named as 'Merview'. It is possible that the demesne had only just been established at this time, as it contained few features and a local road runs through its north-western side. The early 20th century map shows a large amount of development has taken place. A large house is now present within the demesne and the road has been moved further to the north-west to avoid the grounds. The boundaries are all lined with trees and outbuildings, gardens and footpaths have been established around the principal structure. Today the demesne is covered in development and only isolated mature trees survive in places. The principal structure is no longer extant. The NIAH garden survey records the site has possessing virtually no recognisable features.
DL 22	Murrough	Murrough House and demesne. It is possible that this house is present on the first edition OS map, although no demesne is indicated at this time. By the time of the early 20th century the house and its demesne are clearly marked to the immediate south of the railway track. Today the house and its attendant lands survive in good condition. However, it is not included in the NIAH garden survey.
DL 23	Merlin Park	Merlin Park House and demesne. This is one of the largest demesnes marked within the scheme study area on the first edition OS map. The main house is shown at the centre of the demesne and it is surrounded by belts of trees, footpaths, entrances, outbuildings and a walled garden to the north. Little change is shown within the early 20th century mapping. The NIAH garden survey records the areas as 'Main features unrecognisable – peripheral features visible'. Today the principal structure has been removed and the centre of the site is covered by a large hospital. Residential development has impinged on the northern boundaries of the demesne. Some belts of trees are still present within the southern boundary. However, a large portion of the original character has been lost.
DL 24	Roscam	Rosshill House and demesne. Marked on the first edition map to the immediate south of Merlin Park demesne. The house is shown as occupying the centre of a reasonable sized demesne. These continue to be marked on the early 20th century mapping. The NIAH garden survey records the site as 'Main features unrecognisable – peripheral features visible'. The principal structure is still extant and the garden immediate to the building survives relatively well. However, the edges of the demesne have subsumed back into the landscape and been impacted on by some scattered residential development.
DL 25	Ballybrit	Ballybrit House and demesne. This house is marked within a modest demesne on the first edition OS map. Little has changed by the time of the early 20th century map. However, today the demesne is completely covered by development and a road and as such nothing survives. The NIAH garden survey lists the area as possessing virtually no recognisable features.

DL No.:	Townland:	Details:
DL 26	Newcastle	Newcastle House and demesne. Marked on the first edition OS map as Newcastle House, adjacent to a large complex of buildings annotated as 'Newcastle Distillery'. A mill race runs through the distillery, from the River Corrib. The principal structure is present on the early 20th century map, although the distillery is shown as being in ruins. The demesne has also been radically truncated by the railway. Not included within the NIAH garden survey. Today the area has been wholly redeveloped to form part of Galway University Campus. The only historic feature to survive is the mill race. Some mature trees also survive on the periphery of the site.
DL 27	Townparks	Belmont House and demesne. The first edition OS map shows Belmont House within a demesne of reasonable size. The mill race from the Newcastle Distillery is shown as passing through the eastern part of the landscape to a bleach mill, which is marked on the south-eastern edge of the demesne. Not included within the NIAH survey. By the time of the early 20th century, the principal structure has disappeared and Queens College has been established in the southern portion of the former demesne. The mill race from the north has been straightened to run directly south and also services a bad factory marked as occupying the location of the bleach mill. Today the main Queens College building is still extant (BH 37) and with the exception of a number of mature trees, little remains of the original demesne landscape.
DL 28	Shantallow	Shantallow House and demesne. Marked almost to the immediate north of Fort Eyre (BH 39), the house occupies the southern portion of a large demesne on the first edition OS map. It is extant in the early 20th century, but today is no longer present and the demesne is entirely covered by development. The area is not included in the NIAH garden survey.
DL 29	Attithomas-revagh	A house and demesne are shown on the first edition but not named. Located to the immediate east of DL 18. The same unnamed house is marked on the early 20th century map. However, the surrounding demesne has been occupied by a number of additional large houses and as such has lost its character. Today the area is occupied by a large hotel and modern residential housing. The original principal structure is no longer extant.
DL 30	Wellpark	Well Park House and demesne. A house, several outbuildings and a walled garden are shown within a modest demesne on the first edition OS map. There are few changes to note on the early 20th century mapping. Today the principal structure has been removed and the entire demesne developed. No obvious features survive. Despite this, the NIAH garden survey records that the 'Main features unrecognisable – peripheral features visible'.
DL 31	Rahoon	Fort Lorenzo House and demesne. Not marked on the first edition OS map, but present by the early 20th century. A small demesne is shown with gate lodge and entrance drive. This leads to a house of reasonable size. Today the area is covered with residential development and no features appear to survive. Not included within the NIAH garden survey.
DL 32	Rahoon	Merville Lodge and demesne. A modest structure is marked as Merville Lodge on the first edition OS map and an observatory is also shown within the demesne. By the early 20th century the demesne has been reduced in size, although the principal structure has been extended. An additional building marked as Wellfield Cottage is shown to the east of the main building. Not included in the NIAH garden survey.
DL 33	Rahoon	Vicar Croft and St Helen's (houses) and demesne. Two buildings are shown within this demesne, although the division of the demesne is not clear on the first edition. There does not appear to be any access to St. Helen's. By the early 20th century both houses are still present with separate access points shown. The demesne appears to have become smaller. Today both the principal structures survive (BH 46), along with some demesne planting on the southern side of same. However, the northern part of the landscape has

DL No.:	Townland:	Details:
		been impacted upon by residential development. Neither are included within the NIAH garden survey.
DL 34	Rahoon	Taylor's Hill and demesne. The main building is shown within a relatively small demesne on the first edition OS map. By the time of the early 20th century edition, the demesne had been extended slightly and the house enlarged. Today the principal structure appears to survive, albeit in an altered form. The demesne has also been left relatively intact as greenfield. Mature planting survives along the boundaries. Included within the NIAH garden survey and recorded as 'Main features substantially present – peripheral features unrecognisable'.
DL 35	Tievegarriff	Taylor's Hill House, Sea View House and demesne. Two houses are shown within this demesne landscape on the first edition OS map. However, it is not clear from the mapping how the demesne landscape was divided between the two. By the early 20th century, the landscape has been divided again. The western portion is occupied by Taylor's Hill House, which is now named as Ardmore. A new house has been constructed in the central part, which is named as Glenarde House. Sea View House, which was located in the eastern part of the demesne, has been extended and turned into a convent. Today the convent has been removed and Glenarde House substantially extended and turned into a hotel. Ardmore remains present. However, the remaining demesne landscape has been subject to large scale residential development. None of the houses or demesnes are included in the NIAH garden survey.
DL 36	Cloghatisky/ Lenaboy	Lenaboy House and demesne. The first edition OS map shows Lenaboy House in the northern section of a large demesne landscape. A number of landscape features are shown, included tree belts, footpaths and additional outbuildings. A building is shown in the southern section of the demesne, although there is no direct access to the building annotated. By the time of the early 20th century OS mapping, the principal building has been extended and is now named as Lenaboy Castle. New entrances and drive ways are shown. The structure in the southern part of the demesne is now shown as accessible. The NIAH garden survey records the area as 'Main features unrecognisable – peripheral features visible'. The principal structure survives today (BH 41), along with a gate lodge and entrances. However, much of the demesne has been covered with residential development. Mature planting has been retained within portions of the northern section of the landscape.

4.11.3.8 Cultural Heritage

A review of the archaeological chapter of the previous previous N6 Galway City Outer Bypass EIS (2006), revealed a number of areas and sites that could be considered as possessing cultural heritage significance. These include areas and features of archaeological potential such as standing stones and enclosures; ruins of vernacular structures and archaeological anomalies identified in the geophysical survey undertaken in 2005.

Table 4.11.3.7 Sites identified to date as possessing cultural heritage potential

CH No.	Townland	Classification:	ITM Reference (E,N)	Statutory Protection
CH 1	Na Foraí Maola Thiar	Possible enclosure (also listed as AH 1, redundant record)	521380, 723081	None
CH 2	Knocknagreana	Possible enclosure (2006 EIS)	521157,	None

CH No.	Townland	Classification:	ITM Reference (E,N)	Statutory Protection
			723942	
CH 3	Aille	Possible mound (2006 EIS)	524007, 725222	None
CH 4	Cappagh	Possible enclosure (2006 EIS)	524384, 724561	None
CH 5	Cappagh	Vernacular structure, in ruins (2006 EIS)	524576, 724677	None
CH 6	Tonabrocky/ Keeraun	Vernacular structure, in ruins (2006 EIS)	525209, 726268	None
CH 7	Gortacleva/ Tonabrocky	Groups of vernacular structures, in ruins (2006 EIS)	525561, 727992	None
CH 8	Gortacleva	Possible standing stone (2006 EIS)	525560, 728226	None
CH 9	Gortacleva/ Tonabrocky	Groups of vernacular structures, in ruins (2006 EIS)	525661, 728226	None
CH 10	Gortacleva	Possible cairn (2006 EIS)	526075, 728541	None
CH 11	Killeen	Site of 'Albano Cottage'	526277, 728560	None
CH 12	Kentfield	Possible mill race (2006 EIS)	526376, 728637	None
CH 13	Kentfield	Circular feature related to the adjacent railway line (2006 EIS)	527032, 728650	None
CH 14	Brownville, Killeen, Kentfield, Busypark, Dangan Lower, Newcastle, Townparks, Renmore, Murrough, Roscam	Railway line	Through scheme study area	None
CH 15	Dangan Lower	Trapezoidal mound of gravel and earth (2006 EIS)	527850, 728432	None
CH 16	Dangan Lower	Medieval field? (2006 EIS)	527898, 728316	None
CH 17	Dangan Lower	Medieval field system? (2006 EIS)	527801, 728315	None
CH 18	Menlough	Regular rectangular cut feature & Possible standing stone (2006 EIS)	528270, 728137	None
CH 19	Menlough	Vernacular structure, in ruins (2006 EIS)	528431, 728073	None

CH No.	Townland	Classification:	ITM Reference (E,N)	Statutory Protection
CH 20	Menlough	Consumption wall (2006 EIS)	528594, 728032	None
CH 21	Menlough	Vernacular animal shelter (2006 EIS)	528729, 728035	None
CH 22	Menlough	Possible prehistoric tomb (2006 EIS)	528958, 727991	None
CH 23	Menlough	Circular feature? (2006 EIS)	529411, 728367	None
CH 24	Menlough	Small boulder (2006 EIS)	529481, 728367	None
CH 25	Menlough	Possible cairn (2006 EIS)	529607, 728477	None
CH 26	Menlough	Consumption wall (2006 EIS)	529683, 728626	None
CH 27	Ballindooley	Possible corn/turf drying stand, possible ringfort, possible cairn, possible consumption wall, three possible structures (2006 EIS)	530696, 729314	None
CH 28	Ballindooley	Possible *fulacht fiadh* (2006 EIS)	531082, 729466	None
CH 29	Ballindooley	Possible ringfort (2006 EIS)	531273, 729379	None
CH 30	Ballindooley	Rectangular feature (2006 EIS)	531378, 729450	None
CH 31	Ballindooley	Vernacular buildings, in ruins (2006 EIS)	531527, 729374	None
CH 32	Ballindooley	Consumption wall (2006 EIS)	532412, 729640	None
CH 33	Pollkeen	Raised natural limestone platform with possible hut (2006 EIS)	532469, 729688	None
CH 34	Ballintemple	Possible standing stone, isolated boulder, three raised areas of archaeological potential, possible cairn (2006 EIS)	535031, 278254	None
CH 35	Ballintemple	Raised stone circular area (2006 EIS)	535198, 728126	None
CH 36	Ballintemple	Group of vernacular buildings (2006 EIS)	535212, 728018	None
CH 37	Coolagh	Possible stone dump with boulders and trees (2006 EIS)	535424, 727757	None

CH No.	Townland	Classification:	ITM Reference (E,N)	Statutory Protection
CH 38	Killeen	New Park House	525381, 728683	None
CH 39	Barnacranny	Lake View House	527395, 727442	None
CH 40	Dangan Lower	Dangan House	528424, 727442	None
CH 41	Dangan Lower	Site of Dangan Cottage	528076, 727490	None
CH 42	Dangan Lower	Mary Ville	528223, 727333	None
CH 43	Dangan Upper	Ashley Park	528178, 727184	None
CH 44	Aille/Cappagh	Vernacular building, in ruins (2006 EIS)	523821, 725662	None
CH 45	Brockagh	Upright stone (2006 EIS)	534885, 728588	None
CH 46	Coolagh	Burnt mound? (Geophysical survey 2005)	536290, 727535	None
CH 47	Coolagh	Two Burnt mounds? (Geophysical survey 2005)	536184, 727584	None
CH 48	Ballintemple	Burnt mound? (Geophysical survey 2005)	534952, 728474	None
CH 49	Ballindooley	Burnt mound and ditches? (Geophysical survey 2005)	531832, 729346	None
CH 50	Gortacleva	Ditches and pits? (Geophysical survey 2005)	526138, 728539	None

4.11.4 Summary

The purpose of this section was to provide an analysis of the archaeological, architectural and cultural heritage resources within the scheme study area in order to inform the design of the proposed N6 Galway City Transport Project. The scheme study area is located within County Galway and contains all or part of 95 townlands. The study has shown that there is a large cultural heritage resource within the area. The sites and areas listed within this section and shown on **Figure 4.11.1** and **4.11.6** should be considered as constraints during the design process.

As part of the NRA Guidelines for the assessment of archaeological and architectural impacts of National Road Schemes, this phase of assessment aims to identify all recorded archaeological and architectural heritage sites that can be considered as constraints to the design of the proposed routes. A more detailed route selection assessment ahs been carried out in **Chapter 7** of this report, which examines all potential archaeological, architectural and cultural heritage sites within a designated corridor for each route option.

With the exception of Galway City and its suburbs, the remaining landscape is rural in nature containing some scattered settlement, small scale pastoral farming with some farmed peatland. A total of 163 RMP sites of varying dates are listed within the current scheme study area indicating a continuance of activity and settlement in the region. A substantial number of these sites can be ascribed to the early medieval period, with ringforts and enclosures being most frequent. In addition, two sites are listed as National Monuments (Merlinpark Castle AH 139 and Galway City defences AH 103) and four sites are further protected with a Preservation Order (AH 24-27). A total of 22 of the sites are recorded within the Register of Historic Monuments, which was a precursor to the Record of Monuments and Place (RMP). All recorded archaeological sites (AH sites) should be considered as cultural heritage constraints during the design of the proposed scheme and avoided where possible. National Monuments and sites with Preservation Orders should be considered to be key constraints.

In order to fully understand the constraints at Galway Racecourse in Ballybrit, which include a number of monuments (castle, deserted medieval village, ringfort, enclosure) further protected by a Preservation Order, a detailed geophysical survey was carried out. This covered *c.*14ha and two survey techniques were utilised during the survey: Magnetometry and targeted electromagnetic induction (quadrature) survey.

The results from both surveys highlight widespread modern ferrous interference, zones of substantial magnetic disturbance, buried services, responses from recent land use and the remains of former cultivation. A number of isolated potential archaeological anomalies were identified. However, no large scale remains were identified within the survey area.

A survey of the Excavations Bulletin (1970-2014) has revealed that a number of excavations have taken place within the scheme study area. Over 90 investigations have occurred within Galway City Centre, whilst 39 have taken place within the remaining part of the constraints area.

There are a number of Areas of Archaeological Potential (AAPs) within the scheme study area. These consist of the River Corrib, various streams and smaller rivers, small lakes, coastal margins and areas of bog/peat land.

All AAPs should be considered as archaeological constraints and avoided where possible by the route options. Where avoidance is not possible, potential impacts should be minimised through design. This includes the use of clear span structures across water ways.

An analysis of the built heritage within the scheme study area has provided a holistic view of the built heritage resource, with the later years of the post medieval period well-illustrated by the presence of a substantial number of country houses, bridges and churches. Structures that are architecturally and socially important are listed within the Galway City Development Plan, Galway County Development Plan and NIAH survey for County Galway. Protected structures receive statutory protection that helps to ensure their preservation for the future. A total of 100 individual or groups of protected structures and/or NIAH structures are located within the scheme study area. All protected structures and NIAH structures should be considered as cultural heritage constraints during the design of the proposed scheme with direct impacts and impacts on settings avoided where possible.

A total of 36 designed landscapes have been identified within the scheme study area. Some of these still retain their principal building and/or outbuildings, whilst others have been lost over the course of time. Many of the landscapes close to the centre of Galway City have been completely covered in residential development. These landscapes should be considered as cultural heritage constraints during the design of the scheme. It should be noted that analysis undertaken to date is desk based and field inspection will be required to assess the surviving nature and extent of the designed landscapes within the scheme study area.

A total of 50 sites of Cultural Heritage significance have been identified within the scheme study area. These were identified with the use of the historical OS mapping, analysis of previous studies and geophysical survey and include post medieval buildings and sites of archaeological potential. This designation also includes the railway line (part of which has now gone out of use) that runs through the scheme study area in a roughly east-west direction. The railway formed part of the Midland Great Western Railway network, which had reached Galway by August 1851. In 1890 it received a grant of 264,000 pounds (£9,000 per mile) to construct a railway from Galway, across Connemara, to Clifden, with stations at Moycullen, Outhterard, Maam Cross, Recess and Ballynahinch. This section of the railway opened on 1 July 1895 but was closed in 1935. These sites should be considered as cultural heritage constraints. The analysis undertaken to date is desk based and field inspection will be required to assess the surviving nature and extent of the cultural heritage sites within the scheme study area.

As a result of the study it has become clear that two areas in particular (with the exception of the city centre) possess a high cultural heritage value due to the amount of sites recorded. The area surrounding Menlo Castle is one specific area, where multiple constraints are recorded. These include the castle itself (AH 11/BH 2) and gate lodge (AH 9/BH 3) that occupy a relatively intact demesne landscape (DL 10). A further six recorded archaeological sites as located in or within the immediate vicinity of the demesne (AH 10, 7, 8, 6, 117, 116) along with a number of protected structures in and around Menlough Village (BH 9, 10, 31).

To the south-west of Menlough, a further area was identified within Dangan Lower that also contains multiple constraints, despite its development as part of the NUIG Campus. The former demesne landscape (DL 8) here has been impacted upon by development. However, eight recorded archaeological sites are located within this area (AH 42, 115, 43, 44, 39, 40, 34, 41), two of which are also listed as protected structures (BH 14, 32). Three cultural heritage sites were also identified, that relate to the establishment of country houses (CH 40, 42, 41).

4.11.5 References

Bennett, I. (ed.) (1987–2010) *Excavations: Summary Accounts of Archaeological Excavations in Ireland. Bray. Wordwell.*

Bonsall, J & Gimson, H. (2005) *Geophysical Survey of the proposed N6 Galway City Outer Bypass. Unpublished report for Galway County Council.*

Galway City Council. (2011–2017) *Galway City Development Plan.*

Galway County Council. (2015–2021) *Galway County Development Plan*

National Roads Authority. (2005) *Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes.*

National Roads Authority. (2005) *Guidelines for the Assessment of Architectural Heritage Impacts of National Road Schemes.*

National Monument Service, Department of Arts, Heritage and the Gaeltacht. Sites and Monuments Record, County Galway

N6 Galway City Outer Bypass EIS (2006) Vol.2 chp.13. Vol.4 Appendices 13.1-4

National Inventory of Architectural Heritage Handbook, 2011, *Department of Arts, Heritage and the Gaeltacht.*

Ordnance Survey 6" & 25" maps of County Galway (1838/39, 1915-20)

www.excavations.ie - Summary publication of every archaeological excavation that has taken place in Ireland (1970–2014), edited by Isabel Bennett. (accessed on 01-08/10/14)

www.archaeology.ie - DoAHG website listing all SMR sites, National Monuments and sites with Preservation Orders. Database of archaeological sites known to the National Monuments Service.(accessed on 01-08/10/14)

www.osi.ie – Ordnance Survey website containing aerial photographs and historic mapping (accessed on 01-08/10/14)

www.buildingsofireland.ie – Website listing the results of the NIAH building and garden survey for Galway (accessed on 01-08/10/14)

www.googleearth.com – Website containing aerial photographic datasets and street view (accessed on 01-08/10/14)

4.12 Material Assets – Agriculture

4.12.1 Introduction

This section describes the agricultural constraints identified within the scheme study area for the N6 Galway City Transport Project. Agricultural constraints are presented in **Figures 4.12.1.**

Section 4.12.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.12.3** describes the agricultural constraints within the scheme study area. A summary is presented in **Section 4.12.4** and references are listed in **Section 4.12.5**.

4.12.2 Methodology and Sources of Information

Methodology

The NRA 2010 Project Management Guidelines and the Environmental Protection Agency Guidelines on Information to be contained in Environmental Impact Statements (EIS) (2003) were referred to.

Sources of Information

This constraints assessment comprised a desk-top collation, interpretation of available published data and a windshield assessment (April 2014) of the scheme study area. The following sources of information were referred to:

- 2010 Census of Agriculture Report, Central Statistics Office;
- Environmental Protection Agency (EPA) Soil Mapping Data (2013 data set); and
- Orthophotography (2012).

The natural constraints identified were agricultural land and the quality of the land from an agricultural point of view. The land quality assessment is a broad categorisation which seeks to distinguish poor quality land from average-to-good quality land. In this assessment, poor quality land is restricted by impediments such as poor drainage, peaty topsoils and a rough and rocky topography. The land quality was assessed using EPA Soil Mapping Data, aerial photography and wind shield surveying.

The artificial constraints identified were agricultural structures such as cattle holding pens, silage pits, farm sheds, farm yards and farm access roads. At this stage of the environmental assessment process, the boundaries of individual farm properties were not identified.

4.12.3 Existing Environment

4.12.3.1 Farm size and type in the scheme study area (CSO data)

Approximately 40% of the scheme study area is covered by urban development associated with Galway City. To the east of the River Corrib there is approximately 80 hectares of land used for quarrying. The remainder of the land, which is the

subject of this assessment, is mainly agricultural, although there are considerable areas of peatland in the Western Sector which have a very low value from an agricultural point of view.

Analysis of Tables 1, 2, 3 and 8A of the 2010 Agricultural Census shows that:

- The average size of farms in County Galway is 25.8ha compared to the national average of 32.7ha;
- The average economic output of farms in County Galway is €12,864 compared to the national average of €30,726; and
- Approximately 3% of farms of the livestock in County Galway are dairy[15] compared to the national average of 11% of farms.

Analysis of seven electoral divisions (EDs)[16] in the area surrounding Galway City indicates that:

- 70% of farms are less than 20ha in size (compared with 42% of farms in the state and 53% of farms in County Galway); and
- 97% of farmers in the scheme study area are beef cattle, or beef cattle and sheep farmers (similar to overall statistics for County Galway) and 3% are dairy farmers.

4.12.3.2 Results of Windshield Survey (April 2014)

The following was noted during the windshield survey:

- No tillage cropping was noted (although in the past there have been plots of arable ground in Polkeen);
- Four equine enterprises were noted in Ardaun, Ballindooley, Menlough and Tonabrucky. There is an equestrian centre in Tonabrucky and a large equine training track in Ardaun;
- There are no very large farm yards indicating very intensive cattle enterprises or pig or poultry enterprises;
- There are no intensive horticultural enterprises in the scheme study area; and
- In addition to four equine structures, 169 agricultural structures were noted as possible constraints within the scheme study area (e.g. farm yards, sheds, silage pits, holding pens and farm access roads). These are shown in **Figure 4.12.1**.

4.12.3.3 Land Quality

The land quality to the west of the River Corrib is generally poor throughout, and at least 20% is bog or heathland. There is very little grazing or turf cutting activity on these areas and they have a very low value from an agricultural point of view.

[15]Dairy farms are regarded as being High Sensitivity farms compared to other livestock enterprises (Beef & Sheep) and tillage farms which are Medium Sensitivity;

[16]These EDs include Ballintemple (Pt. - 27042), Bearna (Pt. - 27044), Carnmore (27046), Carrowbrowne (Pt. - 27047), Furbogh (27051) and Moycullen (27059)

To the east of the River Corrib, there is poor quality land between Ballindooley and Menlough (shallow soils, rock outcrop and scrub) and there are low lying wet, marshy areas adjoining the River Corrib. However, overall the land quality is generally good in the majority of the scheme study area to the east of the River Corrib.

4.12.4 Summary

The constraints study for material assets non-agriculture is summarised as follows:

- Agriculture in the scheme study area is not intensive and the farm size is relatively small;
- The good quality agricultural land in the Eastern Sector is located throughout and is therefore a natural constraint that is unavoidable;
- While there are no very large livestock farm yards or horticultural enterprises in the scheme study area, farm yards should be avoided to minimise impacts; and
- Two equine enterprises noted in Ardaun and Tonabrucky should be avoided.

4.12.5 References

None.

4.13 Material Assets – Non-Agriculture

4.13.1 Introduction

This section describes non-agricultural material assets constraints identified within the scheme study area for the N6 Galway City Transport Project. Material assets – non-agriculture includes amenities, residential preoperties, commercial properties, industrial properties, ultities and services and waste facilities (other than licenced sites which are dealt with in **Section 4.4 Soils and Geolgoy**). The material assets – non-agricultural constraints identified are presented in **Figures 4.13.1** to **4.13.9.**

Section 4.13.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.13.3** describes the material assets – non-agricultural constraints within the scheme study area. A summary is presented in **Section 4.13.4** and references are listed in **Section 4.13.5**.

4.13.2 Methodology and Sources of Information

The aim of this assessment is to highlight the non-agricultural material assets within the scheme study area and assess these as constraints.

The assessment is based on a desk study, and on information gathered during consultations with landowners and the public. The desk study included an inspection of land registry records, wind shield surveys, consultation with the statutory organisations, examination of orthophotography, and inspection of records from the Galway County Council and City Council Planning Departments, and An Bord Pleanála. Information gathered is listed in **Table 4.13.1** below.

Table 4.13.1 Data Source for Information gathered

Information	Data Sources
Land ownership and Land Use Details	• Numerous meetings with landowners have taken place • A co-located design office in Ballybrit, centrally positioned on the project, facilitated ease of access for landowners and became the central data collection point • Public Consultation in July 2014 • Land Registry – To identify ownership of land and location of boundaries • Orthophotography
Locations of Properties	• Windshield Surveys at crossing points of the local roads and along the existing N6 to identify non-agricultural properties. • Orthophotography
Planning Applications	• Searches through Galway City and County Council Planning Database
ESB	• Consultations between Design Team and ESB and ESBI representatives

Gas Networks Ireland (Bord Gáis)	• Consultations between Design Team and Gas Networks Ireland (Bord Gáis) representatives
UPC	• Consultations between Design Team and UPC representatives
BT Ireland	• Consultations between Design Team and BT Ireland representatives
Eircom	• Consultations between Design Team and Eircom representatives
O2 Ireland	• Consultations between Design Team and O2 Ireland representatives
Vodafone	• Consultations between Design Team and Vodafone representatives
Meteor	• Consultations between Design Team and Meteor representatives
Three	• Consultations between Design Team and Three representatives
Coillte	• Consultations between Design Team and Coillte representatives
E-Net	• Consultations between Design Team and E-Net representatives
SSE Ireland	• Consultations between Design Team and SSE Ireland representatives
An Garda Síochána	• Consultations between Design Team and An Garda Síochána
Water Supply	• Consultations between Design Team and Irish Water

The following sources of information were consulted in order to identify waste constraints:

- Replacement Waste Management Plan for the Connacht Region 2006 – 2011;
- Evaluation of the Replacement Waste Management Plan for the Connacht Region 2006 – 2011;
- Galway City Council waste management;
- Galway County Council waste management; and
- Repak website.

4.13.3 Existing Environment

4.13.3.1 Amenities (Amenity Zones, Local Amenities)

Large areas within the scheme study area are zoned RA for *"Natural Heritage, Recreation and Amenity"*. Specific objectives have been set out in Galway City Development Plan 2011-2017 in relation to these RA zoned lands. These objectives include:

- Regeneration plans for the amenity areas of Ballybane and Ballinfoyle;
- Using Galway Racecourse for conferences and exhibitions outside of festival hours. Provision for a park and ride facility into the city from the racecourse;
- Use the area north of Túr Uisce in Doughiska as a swimming pool, leisure centre and community centre;
- Utilise and upgrade the existing facilities at Cappagh Park with the provision of a new community centre at this location; and
- The relocation of Galway Rowing Club to the River Corrib banks at Dyke Road.

The recreationally zoned lands in the study area reflect the main parks in Galway City. The banks of the River Corrib and the River Corrib itself are a significant recreational area serving the population of Galway. The major educational facilities of GMIT and NUIG are substantial amenities with many of their facilities being open to public use.

To the east of the River Corrib the most important amenity areas include Merlin Woods, Lough Atalia and Terryland Forest Park. Ballyloughane Strand is a significant amenity serving the east of the city. There are many outdoor recreational facilities on the east of the city including Galway Sports Ground and Greyhound Stadium, Galway Racecourse, GMIT pitches and many other sports facilities. The indoor amenity facilities include the IMC and EYE cinemas and the bowling complex along Headford Road.

The coastal amenities to the west of the River Corrib are utilised more than that of the eastern side. Galway Bay, Rusheen Bay and Salthill Promenade are significant recreational areas. Salthill Promenade is a national tourist attraction bringing many visitors to Galway annually. The golf courses at Glenlo Abbey Hotel and Galway Golf Course are noteworthy recreational facilities. Pearse Stadium in Salthill is another outdoor recreational facility to the west of the city, this is home to GAA in Galway with matches and major concerts taking place here. Other sports facilities include NUIG Recreational Facilities at Dangan, Kingfisher Fitness Centre and water based recreational facilities along the River Corrib.

4.13.3.2 Residential Properties

The residential areas are well distributed throughout the study area. Galway has an inner city residential hub sprawling out to the suburbs of Knocknacarra, Castlegar and Doughiska. The established suburbs within the scheme study area include Renmore, Mervue, Dangan, Westside, Tirellan and Ballinfoyle. Each of these established suburbs have their own unique character. Demolition of existing dwellings in the established residential areas is limited, especially for the construction of high rise apartment development which is deemed unacceptable in the context of the Development Plan. The aim of this is to maintain the residential amenity of the established areas.

The type of housing in the study area at present varies significantly. Large residential estates, one off housing, high rise apartment complexes, linear development and small residential clusters can all be found. The type of residential development is not defined to certain areas; the type of housing is varied throughout the study area. Student accommodation is also centred around the third level institutes.

In 2011, 158ha of land were zoned for residential purposes. According to statistic reported in Galway City Development Plan 2011-2017 over 6,000 new houses will be required in Galway by 2017. This resulted in 248ha of land being zoned as residential to meet this increased demand. In addition to consolidation of the existing residential areas of Knocknacarra, Doughiska and Castlegar, the Plan sets out that housing will be required at Ardaun and Murrough.

The Housing Strategy of the Galway City Development Plan 2011-2017 has set some specific objectives for residential areas in Galway to include:

- Environmental improvement schemes for the residential areas of Mervue, Claddagh, Shantalla and Bohermore;
- Prepare an environmental improvement scheme for the area known as 'The West' that incorporates submissions already made by residents;
- Prepare a regeneration plan for the open space areas of Ballybane;
- Finalise the draft regeneration plan for Ballinfoyle Park entitled 'A Better Ballinfoyle' and implement actions where feasible and subject to funding; and
- Prepare an enhancement scheme for Whitehall.

4.13.3.3 Commercial Properties

Galway is defined as a Gateway City in national context under the National Spatial Strategy (NSS). The NSS identifies Galway as the dominant economic hub in Connaught and highlights its significance importance to the surrounding area. The commercial and light industries are the most important employment sectors in Galway.

The retail industry is a key element in Galways economic development. Galway has seen a significant expansion of retail floor space in recent years. The main retail areas have expanded and also new “District Centres” have developed. Due to housing sprawling out from the city, commercial development too has been required further from the core retail area to facility a new demand in the suburbs. District Centres have been developed in Knocknacarra, Rahoon, Doughiska and proposed at Ardaun. The city centre still remains the dominant retail area in Galway. Other popular retail facilities include Briarhill Shopping Centre, the commercial estates at Tuam Road, Liosbain and Westside Retail Centre. The Headford Road area occupies 30ha and has long been a major contributor to the commercial development of Galway. The Galway Shopping Centre and Galway Retail Park are located here. A Local Area Plan has been proposed for the Headford Road area to improve and enhance its function ability as a core shopping area.

Residential commercial developments have a significant function to Galway as a tourist destination. Hotels and B&Bs brought an estimated 1 million overseas tourists to Galway (Galway City and County) in 2004. This type of commercial development is very important to Galway as a Gateway City. Some key residential commercial facilities in the scheme study area include:

- Glenlo Abbey Hotel and Golf Course;
- Clayton Hotel at Ballybrit;
- Pillo Hotel;
- Menlo Park Hotel; and

- Clybaun Hotel

Medical and emergency facilities are a significant employer in the commercial sector in Galway. The noteworthy facilities in the scheme study area include:

- University Hospital Galway, Newcastle;
- Merlin Park University Hospital, Merlin;
- Bon Secours Hospital, Renmore; and
- Galway Clinic, Doughiska.

Educational facilities in Galway are a major contributor to the commercial sector. The main educational centres in Galway are National University of Ireland, Galway (NUIG) and Galway Mayo Institute of Technology (GMIT). The main NUIG campus is located on the west banks of the River Corrib in Newcastle. The campus is currently severed by the N6 carriageway. The NUIG campus also includes Recreational Facilities at Dangan and the Corrib Village Student Accommodation in the northern campus. GMIT is located along the Dublin Road in Renmore. The campus is smaller than that of NUIG. The campus is flanked by a number of sports facilities all within walking distance in the Renmore area.

4.13.3.4 Industrial Properties

The industrial sector in Galway is fed by a skilled workforce from the third level institutes. The main industries in Galway are medical technology and ICT services. The main business parks and industrial estates in the study area include:

- IDA Business Parks at Mervue, Dangan and Parkmore;
- Harbour Enterprise Park;
- Galway Technology Park;
- Ballybrit Business Park;
- Ballybane Industrial Estate;
- Liosban Business Park; and
- Galway West Business Park.

More detail on the location of these business parks and industrial estates can be found in Section 4.3.9 (Human Beings).

4.13.3.5 Utilities and Services

Gas Networks Ireland (Bord Gáis) gas supply

Bord Gáis gas supply lines are widespread throughout the scheme study area as shown on **Figures 4.13.3.1** and **4.13.3.2**. They provide a range of different gas supply levels from 63 PE-80 4 bar to 250 PE-80 4 bar. The larger gas lines follow paths along the following roads:

- Doughiska Road;
- R339 Monivea Road;
- R865 Ballybane Road;

- R336 Tuam Road;
- R864 Newcastle Road;
- R338 Seamus Quirke Road;
- R337 Taylors Hill Road; and
- Western Distributor Road.

These main supply lines then branch off to serve the residential areas and follow housing estate patterns. There are also many arteries of gas supply in the city centre.

Water supply

Numerous waterlines carry a water supply within the scheme study area as shown on **Figures 4.13.2.1** and **4.13.2.2**. The larger of these pipe lines range from 300-500mm. The 500mm pipeline follows a route similar to the N17 Tuam Road from Twomileditch and verges southeast towards the Ballybrit Junction The 450mm pipeline serves Terryland and areas of the western side of the city including Letteragh and along the R338 Seamus Quirke Road between the Browne Roundabout and the Dean Roundabout. The 300mm pipeline is spread throughout the study area; it follows for some part the Letteragh Road, R864, R866 onto the N84 Headford Road and the R339 from Lough Atalia through to Wellpark Road.

ESB electricity supply

The ESB provide electricity supply connections across the city and throughout the scheme study area as shown on **Figures 4.13.3.1** and **4.13.3.2**. There are a number of high voltage underground lines and high voltage overhead lines of 38kV and 110kV present. These would be a significant constraint as the diversion of HV ESB cables pose major difficulties and should be avoided where possible. The HV lines can be found on the outskirts of the city. The medium and low voltage cables are more commonly found within the city centre. However, these do not pose a significant constraint. There are two substations present in the study area at Ballybrit and Salthill. More detail on the location of these electricity supply cables can be seen in **Figures 4.13.3.1** and **4.13.3.2**.

UPC

UPC lines are widespread through all of the scheme study area serving all major residential and industrial areas. Refer to **Figures 4.13.4.1** and **4.13.4.2** for more detail.

E-Net

E-Net provides fibre optic cables throughout the scheme study area as shown on **Figures 4.13.4.1** and **4.13.4.2**. On the east side of the River Corrib, the cables follow patterns similar to the road network. These lines are present along the N17 Tuam Road and south at Ballybrit Crescent, Doughiska Road, east bound at the Dublin Road, traveling north to south on Tuam Road and Wellpark Road and south on Lough Atalia Road into the city centre. Likewise on the western side the cables cross the River Corrib at Quincentenary Bridge, travelling north and south along the Newcastle Road, west bound on Seamus Quirke Road and Taylors Hill Road and then loops from Gort na Bró to Bóthar Stiofáin and then back south along Rahoon Road. The E-Net cable would be a major constraint as diversions are very expensive.

Eircom

Eircom lines are a prominent throughout the scheme study area as shown on **Figures 4.13.4.1** and **4.13.4.2**. These lines follow the existing road network and housing patterns. It is evident that any proposed solution will cross a number of Eircom lines and these will have to be diverted. The extent of the Eircom supply lines can be found in **Figures 4.13.4.1** and **4.13.4.2**.

BT

BT Ireland provide a service within the scheme study area as shown on **Figures 4.13.4.1** and **4.13.4.4**, a number of lines are present. One existing line runs west from the Coast Road to the Dublin Road with an arm verging south to Ballyloughane Road while the main artery follows the road north west from Michael Collins Road to Connolly Avenue. At this location it connects with another line that has travelled west along the N6 Bóthar na dTreabh as far as the junction with the N17 Tuam Road, this provides links to Ballybrit Business Park and Mervue Business Park. The line then follows Lough Atalia Road into the city centre and then north on Newcastle Road.

Three

There are 25 Three facilities spread amongst the scheme study area as shown on **Figures 4.13.4.1** and **4.13.4.2** at various locations. 10 of the locations are to the west of the city with the remaining 15 located to the east of the city.

Eirgrid

There is a proposed 110kV line, which SSE Ireland are designing and constructing, that will have form a constraint of the scheme study area as shown on **Figures 4.13.4.1** and **4.13.4.2**. The cables are to be in an underground trench, 1.2m deep and 1m wide and encased in concrete. The proposed line is set to follow the N59 south until the NUIG Recreational Facilities at Dangan at which it will divert east across the River Corrib to go south along Coolagh Road and then follow the N6 Road as far as the Ballybrit Junction and will connect to the Ballybrit substation. Eirgrid have been contacted but no other information or drawing received to date.

Meteor

Meteor contacted but no information or drawing received to date.

4.13.3.6 Proposed Developments

Proposed developments are detailed in **Section 4.9 Land Use and Planning Constraints**

4.13.3.7 Waste Facilites

The constraints identified in relation to waste management include composting facilities, landfill sites, transfer stations, recycling plants, thermal treatment plants and bring banks. In addition to the facilities that are located within and service the scheme study area have also been included in this constraints study.

Ireland is divided into 3 regions for the purposes of waste management planning, Connaught Ulster, Eastern Midland and Southern. Each region is currently

preparing a Waste Management Plan which will allow for the effective and efficient delivery of waste management services for the region.

Galway City is a member of the Connaught Ulster Waste Region, along with Galway County Council, Mayo County Council, Leitrim County Council, Roscommon County Council, Sligo County Council, Donegal County Council and Cavan County Council. The group is co-ordinated by the Regional Waste Management Office based in Castlebar, with the lead local authority as Mayo County Council.

The Connacht Ulster Region Waste Management Plan 2015-2021 has been published. This new plan replaces the Connaught Regional Waste Management Plan 2006-2011, and sets out the strategic vision for waste in the region, the present position with regards waste and how the plan is to be implemented for the future in the region.

Composting Facilities

There are no composting facilities located within the scheme study area but it would be remiss not to include the facilities located at Carrowbrowne as a constraint.

Galway City Council manages and operates a large composting facility in Carrowbrowne. It is licenced to accept 9,500 tonnes of organic waste annually. The facility has not accepted any waste material since 2013 as further investment would be required to upgrade the facility to meet licence requirements. Prior to 2013, the facility used to receive the brown bin waste from over 20,000 households in Galway City that was transported to the site, from Galway City Council's waste collection service and also a number of private waste collectors. Galway City Council ended its household waste collection service in 2014. It is now operated by private sector operators. The waste was used to cover the old landfill site also at Carrowbrowne. Currently, it is intended to lease the composting facility to a private operator.

Bearna Recycling has the largest composting facility in Connacht which is located at Carrowbrowne, Galway. The maximum annual capacity of the facility is 40,000 tonnes of organic waste.

Landfill Sites

There are no operational local authority landfills in Galway City or County. Tuam landfill was closed in September 1998 and replaced by a civic amenity site to which the public can bring waste. Carrowbrowne landfill was closed by the High Court in December 1998. There are presently only two local authority operated landfill sites in Connaught; Derrinumera landfill and Killala landfill, both located in County Mayo.

Prior to the adoption of the Connacht Waste Plan, each of the Region's Local Authorities operated at least one landfill. The plan designated that there should be two regional landfills – one each in North Connaught and South Connaught. No progress has been made on the development of the North Connaught landfill but currently only one other landfill is operational in the Region. The Mayo Landfill is deemed to be the North Connaught landfill for the moment.

The development of the siting study and statutory process for the North Connaught Regional Landfill was targeted for completion by the end of 2009. The need to develop the North Connaught Regional Landfill is not sufficiently clear due to the lack of sufficient commercial certainty in the area combined with changes in the

waste management landscape. The regional landfill requirements and available landfill capacity is assessed every two years.

Transfer Stations

The Galway City Council Recycling Centre located in the Liosbaun Industrial Estate is the only transfer station operated by a local authority in Connaught.

The Bearna Waste Facility in Carrowbrowne is currently the largest waste transfer station in Connaught and handles waste from all over the country. The facility is outside of the study area of the project but as the facility is located less than 1.5km north of the scheme study area it should be included as a constraint.

Recycling Centre

Galway City Council Recycling Centre is located in the Liosbaun Industrial Estate. It provides a facility for residential customers of Galway City to bring and dispose of unwanted household or electrical items free of charge.

There are three recycling centres in Galway County operated by the County Council which are located in Ballinasloe, Clifden and Tuam. A community cooperative: 'Athchursal Aran' operates a facility on Inis Mór. These recycling centres are unlikely to have any affect within the scheme study area.

Bearna Waste and The City Bin Co. operate facilities within the Council's functional area but adjacent to the city. The Bearna Waste facility is located in Carrowbrowne and The City Bin Co. is located in Oranmore.

4.13.3.8 Summary

In conclusion the major non-agricultural material asset constraints within the scheme study area are:

- Residential properties;
- River Corrib and its associated amenities;
- Galway Racecourse;
- Major utility transmission lines;
- The large industrial estates and business parks;
- National University of Ireland, Galway (NUIG); and
- University Hospital Galway and Merlin Park University Hospital.

There is a transfer station, recycling centre and 13 bring banks located within the scheme study area. There are other waste facilities located directly outside of the study area boundary which have also been accounted for such as the Bearna Recycling facility and the Galway City Council composting facility located in Carrowbrowne.

4.13.3.9 References

Galway City Development Plan 2011-2017

National Spatial Strategy for Ireland 2002-2020

Connacht Waste. (2012), *Evaluation of the Replacement Waste Management Plan for the Connacht Region 2006 – 2011*

Connacht Waste. *Replacement Waste Management Plan for the Connacht Region 2006 – 2011*

http://www.repak.ie/recycling_facilities.php#facilities - Website containing information on the bring banks, recycling centres and civil amenity centres in Galway City and County. Last accessed 25th November 2014.

http://search.galwaycity.ie/AllServices/WasteManagement/AwarenessandEducation/Composting/CarrowbrowneCompostingFacility/ - Website of Galway City Council containing information on the Carrowbrowne Composting Facility

http://galwayindependent.com/20150311/news/council-to-lease-carrowbrowne-S51953.html - Website of Galway Indepentent detailing Galway City Councils intention to lease Carrowbrowne.

http://search.galwaycity.ie/AllServices/WasteManagement/WasteManagementPlan/ - Website of Galway City Council detailing the proposed waste management plan for the Connacht Ulster region.

http://www.barnarecycling.com - Website of Bearna Recycling containing information on their waste, recycling and composting facilities.

http://www.mayococo.ie/en/Services/Environment/WasteManagement/CollectionandDisposal/Landfills/ - Website of Mayo County Council containing information on the landfill facilities in County Mayo.

4.14 Air Quality and Climate

4.14.1 Introduction

This section describes the air quality constraints identified within the scheme study area for the N6 Galway City Transport Project.

Air quality constraints are presented in **Figure 4.15.1.**

Section 4.14.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.14.3** describes the air quality constraints and the ambient air quality within the scheme study area.

A summary is presented in **Section 4.14.4** and references are listed in **Section 4.14.5**.

The main constraints associated with air quality are the numbers of sensitive locations in the scheme study area and the assimilative capacity of the baseline air quality relative to limit values. No significant variation in climatic impacts is expected which influence the choice of route options as climate is a regional issue. Therefore climate is not considered further in this assessment.

4.14.2 Methodology and Sources of Information

Methodology

The air quality assessment has been prepared in accordance with the National Roads Authority (NRA) document *'Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes'*, 2011.

Section 2.3 *Route Selection Process Stage 1 Preliminary Options Assessment* of the above document includes the initial steps to be taken to identify air quality constraints within a study area as follows:

"The initial step (Stage 1, i.e., Preliminary Options Assessment) in the Route Selection Process is to identify the nature and extent of significant constraints within a defined Study Area. These constraints should be documented and mapped so that feasible route options can be designed to avoid such constraints, where possible. The first part of this data collection should be based on deskbound research studies. All known physical constraints from an air quality perspective should be identified and recorded on suitably scaled maps.

The specific objectives of the air quality input to the Stage 1 Preliminary Options Assessment of the Route Selection Process are to characterise the existing ambient air quality in the study area and to initially identify all sensitive receptor locations within the study area likely to be impacted by a proposed scheme before feasible route options are identified……..."

The above approach has been followed for this constraints assessment. The "study area" as described above is the "scheme study area" as shown on **Figure 4.1**.

In addition, Section 2.3 of the above document also describes the air quality input required for the Stage 1 Preliminary Options Assessment as follows:

1. Describe existing local air quality conditions within the study corridor in relation to nitrogen dioxide (NO_2) and PM_{10}. This should take full account of any existing monitoring data from networks established by the Environmental Protection Agency (EPA) and local authorities and monitoring carried out by other organisations, as relevant. It should also identify any areas where the standards are exceeded;
2. Describe any non-road sources that may significantly affect air quality within the study corridor, for example, industry, ports, areas of domestic solid fuel combustion, or power stations;
3. Identify and record all sensitive receptor locations within the study area and all sensitive receptors within 50 m of the carriageway of each feasible route option that are, or have the potential to be, significantly affected by a proposed scheme;
4. Take full account of all previous studies, local air quality assessments or reports, and any other air quality work undertaken by the NRA, EPA or local authorities, and
5. Include a review of planning permissions granted within the Study Area of relevance from an air quality perspective (e.g. significant sensitive receptors and developments likely to have a significant impact on air quality.)

The above information is included in this assessment with the exception of Item 3 in relation to feasible route options as this is detailed in Chapter 6 of this report.

Sensitive receptor locations are defined in the guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas, i.e. locations where members of the public are likely to be regularly present. Refer to **Figure 4.15.1** for sensitive receptor locations. Designated habitats are also potentially sensitive receptors. Such sites include, Natural Heritage Areas (NHA), candidate Special Areas of Conservation (cSAC), Special Protection Areas (SPA), National Parks, Nature Reserves, Refuges for Fauna, Refuges for Flora, Wildfowl Sanctuaries, Ramsar Sites, Biogenetic Reserves and UNESCO Biosphere Reserves. These receptors are detailed in **Section 4.3 Ecology.**

All ecologically sensitive sites identified in **Section 4.3** will be considered in terms of nitrogen oxide concentrations in the assessment of air qaulity in **Chapter 6**.

Air Quality Standards

In order to reduce the risk of poor air quality, National and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values are set for the protection of human health and ecosystems.

On 12 April 2011, the Air Quality Standards Regulations 2011 (S.I. No. 180 of 2011) came into force and transposed EU Directive 2008/50/EC into Irish law.

The purpose of the 2011 regulations is to establish limit values and alert thresholds for concentrations of certain pollutants, to provide for the assessment of certain pollutants using methods and criteria common to other European Member States, to ensure that adequate information on certain pollutant concentrations is obtained

and made publically available and to provide for the maintenance and improvement of ambient air quality where necessary. The limit values established these regulations are included in **Table 4.14.1** below.

Table 4.14.1 Air Quality Standards (AQS) from Regulations 2011 (S.I No. 180 of 2011)

Pollutant	Limit value for the protection of:	Averaging period	Limit value (µg/m3)	Basis of application of limit value	Limit value attainment date
NO2	Human Health	1-hour	200	≤18 exceedances p.a. (99.79 %ile)	1 January 2010
		Calendar year	40	Annual mean	1 January 2010
NOx	Vegetation	Calendar year	30	Annual mean	1 January 2010
PM10	Human Health	24-hours	50	≤35 exceedances p.a. (98.1%ile)	1 January 2005
		Calendar year	40	Annual mean	1 January 2005
PM2.5	Human Health	Calendar year	25	Annual mean	1 January 2015
		Calendar year	20	Annual mean	1 January 2020
CO	Human Health	8-hour Annual Average	10,000	8-hour Average	1 January 2005
Benzene	Human Health	Calendar year	5	Annual mean	1 January 2010

Sources of Information

The baseline environment has been determined through the review of published data from the EPA. The EPA collate all air quality monitoring data carried out by the EPA and local authorities.

4.14.3 Existing Environment

This section describes the existing local air quality conditions within the scheme study area. Any non-road sources that may significantly affect air quality within the scheme study area are also described. Finally sensitive receptor locations within the scheme study area are described.

4.14.3.1 Existing local air quality conditions within the scheme study area

The existing air quality is determined from air quality data recorded by the EPA in Zone C. Zone C is defined by the EPA as 21 large towns in Ireland with a population greater than 15,000 and includes Galway City and its environs.

Pollutants that are of concern in relation to road scheme developments have been identified.

They are nitrogen oxides, carbon monoxide, particular matter, and benzene. **Table 4.14.2** presents baseline data for the most recent available years, 2013, 2012, and 2011 for these pollutants. In cases where no data is available for Zone C, the most

applicable data has been used. Baseline values are compared to the limit values from the Air Quality Standards.

Table 4.14.2 Baseline Concentrations of Pollutants

Year	Pollutants	Time Period	Location	Measurement µg/m3	Air Quality Standard Limit µg/m3	% of Air Quality Standard Limit
2013	NO2	Annual Average	Zone C	5	40	12.5
	NOx	Annual Average	Zone C	9	30	30
	CO	8 hour Annual Average	Zone C	300	10,000	3
	PM2.5	Annual Average	Zone B	11	25	44
	PM10	Annual Average	Zone C	20.5	40	51.3
	Benzene	Annual Average	Zone C	0.5	5	10
2012	NO2	Annual Average	Zone C	6.7	40	16.8
	NOx	Annual Average	Zone C	11	30	36.7
	CO	8 hour Annual Average	Zone C	450	10,000	4.5
	PM2.5	Annual Average	Zone C	12	25	48
	PM10	Annual Average	Zone C	17	40	42.5
	Benzene	Annual Average	Zone C	0.4	5	8.0
2011	NO2	Annual Average	Zone C	12	40	30
	NOx	Annual Average	Zone C	20	30	66.7
	CO	8 hour Annual Average	N/A	N/A	10,000	N/A
	PM2.5	Annual Average	Zone C	14	25	56.0
	PM10	Annual Average	Zone C	19	40	47.5
	Benzene	Annual Average	Zone A	1.6	5	32.0

As presented in Table 4.14.2, an improvement in overall baseline concentrations in Zone C has occurred over the past three years for all pollutants. The greatest levels of baseline concentrations for 2013 relative to AQS are for $PM_{10}$and $PM_{2.5}$, at 51% and 44% of the AQS limits respectively. These will be of primary concern during the air quality assessment. NO_x baseline levels are low in 2013 but higher in previous years. NO_x emissions will be of critical importance in instances where any route crosses, or comes into close proximity to an ecologically sensitive area due to their harmful effect on vegetation. The scheme study area includes the following ecologically sensitive areas; Lough Corrib cSAC, Lough Corrib pNHA, Galway Bay Complex pNHA, Inner Galway Bay SPA and the Moycullen Bogs NHA.

In general, the air quality concentrations recorded in Zone C by the EPA is shown to be well within air quality standards and the assimilative capacity of the air within the scheme study area is considered good.

4.14.3.2 Existing sources of air pollution in the study area

Table 4.14.3 presents the major road networks and volumes located in the scheme study area. Annual average daily traffic (AADT) volumes have been provided where measured by the NRA`s Automatic Traffic Counter Statistics.

Table 4.14.3 AADT for Major Roads within Study Area

Roads	Year	Location	AADT
N6/M6	2011	West Ballinasloe	11,204
N17	2012	Claregalway	20,738
N18	No data available within the study area		
N64	No data available within the study area		
N59	2011	Maam Cross	2,963

The data presented in **Table 4.14.3** show the current major volumes of traffic within the scheme study area. The air emissions from these vehicles are assumed to form part of the baseline concentration levels as presented in **Table 4.14.2**.

4.14.3.3 Non-road air quality sources within scheme study area

Table 4.14.4 presents a list of industrial facilities licenced by the EPA within the study area, under the Industrial Emissions Directive (IED) or Integrated Pollution Licence (IPC).

Table 4.14.4 EPA IED/IPC Licence holders within the Scheme Study Area

Licence No	Company	Address	IPC/IED
P0142-01	Thermo King Ireland Limited	Monivea Road, Mervue, Galway.	IPC
P0264-02	Medtronic Vascular Galway	Parkmore Industrial Estate, Galway.	IPC
P0279-01	Irish Finishing Technologies Limited	Riverside Industrial Estate, Tuam Road, Galway.	IPC
P0285-01	Nellcor Puritan Bennett Ireland Ltd.	Michael Collins Road, Mervue, Galway.	IPC
P0339-01	Heiton Buckley Limited	Heiton Buckley Limited t/a Heiton Buckley Builders Merchants, Wellpark, Galway, Co Galway.	IPC
P0384-01	Irish Finishing Technologies Limited	Units 35-38 Ballybane Industrial Estate, Tuam Rd., Galway.	IPC
P0725-01	Boston Scientific Ireland Limited	Ballybrit Upper Industrial Estate, Galway.	IPC
P0324-01	Hygeia Chemicals Limited	Carrowmoneash, Oranmore, Co Galway.	IPC
P0056-01	Cold Chon (Galway) Limited	Oranmore, Galway.	IED

Licence No	Company	Address	IPC/IED
P0133-02	APW Galway Limited	Deerpark Industrial Estate, Oranmore, Co Galway.	IPC

In addition to the air emission sources outlined above, the effect of the emission sources presented in the above table are likely to be reflected in the baseline air monitoring data presented in **Table 4.14.2**.

Sensitive receptor locations within the scheme study area sensitive receptor locations are defined in the guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas, i.e. locations where members of the public are likely to be regularly present. Refer to **Figure 4.15.1** for sensitive receptor locations. Designated habitats are also included. These receptors are detailed in **Section 4.3 Ecology.**

4.14.4 Summary and Conclusions

The air quality concentrations recorded in Zone C by the EPA are shown to be well within air quality standards and the assimilative capacity of the air within the study area is considered good. The main constraint associated with air quality is the statutory requirement to continue to comply with air quality standards for the protection of human health and vegetation.

4.14.5 References

National Roads Authority. (2011) *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes*,

National Roads Authority. (2008) *Project Appraisal Guidelines*,

Environmental Protection Agency. (2013) *Air Quality in Ireland 2012*.

Environmental Protection Agency. (2012) *Air Quality in Ireland 2011*.

Environmental Protection Agency. (2011) *Air Quality in Ireland 2010*.

4.15 Noise and Vibration

4.15.1 Introduction

This section describes the noise and vibration constraints identified within the scheme study area for the N6 Galway City Transport Project. Noise and vibration constraints are presented in **Figures 4.15.1** to **4.15.3.**

The specific objective on the noise constraints study is to identify any receptors that may be deemed to be particularly sensitive to noise and/or vibration. Examples of receptors include schools, hospitals, places of worship, heritage buildings, special habitats, amenity areas in common use and designated quiet areas (Source: *NRA Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes - 2013 & Guidelines for the Treatment of Noise and Vibration in National Road Schemes - 2004*).

Residential buildings including houses, hotels, hostels etc. are also noise sensitive. Some commercial or industrial uses can also be noise sensitive, for example noise recording studios and research of manufacturing facilities using noise or vibration-sensitive equipment.

The objectives for new road projects relate to avoidance, where necessary of new routes through built up areas with a large density of noise sensitive buildings, particularly those not already exposed to high volumes of traffic. The specific impacts relating to all noise and vibration sensitive locations are considered in **Chapter 6** and **7**.

Section 4.15.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.15.3** describes the noise and vibration constraints within the scheme study area.

A summary is presented in **Section 4.15.4** and references are listed in **Section 4.15.5**.

4.15.2 Methodology and Sources of Information

The noise and vibration constraints study has been prepared in accordance with the following guidelines:

- NRA Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes – 2013
- NRA Guidelines for the Treatment of Noise and Vibration in National Road Schemes – 2004

The study consisted of a desk study and a preliminary site inspection of the scheme study area.

The following information was reviewed as part of this study:

- OS Mapping 2012;
- Orthophotography Mapping 2012;
- Satellite Mapping (Google Earth, Bing Maps);

- Galway City Council, Noise Action Plan 2013 to 2013;
- County Galway Local Authorities City Council Noise Action Plan 2013 to 2018, and;
- Public Consultation No. 1 Submissions (July 2014).

4.15.3 Existing Environment

This section is set out as follows:

- Identification of any receptors that may be deemed to be particularly sensitive to noise and/or vibration;
- Description of existing noise environment; and
- Discussion of opportunities for mitigation.

4.15.3.1 Identification of Noise and/or Vibration sensitive receptors

The scheme study area was examined to identify the distribution of noise and/or vibration sensitive receptors and to determine the presence, if any, of significant constraints relating to noise and/or vibration.

Noise and or vibration sensitive areas were grouped into the following categories:

- Education Establishments (Primary Schools, Secondary Schools , College and University Buildings);
- Hospitals (Including nursing homes);
- Amenity Areas (Racecourses, golf clubs, equine areas, parks etc.);
- Religious Buildings; and
- Residential Areas.

These areas were overlaid with the aerial and OS mapping for the scheme study area in order to develop the noise constraint map. For the purpose of this assessment, individual residential locations were not highlighted in the constraint mapping due to the large proportion of residential development throughout the scheme study area. The constraint map has highlighted those areas with high density development likely to contain a high proportion of residential dwellings. These areas are still considered noise sensitive and will be assessed specifically during the route selection phase and as part of the overall assessment for the preferred option. Noise and vibration sensitive receptors relating to flora and fauna species are dealt with within the ecological constraints **Section 4.3**.

It is important to note that the presence of the noise sensitive receptors listed above is not necessarily considered to be a strict constraint which would prevent the development of a route in close proximity to them. The purpose of this initial exercise is to highlight those areas which should be considered, where possible when developing options in conjunction with the other identified constraints. In this instance, where it is not possible to develop horizontal route options away from identified noise sensitive locations, consideration can be given to the vertical alignment, the use of natural screening or false cuttings to act as noise buffers and mitigation measures as part of the base design.

Given the urban and suburban nature of the existing environment which the scheme study area is based, it will not be possible to avoid every noise sensitive location within the scheme study area. It is also important to note that the majority of the above listed constraints are currently located in proximity to existing busy roads or within areas exposed to noise from other urban and sub-urban sources. The existing noise environment is discussed further in **Section 4.15.3.2.**

4.15.3.2 Noise Environment

The scheme study area comprises a mixture of urban and suburban areas. In terms of the existing noise environment towards the city centre, road traffic in addition to urban sources from retail, commercial and light industrial facilities etc, all contribute to noise levels over day and night-time periods. Further out from the city centre, road traffic is the main contributor to ambient noise levels.

Galway City Council's most recent Noise Action Plan (2013 to 2018) presents an overview of the contribution of road traffic within the city boundary. As part of the noise mapping requirements, all roads with traffic flows greater than 3 million vehicle trips per annum (approximately 8,000 AADT) were required to be mapped. For Galway City Council, sections of the following roads within the vicinity of the city boundaries met this criterion and hence were included within the noise modelling and mapping process:

- R336, R337, R338, R339;
- R446, R863, R864, R865; and
- R866, R921, N6, N17 & N59.

Noise levels due to road traffic sources from these sections of road have been modelled and the relevant noise maps prepared. The maps are presented in noise contour bands in increments of 5 decibels starting at 55dB L_{den} and 45dB L_{night}. **Figures 4.15.2** and **4.15.3** display the noise maps for the L_{den} period (Annual 24 hour average) and the L_{night} period (night-time 07:00 to 23:00hrs).

These figures illustrate the key routes into and across the city which contribute road traffic noise to the existing environment. Reference to the maps indicates that the N6, N17 and N84 Roads contribute the highest noise levels due to the traffic volumes along these routes. The noise action plan notes that approximately 70% of the population are exposed to noise levels equal to or below 50dB L_{den} and approximately 80% of the population are exposed to noise levels equal to or less than 45dB L_{night}.

Both Galway City Council and Galway County Council have applied a threshold level above which areas may require noise mitigation or management. The proposed onset levels for the assessment of noise mitigation measures are:

- 70dB, L_{den}; and
- 57dB L_{night}.

The results of the noise mapping exercise indicate that 1.69% of the population within the functional area of Galway City Council are exposed to road traffic noise above the proposed onset levels noted above. Those properties which have been identified to be above these threshold levels are typically properties which are located immediately along the road edges.

It should be noted that noise contour maps are based on road traffic only for those routes which have been mapped. Noise from road traffic along other regional and local roads with traffic volumes less than the mapping requirement (8,000 AADT) will also contribute to the ambient noise levels at properties in the vicinity of these routes.

The scheme study area comprises a mix of the noise sensitive receptors noted above which are therefore already exposed to varying levels of road traffic noise. In addition, noise from industrial process, quarries, plant noise and other urban sources are not included in the noise mapping study but will contribute to the noise environment depending on their proximity to these sources.

4.15.3.3 Opportunities for Mitigation

Operational Phase

Given that the noise environment within the scheme study area is dominated to a large extent by existing traffic flows, changes to the noise environment will be dependent on the redistribution of traffic flows from the existing N6 Road along any new or upgraded alignment as part of the N6 Galway City Transport Project.

Residential dwellings make up the majority of the noise sensitive receptors within the scheme study area extending out to all areas of the constraint boundaries. Other noise sensitive receptors include hospitals, hotels, educational, religious buildings etc. These tend to be centred more towards the existing built up areas nearer the city centre or are significantly less distributed across the scheme study area compared to housing and are, in turn, easier to direct options away from.

In terms of the constraint study, the development of options needs to consider the following for residential areas:

- Areas of high density housing within areas set back from existing road traffic noise;
- Areas of high density housing in close proximity to existing road traffic noise (e.g. along the existing N6 across the city);
- Residential clusters at crossroads, townlands, village centres, etc.; and
- Ribbon style residential housing along local roads radiating from the city centre.

In this instance, consideration will be given to a balance between protecting residential properties currently not exposed to high levels of road traffic noise and not increasing or generating significant negative impacts to residential properties already exposed to high levels of road traffic and other environmental sources. Where possible, routes passing through or in close proximity to clusters of residential estates etc. with large populations should be avoided.

For other noise sensitive areas consideration will be given to the sensitivity of specific receptors depending on their use in addition to the existing noise environment in which they are located.

For all receptors, the availability for noise mitigation in the form of the horizontal and vertical alignments, natural screening and road surfaces will all be considered during the route development stage.

Construction Phase

In terms of the construction phase, during standard road building activities, the use of standard noise and vibration mitigation measures and suitable noise and vibration limits will be sufficient to provide adequate protection to noise sensitive areas. Where tunnelling forms part of an option construction (TBM, drill and blast or cut and cover), the proximity and density of occupied noise sensitive buildings (residents, hospitals, nursing homes etc.) to tunnel works (horizontal and vertical), TBM launch pits, construction compounds etc. will be a key significant constraint, particularly where night-time works are required.

In addition, depending on any tunnelling options proposed, there is potential for significant vibration impacts to building occupants or at vibration sensitive buildings and structures which will also have the potential to pose a significant constraint for the preferred options. As part of the route options assessment therefore, consideration will be given to the presence, density and sensitivity of noise and/or vibration sensitive buildings and structures along each of the routes.

In terms of mitigation measures at the design stage, consideration will be given to:

- Siting of launch pits and site compounds away from noise and vibration sensitive areas as far as practicable; and
- Design of tunnels to adequate depths to avoid excessive vibration and noise transfer to sensitive receptors above.

Further site specific mitigation measures will be developed for work areas during the construction phase which will be governed by noise and vibration limits at sensitive locations.

4.15.4 Summary

The scheme study area for the N6 Galway City Transport Project is made up of a mixture of urban and suburban regions. The scheme study area immediately surrounding Galway City consists of high density urban residential zones in addition to a large number of schools and churches and some universities and hospitals. Outside of Galway City, the scheme study area consists of lower density suburban residential zones, schools, churches and hospitals and some amenity areas.

All of the sensitive receptors are exposed to some degree of road traffic noise from existing roads including the existing N6 which currently transverses the city. The noise maps prepared as part of Galway City Council's Noise Action Plan indicate that whilst there is a large mix of noise sensitive areas distributed across the scheme study area, a large proportion of these are already exposed to road traffic noise to varying degrees depending on traffic volumes, distance from the road centre line and screening.

During the development of the options for the transport project, consideration will be given to protecting existing noise sensitive areas through route alignment options and incorporating noise mitigation into the base design including the use of natural topographical features and false cuttings.

4.15.5 References

National Roads Authority. (2013) *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes*.

National Roads Authority. (2004) *Guidelines for the treatment of noise and vibration for national road schemes*. 2004

Galway City Council. *Noise Action Plan 2013 to 2018*

County Galway Local Authorities City Council. *Noise Action Plan 2013 to 2018.*

4.16 Human Beings

4.16.1 Introduction

This section identifies the constraints relating to human beings identified within the scheme study area for the N6 Galway City Transport Project, as shown on **Figure 4.16.1**. This section can be read in conjunction with **Material Assets Non-Agriculture Section 4.13** which contains details of residential properties and, by association, constraints in terms of individual dwellings. The **Air Quality and Climate Section 4.14** and **Noise and Vibration Section 4.15** also address constraints in terms of human beings. **Landscape and Visual Section 4.7** also includes for constraints relative to amenities enjoyed by individuals.

Section 4.16.2 describes the methodologies and sources of information that were used to carry out the study. **Section 4.16.3** describes the human beings constraints within the scheme study area. A summary is presented in **Section 4.16.4** and references are listed in **Section 4.16.5**. The objective of the human beings constraint study is to identify activities and locations of social or economic importance that could present constraints to the development of route options corridors.

These include locations where mitigation may need to be considered or locations which, by virtue of their characteristics, should be avoided where possible. Locations for example, where there are concentrations of important community facilities. There are interactions with other environmental disciplines in that impacts on social well-being or the use of community facilities can also arise from environmental impacts such as noise.

Even where a road development is in close proximity to community facilities, impacts such as severance can often be mitigated through the design of crossing points for pedestrians, cyclists or local traffic or through the use of tunnels or overbridges. However, the physical presence of a road can also present a social or psychological barrier to social interaction and cohesion and impact on community identity.

Road schemes can also have positive impacts by reducing existing levels of severance or environmental impact. They can enhance accessibility and connectivity and so supply benefits for social interaction, economic growth and employment. A new road development can provide additional capacity for traffic within a city, improved connections between homes and places of employment, improved interaction with other transport modes, and improved connections to other parts of the country. This would have the effect of reducing journey times, thereby improving quality of life or economic competitiveness.

4.16.2 Methodology and Sources of Information

The human beings constraints study has been prepared in accordance with the following guidelines:

- EPA Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (2003);
- EPA Guidelines on the Information to be contained in Environmental Impact Statements (2002); and

- NRA Environmental Impact Assessment of National Road Schemes – A Practical Guide (2006).

The emphasis of this study is to identify key community facilities in the study area. These include facilities such as schools, community centres, sports centres and playing fields, medical centres and hospitals, parks and greenways, shops, pubs and places of employment. These facilities have been identified on **Figure 4.16.1**. As the study area encompasses the entire city of Galway there is a considerable number of community facilities. The core city centre area contains a high concentration of such facilities and so these have not been identified individually.

The purpose of the Human Beings constraints study is to identify locations where impacts on local people and communities could potentially occur. The socio-economic impacts associated with transport schemes fall into four key categories, namely:

- Journey characteristics, accessibility and connectivity, i.e. potential impacts on journey time, journey time reliability and travel patterns;
- Community severance with regard to the use of community facilities, particularly those used by older people, children or other vulnerable groups;
- Amenity, i.e. impacts on individual and community well-being due, for example, to people's exposure to the environmental impacts of traffic (e.g. safety, noise, dirt, visual intrusion and air quality); and
- Impacts that could affect economic growth prospects and employment.

Impacts can be positive or negative. Their significance depends, among other considerations, on the nature of the environment affected, the duration of an impact and the probability of its occurrence. It often follows that impacts of a socio-economic nature are a function of:

a) The scale of the impact itself;

b) The numbers of people likely to be affected; and

c) The impact on vulnerable or sensitive groups.

Sources of Information

Documents consulted for the development of the constraints include the Galway County Development Plan 2015-2021, the Galway City Development Plan 2011-2017, strategic documents and reports by Galway City Council or Galway County council such as the *Socio-Economic Statement of County Galway, April 2015* and various websites relating to economic developments, tourism, amenity and recreation. Key areas of the city have been visited and community facilities identified by means of car, bicycle and on foot.

4.16.3 Existing Environment

The following section describes the existing environment as regards human beings, specifically the demographic character of the city, its economy, its amenities and community facilities.

4.16.3.1 Population

The population of Galway city was 75,529 persons in the CSO Census of 2011. The city population has been growing rapidly and although the 2011 total represented an increase of 4.3% on 2006 this followed a 10% increase on the previous census.

Table 4.16.1 indicates the population of each Electoral Division (ED) in the study area as recorded at the time of the most recent Census in 2011. As might be expected it demonstrates that central city areas have a relatively high population density. Districts with population densities in excess of 2000-3000 persons per km can be regarded as especially urban in character. Central areas districts such as Eyre Square, Claddagh, Salthill and St Nicolas each contain areas of high population density reflected in older housing stock, although there are neighbourhoods of higher density in Dangan, Bearna and west Ballybaab (Ballybane) too. In many, but not all cases, these higher densities coincide with areas of less affluent socio-economic groups or social housing.

Table 4.16.1 Population and population density of Galway Electoral Divisions

Electoral Division	Population	Population Density
WEST		
044 Bearna (Bearna Rural)	3630	159
003 Bearna	14384	2134
008 Knocknacarra	1515	732
015 Rahoon	3009	629
006 Dangan	3686	2441
013 Newcastle	1820	2528
WEST CENTRAL		
021 Taylors Hill	2457	3233
017 Rockbarton	1922	2669
020 Shantalla	1785	3188
019 Salthill	3482	4408
014 Nun's Island	1293	2085
005 Claddagh	2429	3155
NORTH		
010 Mionlach	4990	632
CENTRAL		
018 St Nicolas	2598	3021
007 Eyre Square	4461	4797
009 Lough Atalia	920	754
016 Renmore	1394	1566
WEST		
004 Castlegar	4135	1085
022 Wellpark	1843	2275
011 Mervue	1796	1974

Electoral Division	Population	Population Density
012 Murrough	2414	816
002 Ballybrit (Baile an Bhriotaihg)	898	364
001 Ballybane	12298	1708

The Galway City Development Plan (2011-2017) illustrates the largely west-east zoning of residential development extending from development east of the Cappagh Road in Knocknacarra across to Doughiska and Roscam in the east with areas such as Newcastle and Terryland situated north of the N6/R338.

The central areas of Galway contain some communities with distinct identities. The Galway City Development Plan 2011-2017 lists indicative neighbourhoods, (see **Table 4.16.2 below)** for which it has a number of aims, including good accessibility, but also the prioritisation of walking, cycling and public transport over the use of private cars. The more well-established neighbourhoods can be expected to contain a high proportion of vulnerable age and social groups such as older people and people without access to private vehicles.

There are also areas containing a high proportion of more recent housing development that are spatially distinct and which could be vulnerable to the social or psychological severance that can arise from busy roads with or without ample crossing facilities. These locations include such outlying communities as Castlegar, and Terryland. In addition, the established rural communities of Menlough, Bearna and Ballindooley have a distinct identity despite low density development as do some areas of predominantly recent low density residential development. As well as these physical or social characteristics, the rural Electoral Division (ED) of Bearna falls within the Gaeltacht area. Údarás na Gaeltachta estimate that 15,300 people within the Gaeltacht fall within the suburbs of Galway City. Menlough and Bearna are two important Gaeltacht communities within the scheme study area. These areas are a potential constraint due to the need to avoid a high level of linear separation or severance within populated locations which could undermine the spatial integrity of the communities.

Table 4.16.2 Indicative suburban neighbourhood areas in Galway City

Outer Suburbs	Established Suburbs	Inner Residential Areas
East	**East**	**East**
Ardaun	Renmore	Bohermore
Doughiska	Mervue	College Road
Roscam	Ballybane	Lough Atalia
West	**West**	**West**
Knocknacarra	Dangan	Claddagh
Ballyburke	Salthill	Shantalla
Ballymoneen	Taylor's Hill	Newcastle
	Westside	
North	**North**	

Outer Suburbs	Established Suburbs	Inner Residential Areas
Castlegar	Tirellan	
Tuam Road	Ballinfoyle	

Source: Galway City Development Plan 2011-2017

Distinct neighbourhoods are often represented by traditional parishes, housing estates of the same age, areas of homogeneous social class or bounded by existing roads. For example, distinct neighbourhoods exist between the more established area along Bóthar An Chóiste in Castlegar and new apartment development to the immediate south. Green areas of open space between communities can appear as opportunities for route options, but may contribute to local socio-cultural identity in their own right or often contain playing fields or parklands such as Galway Racecourse, Terryland Park, Merlin Woods and the NUIG Recreational Facilities along the west bank of the River Corrib.

As well as the community identity of the more built up areas, several outlying communities include linear residential development along major or minor roads. This type of spatial development could incur socio-economic impacts where there is a risk of severance by a new road development. Examples of such locations include Ballintemple, School Road in Castlegar, the Headford Road, Ballagh and Boleybeg to Drum in Tonabrocky, An Chloch Scoilte, Truskey West and Na Foraí Maola.

Significant severance is already found along the route of the existing N6. For example, there are no cyclist or pedestrian crossings of the road between the Briarhill Business Park and the Ballybane Junction. There are few community facilities here, but the importance of the location for employment means that many workers are forced to use private transport to reach their employment destination, while those who do have to walk or cycle may need to make an unsatisfactorily long journey. High volumes of traffic mean that significant existing pedestrian severance is present further west in the vicinity of shopping centres such as the Galway Retail Park or along Seamus Quirke Road. Signalised crossings and cycle paths have eased the level of severance, although the latter often terminate at roundabout junctions where hazards are most pronounced.

The Galway Metropolitan Area includes a number of EDs and satellite settlements on the edge of Galway City including Bearna and Oranmore. Both the Galway City Development Plan and Galway County Development Plan envisage an outward extension of development eastwards towards the proposed Ardaun development east of Doughiska and located between the R339 Monivea Road and the Eastern Approach Road R446. This area is currently largely undeveloped except for Coolagh Village and the Galway Clinic. The plans acknowledge the potential pressure that this new development will place on existing transport infrastructure westwards into the city and the need to integrate land use and transportation.

A need for consolidation or regeneration within selected neighbourhoods is identified in the plan. These neighbourhoods tend to be bordered by existing major roads, but should be avoided where possible by route options with severance minimised where neighbourhoods adjoin. In addition, the Development Plan places an emphasis on networks of open space and greenways as alternatives to roads.

4.16.3.2 Economy

The Galway City economy has a strong representation of software, pharmaceuticals and engineering businesses. Tourism is also an important economic sector. High quality transportation access in and out of the city is essential to the city's economy and to its capacity to stimulate economic growth across Galway County including more peripheral areas to the west of the city. Upgrades to the N6 and national primary routes will contribute significantly in this regard.

4.16.3.3 Business

Business and industrial parks or industrial areas

The Galway City Development Plan has zoned three principal areas for enterprise and industrial activity, namely a large area (A) between the N6 and N17 continuing down into Mervue as far as the Joyce Roundabout, the Galway Harbour enterprise area (B) and Clybaun (C). These areas also include land zoned for light commercial activity in addition to this zoning in parts of Briarhill and between the R336, N6 and south of Bodkin Roundabout. Refer to **Figure 4.16.1.**

Generally, there are few large business parks to the west of the River Corrib. However, in Rahoon and Clybaun there is the Galway West Business Park and the Gateway Retail Park. A large area is zoned for enterprise and commercial activity extending from Bóthar Stiofán in Knocknacarra/Clybaun across to the Western Distributor Road. Business parks are situated off the N59 at Corrib Village and Galway Business Park. The Galway Business Park is located off the N59 Headford Road and benefits from its proximity to the University (NUIG).

Most of the city's business and industrial parks are located in the eastern part of the city and benefit from good road connectivity with the east of the country. The greatest concentration of this infrastructure is along the N6 in Ballybane, and between the N6 and N17. These include the Ballybrit Industrial Park and Ballybrit Business Park. Several retail businesses, including household or hardware type businesses and car showrooms, are located at intervals along the N17 for a few kilometres to the northof the junction with the N6. Business parks and commercial estates are also located off the R336 Tuam Road heading to the centre of the city, but with good access to the N6. Galway Harbour Enterprise Park is located beside Galway Port. There are also enterprise parks situated close to the N59 Moycullen Road.

Between the N17 and M6, the Briarhill Business Park is located to the north of the Coolagh Roundabout on the N6 approach to the city. Car dealerships are located in the vicinity. A pedestrian, cycle and service underpass links the business parks from the south side of the N6. A short distance to the north, and separated from the aforementioned Ballybrit Industrial and Business Parks by the racecourse, are the Galway Technology Park, Racecourse Business Park and Parkmore Business and Technology Parks which cover a large area off Castlepark Road.

Located west along the N6 approach to the city are the City East Ballybrit Business Park the Ballybrit Business Park and the Ballybane Industrial Park. The Oldenway Business Park and Ballybrit Upper Industrial Estate are located to the south of this major road. Further south in Doughiska is the Merlin Commercial Park off Doughiska Road.

South of the junction between the N6 and N17 is the Riverside Commercial Estate, the IDA Small Business Park and Mervue Business and Technology Park. A substantial number of small industrial units are located in the Liosban Industrial Estate. Together with the business and industrial parks in Parkmore and Ballybrit, these form a large area of land zoned for enterprise use in the north-east of the city.

To the east of the River Corrib and north of the city there is a large site along the Headford Road occupied by a commercial property. The Lackagh Quarry is located between here and the N84, but is currently inactive.

Tourism

Most tourist activity is focused on the historic centre of the city. The city is also an important staging post for tourist trips into Connemara, visiting the Wild Atlantic Way, or travelling to the Aran Islands. The NUIG area, the River Corrib, Lough Corrib and Galway Bay attract many visitors for walking, fishing, and a multitude of water based activities throughout the year. Within the city annually numerous festivals are held which attract large numbers of visitors, examples of which include the Galway Arts Festival, The Galway Food Festival, The Cúirt International Festival of Literature, The Galway Oyster Festival, and the Annual Galway Races.

Amenities

The Galway City Development Plan illustrates the zoning of numerous areas of the city for amenity and recreation. These lands include greenways along the River Corrib and Terryland River, areas along the western and coastal edge of Knocknacarra (including Bearna Woods) and Merlin Park Woods as well as other landholdings such as the Galway Racecourse and golf courses such as the Galway Golf Club.

West of the River Corrib

Barna GAA club is located south-east of Lough Inch at the western edge of the study area. The grounds of the adjacent Lough Inch pitch-and-putt are adjacent to the GAA grounds. Barna Golf and Country Club occupies an extensive area on the north side of the lough with the club house sited at Paddy's Cross. Some angling occurs on the lough, although access is currently rather limited and difficult around the lough itself due to the boggy ground. The playing fields of the Salthill Devon Football Club are located off the Boleybeg-Drum Road. Those of the Rahoon Newcastle Hurling Club are found on the Tonabrocky Road between Drum and Rahoon. An equestrian centre is also located on this road.

Bearna Village, representing the core of a wider surrounding community is located in the western part of the scheme study area. Bearna Woods is a popular recreational area just over one kilometre to the east and located mainly on the northern side of the R336. Galway Golf Course occupies a large area between the R337 Kingston Road and Knocknacarra Road with a further golf course between the latter and Galway Bay. McGraths Fields is located on Shangort Road and includes amenity space, tennis courts and Gaelic playing pitches. Pearse Stadium and sports grounds are located off Dr. Mannix Road to the east. Salthill Park is located a short distance to the south on Rockbarton Road.

A sports ground used for soccer is located in Rahoon at Millar's Lane off Gort na Bró and an all-weather pitch at Glen Oakes. Rahoon Cemetery is located in the same community off Rahoon Road. Playing fields and indoor sports facilities are

also proposed for the area between Rahoon Road and bother Stiofan as part of the plans for the Knocknacarra District Centre. Between Seamus Quirke/Bishop O'Donnell Road and Taylor's Hill are sports fields in the grounds of St. Mary's College.

Westfield Park includinig St. Michael's GAA is located at the corner of Seamus Quirke Road and Circular Road. Corrib Park is a few hundred metres to the east behind Sacred Heart Church. Shantalla Park is a few hundred metres to the east behind Sacred Heart Church. Shanttal Park is located beside the Galway university Hospital below Browne Roundabout. Between the N59 and Seamus Quirke/Bishop O'Donnell Road are sports grounds at Laurel Park beteen Thomas Hynes Road and Siobhan McKenna Road.

There are number of club and university recreational facilities forming the Regional Sports Complex along the west bank of the River Corrib which occupy more than one square kilometre of green space. There are undeveloped green spaces between these playing fields in addition to the built development of Galway Business Park. Tennis courts are located in Corrib Village near Jordan's Islands. Glenlo Abbey Golf Course is located on lands belonging to the hotel of the same name and occupies an area of around one square kilometre beside the river towards the northern boundary of the study area.

East of the River Corrib

Between the N17 and N6, Galway Racecourse accounts for a large area of green space in Ballybrit. Typically there are three annual race meetings, in July/August, September and October. The major event annually is the summer festival which in 2014 attracted 148,287 visitors. Between the N6 and R338, Merlin Woods is a large wooded parkland area in Doughiska which contains a network of paths and is popular for recreation. West of the N17, is the Terryland Forest Park, an area of rough grassland and wetland on both sides of the narrow Terryland River. Much of the park area is lightly used, but the green space is valued and appreciated by local people as evidenced by the existence of local residents' action groups.[17] To the west of this park, there are several playing fields and tennis courts at Crestwood Park in Terryland. The park itself is as yet rather underdeveloped, but includes natural areas and walkways. Pairc Bhaile an Phoill is situated to the north of the Terryland community. Galway Football Club is located at Eamonn Deacy Park on the Dyke Road beside the River Corrib.

There are several large areas of green space on the outskirts of the built-up area of the city that are given over to playing fields, for example in Ballybane at Castle Park between Monivea Road and Ballybane Road. The R338 Dublin Road corridor contains a concentration of community facilities including sports grounds and playing fields. These include the Galwegians Rugby Football Club, sports grounds in Renmore beside Galway Hospital, grounds opposite the Galway-Mayo Institute of Technology (GMIT) near Skerrit Roundabout, beside the R338 below Merlin Park University Hospital and immediately west of Doughiska Road on the south side of the Dublin Road (R921). Mervue United Football Club has grounds just to the west off Michael Collins Road beside Mervue Public Park. The Mervue Sports Centre is situated on the east side of the road. Galway Hibernians Soccer Club is located off the R338 extension on Sean Mulvey Road. The home of Connacht

[17] For example, Friends of the Terryland Forest

Rugby and the Galway Greyhound Stadium are located off College Road beside Lough Atalia.

4.16.3.4 Public bodies and local interest groups

Key community groups are represented in the Galway City Community Forum including the Galway City Partnership and Galway City Sports Partnership, Ballybane Community Forum, the Knocknacarra Community Group, the Galway Cycling Campaign and residents associations in Ballybane, Bushypark, Castlepark, Crestwood, Doughiska, Monalee, Monivea and Shantalla amongst others.

In addition, there is the Galway City Business Association and sports associations and clubs. University College Hospital and the National University of Ireland Galway (NUIG), including the management of the Regional Sports Complex, are some of the bodies that could be impacted by potential route corridors.

4.16.3.5 Community facilities

Educational facilities

National and secondary schools are found throughout the city and are well attended in many of the more recently developed suburbs. Of tertiary educational institutions, the main educational facility to the west of the River Corrib is NUIG whose main campus is located between Newcastle Road Lower/University Road and the river and which extends below the N6 Quincentenary Bridge across to the grounds off Newcastle Road Upper.

East of the River Corrib, higher education facilities include GMIT on the corner of the R338 Dublin Road and Ballybane Road. Moneenageisha Community College is located in Mervue off Wellpark Road. The Cluain Mhuire Campus (part of GMIT), Galway Education Centre and Galway Film Centre are also located to the east of Wellpark Road.

The table below lists the schools found in the scheme study area.

Table 14.16.3 Schools in the scheme study area

Primary Schools	
St. James' National School	Gael Scoil Mhic Amhlaigh
Gael Scoil Dara Renmore	Scoil Naisunta Iognaid
Scoil Naomh Einde	Parochial National School
Merlin Woods Primary School	Tirellan Heights National School
Knocknacarra Educate Together	St. Michael Mervue
Scoil na Trionoide Naofa	Abalta Special Needs – Parkmore
Scoil Scoil Chroi Iosa	Scoil Naomh Seosaimh
Scoil Caitriona	Holy Family
Scoile Ide	Scoil Bhride, Shantalla
Scoil Padraic Noafa	Scoil Aine
Scoil an Linbh Iosa	Scoil Rois, Taylors Hill
Galway Educate Together	St. Josephs – Newcastle

Primary Schools	
Knocknacarra National School	Rosedale School.
Claddagh National School	Castlegar National School
Scoil Mhuire, Briarhill	
Secondary Schools	
Salerno Secondary School	St. Josephs | The Bish
Galway Technology Institute	Merlin College
Presentation Secondary School	Dominican College –Taylor's Hill
St. Marys College	Colaiste Na Coirbe
Mercy College Galway	Coláiste Einde
Galway Community College.	Coláiste Iognáid

Clinics, hospitals and nursing homes

West of the River Corrib, University Hospital Galway is situated between Newcastle Road Lower and Seamus Quirke Road. St Francis Community Nursing Unit is located off Newcastle Road Upper. To the East of the River Corrib, the Bons Secours Hospital Galway, a private healthcare facility, is located on the R338 Dublin Road in Renmore. The Merlin Park University Hospital is also situated on the Dublin Rd. In Doughiska the Galway Clinic, a private healthcare facility, is situated on the R446 Bóthar na dTreabh north of the Martin Roundabout.

Nursing homes are located across the city and include Coral Haven Nursing Home on the N84 Headford Road close to the junction with Bóthar an Chóiste, Caiseal Geal Nursing Home in Castlegar, Cheshire Home in Merlin Park, and St. Mary's Nursing Home on Shantalla Road.

Religious facilities

There are many churches and religious facilities throughout the study area. Although predominantly Catholic, all major faiths are represented in the study area. West of the River Corrib, the Mary Immaculate Queen Church is located on the Coast Road in Bearna. The Sacred Heart Church is located on Seamus Quirke Road in Westside. Rahoon Cemetery is located north of Rahoon Park (see also Cultural Heritage section). This cemetery is also of heritage interest. St. James' Church is located off the N59 in Bushypark. The Church of St Columbanus is located on the grounds of NUIG. St. John the Apostle Church is located off Ballymoneen Road.

East of the River Corrib, St Brigid's Church is located on Castlepark Road in Doughiska. The Bohermore Cemetery occupies a sizeable site off the Dublin Road. West of the N84, the Church of Resurrection is located off the Headford Road in Terryland. St. Peter's and St. Paul's Church is located off the Dyke Road and Menlo Graveyard is located at Pier Road alongside the River Corrib. The Castlegar, St Columba's Church is located to the East of the N17.

Community and related centres

West of the River Corrib, the Westside Resource Centre is located near Sacred Heart Church on Seamus Quirke Road. There is a nearby library and boxing club. Corrach Buí Community Centre is located immediately west of the Westside Park.

Community facilities are also located and proposed as part of the Knocknacarra District Centre plans on the Bóthar Stiofán and Rahoon Road.

East of the River Corrib, the Ballybane Enterprise Centre is located on Castlepark Road in the east of the city beside the Ballybane Community Centre.

The Brothers of Charity are located within the Pope John Paul II Centre in Ballybane off Castlepark Road. Additionally a new community centre is under construction on the Headford Road at Ballinfoyle.

Retail facilities and shops

West of the River Corrib, there is an extensive area of retailing in the Westside area including Dunnes Stores and Aldi which are on both sides of Seamus Quirke Road. A number of retail units are located in a small business centre fronting onto Old Seamus Quirke Road. The Gateway Retail Park is located between Rahoon and Clybaun.

To the east of the River Corrib, the Galway Retail Park, an extensive area of retailing is located between the Kirwan Roundabout on the N6 and the Bodkin Junction, with the Galway Shopping Centre located to the south of Bodkin Junction. Additionally, there are a few shops and community facilities at Castlelawn Heights near the Kirwan Roundabout. In addition, there are retail facilities such as home furnishings located along the Tuam Road between Castlegar and Cemetery Cross.

4.16.3.6 Walking routes

Most designated public walkways are to be found along the coast or at the beaches at Silverstrand, South Park/Claddagh/Salthill, at Ballyloughane and Lough Atalia in Renmore. To the east of the River Corrib, there is a signposted walk Baile an Dulaigh, along a minor road commencing at the N84. Spellman's Bóithrín is a short unsurfaced path connecting Castlegar Village to School Road. Hynes' Bóithrín is also located in Castlegar and castle ruins are found in the vicinity.

Closer into the city centre, a slí-na-slainte route circles Mervue on Wellpark Road, Connolly Avenue and the Tuam Road. A walking route also follows the Terryland River from the River Corrib to the N6 at Bóthar na dTreabh with future plans for an extension to Glenburran Park at Castlegar. There are also paths at Menlo Castle and Eglington Pier. Medium to long term plans are contained in the City Development Plan for an extended walk on the east bank of the river between Dyke Road and Menlo Pier.

On the west bank of the River Corrib between the Regional Sports Complex at Bushypark south to the Quincentenary Bridge and below there is a riverside walk and cycle way. The Corrib Princess Rose provides boat tours of the river itself.

Galway County Council has published a Walking and Cycling Strategy (2013) and both the County and City Development Plans include objectives to promote the development of walking and cycling routes and greenways. The County Development Plan includes a policy to preserve and protect verified public rights of way. The City Development Plan includes future plans to upgrade bóithríní in the west of the city at Cappagh and Ballyburke as walking routes. The City Development Plan also seeks to expand the city's cycle network and proposes a number of cycle ways in the central city area, including one along the Terryland River from the Headford Road to Castlegar. The Galway City and Environs

Walking and Cycling Strategy sets identifies four proposed green corridors, namely Bearna to Oranmore, Moycullen to City Centre, Ardaun to Knocknacarra, and Menlo Castle to City Centre.

4.16.4 Summary

Inevitably, as a major city, Galway contains many community facilities, areas of employment and residential areas. Some of these are concentrated in areas zoned for community and cultural or enterprise land uses. Others are represented in small neighbourhood centres or as individual premises. In addition, there are large areas of zoned open space used for amenity and sports, very little of which is undeveloped. Various areas of open space also include locations of ecological value (see **Section 4.3 Ecology**).

As a result, constraints are very numerous and opportunities for uncontested route options are limited. On the other hand, existing routes into and across the city present significant adverse impacts in terms of severance and congestion with consequent implications for quality of life. Consequently, there is potential for route options to have positive impacts by reducing severance.

4.16.5 References

Central Statistics Office. (2011) *Census.*

Environmental Protection Agency. (2003) *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements*

Environmental Protection Agency. (2002) *Guidelines on the Information to be contained in Environmental Impact Statements and*

Galway City Council. (2010) *Galway City Development Plan 2011-2017.*

Galway City Council. (2007) *Draft Proposals for Knocknacarra District Centre.*

Galway City Council. (2014) *Ardaun Local Area Plan Stage 1 – Pre-draft Consultation Issues Paper.*

Galway City Council. (2014) *Proposed Ardaun Local Area – SEA Scoping Report.*

National Roads Authority. (2006) *Environmental Impact Assessment of National Road Schemes – A Practical Guide*

Socio-Economic Statement of County Galway April 2015

4.17 External Parameters

4.17.1 Introduction

External Parameters are those constraints which do not fall under the headings of Natural or Artificial Constraints and include the following:

- Funding & Scope;
- Construction Phasing;
- Required Levels of Service;
- Technical Standards;
- Access Control;
- Policy Documents; and
- Procedural & Legal Requirements.

Section 4.18.2 describes the external parameters which may influence the scheme. A summary is presented in **Section 4.18.3** and references are listed in **Section 4.18.5**.

4.17.2 External Parameters

4.17.2.1 Funding & Scope

The planning, design and implementation of national roads projects is a matter for the National Roads Authority, (NRA) under the Roads Acts 1993 to 2007 in conjunction with local authorities. The N6 Galway City Transport Project had been highlighted for funding by the Department of Transport under the Irish Government's economic stimulus package in 2012. Funding is available to the National Roads Authority through central government on an annual basis.

As funding is subject to change, the NRA continuously monitor their commitments to on-going schemes. The decision to proceed with the various phases of a scheme relies on the funding being made available by central government.

Galway County Council, on its own behalf and on behalf of Galway City Council, under an agreement made pursuant to Section 85 of the Local Government Act 2001, are developing a solution to the existing transportation issues in Galway City and environs. Funding has been provided to take the scheme through Stages 1, 2 3 and 4 of the NRA Project Management Guidelines (NRA PMG). This includes Scheme Concept and Feasibility, Option Selection, Design and EIA/EAR and The Statutory Processes. The N6 GCTP will be part of the overall Integrated Traffic Management Programme (IMTP) study for Galway which is currently being carried out by Galway City Council in conjunction National Tranpsort Authority.

The capital investment required for construction of schemes of this value have been funded by a public private partnership in general in the past, and it is likely that such will be the case in this instance.

4.17.2.2 Construction Phasing

Construction phasing and sequencing is a key concern with any construction project. Successful site management minimises the length of time for which land disturbing activities are undertaken; essentially one part of the site is graded and completed before construction commences on other parts of the site. As well as planning and scheduling benefits, construction sequencing seeks to minimise the environmental impacts to an area, such as excess sedimentation.

Construction phasing becomes much more critical at the interfaces with existing infrastructure. At these locations, sequencing of work would also seek to minimise delay and impact of existing road users throughout the construction of the scheme.

As the scheme study area encompasses the city and surburban areas of Galway, the potential to affect a significant number of people increases the closer an option is to existing communities. Construction phasing then becomes key in seeking to reduce the amount of delay and nuisance caused to the public and also getting the project completed in a reasonable amount of time.

The scheme may be broken down into smaller segments, each of which can be completed separately. More precise details of exact construction phasing will be developed at detailed design stage. Potential impacts due to any interim construction phasing arrangement will be assessed as part of the Environmental Impact Statement, to be completed at Phase 4 of the process.

4.17.2.3 Key Performance Indicators

Traditionally the Level of Service concept in terms of highways was developed with the private motor car and the aspiration of keeping traffic congestion to a minimum as its primary concern. More recently the concept has evolved to include all road users, including pedestrians, cyclists and public transport users. Level of Service in terms of pedestrians and cyclists includes wait time at junctions, and actual routes length comparable to desire lines. The Level of Service of a public transport network includes wait time, frequency of available services, and the location of bus stops relative to users and routes that appeal to users.

One of the main scheme objectives is to reduce delay and journey time within the city, consequently the aim is to improve the Level of Service of the existing networks within the city for multi modal public road users.

This may come in the form of a reasonable free flow route through the city from the west to east of the city for traffic combined with increased permeability, connectivity and provisions for pedestrian and cyclists and provision of a more efficient public transport system. Key Performance Indicators (KPI) were identified, and the performance of each option will be assessed against these KPIs to ensure that a robust scheme which meets the project objectives is delivered.

4.17.2.4 Technical Standards

Roads

All new national roads, associated link and connector roads and merge/diverge slip roads will be designed in accordance with the National Road Authority Design Manual for Roads and Bridges (NRA MRB).

All new public streets and city centre public roads will be designed in accordance with the Department of Transport's Design Manual for Urban Roads and Streets (DMURS). Pedestrian facilities also comply with the guidelines outlined in DMURS.

The internal road network of residential housing estates will be designed in accordance with "Recommendations for Site Development Works for Housing Areas" by the department of the Environment and Local Government.

Cycle and Pedestrian Routes

Cyclist facilities will take into account the recommendations outlined in the National Transport Authority, National Cycling Manual 2011.

Drainage

Runoff generated from any new road development or upgrade to the existing infrastructure, or runoff from catchments, impacted on by a new road development or upgrade to the existing infrastructure, will be designed in accordance with the requirements of the NRA DMRB.

Any public foul sewers impacted on by the works, will be designed in accordance with EN 752: Design of Sewer Systems outside buildings, "Recommendations for Site Development Works for Housing Areas" by the department of the Environment and Local Government and will comply with any particular drainage requirements outlined by the relevant Local Authority as appropriate to the sewer in question.

Public surface water sewers will be designed in accordance with national best practice for drainage Works i.e. Greater Dublin Strategic Drainage Study Regional Drainage Policy Volume 2 – New Development (GDSDS-RDP Volume 2) and will comply with any particular drainage requirements outlined by the relevant Local Authority as appropriate to the sewer in question.

Works involving alteration to significant rivers or streams will be subject to Section 50 approval under the Arterial Drainage Act, 1945 by the Office of Public Works.

4.17.2.5 Structures

The design of structures will be carried out in accordance with the NRA DMRB and the relevant Eurocodes. Loading will be applied in accordance with EN 1991-2: Eurocode 1 - Actions on Structures – Part 2: Traffic loads on bridges and its associated National Annex.

4.17.2.6 Access Control

A controlled access road is a road which has been designed with unrestricted free flow of traffic on the mainline and access regulated at specific junctions only. The

extent of access control is also dependent on the final cross-section selected and ultimately could restrict access for learner drivers, vehicles under 50cc, slow moving vehicles (under 50km/h), invalid carriages, pedestrians, pedal cycles, and animals. In such a case, a safe alternative route has to be provided.

Whilst it is not anticipated that a motorway will be provided as part of this scheme, a road component of the transport solution may be designated as a protected road under the Roads Act 1993. A protected road scheme approved by the Minister may provide for restriction of all means of direct access to the protected road from or to specified lands. It can also provide for restriction of specific types and classes of vehicles similar to that of motorways. Again as above, a safe alternative route has to be provided in the instance that a protected road is proposed as part of the scheme.

4.17.2.7 Policy Documents

One of the key project objectives is to provide connectivity from the western part of Galway City and County to the N6 east of Galway City. This provides key connectivity from all of Galway City and County west of the River Corrib to the National Motorway Network, linking Dublin and the other national Gateways.

As outlined in **Chapter 2 Need for the Scheme**, this objective fits in with the framework of the National Development Plan (NDP), National Spatial Strategy (NSS), the Regional Planning Guidelines, The Galway County and City Development plans. Each of these documents outlines policy which drives the project objectives and in turn therefore, constrains all solutions in so far as the ultimate solution must align with the polices within these documents.

The linking of Ireland's major cities through an effective road network is a basic element of balanced economic and regional development throughout the country. National competitiveness is dependent on an efficient use of resources, including labour, time, location and land. Accessibility to markets for industry growth and employment generation and accessibility for tourism is critical for the economic development of our more peripheral locations, particularly those areas on the western seaboard. Road improvement and transportation schemes are one piece of this jigsaw of essential elements.

Galway is designated as a Gateway City in the NSS and it is of national importance that this connectivity is achieved in order to offer a counterbalance to the development of the Greater Dublin Area. It is within this national strategic context that the Galway City Transportation Project is framed from inception.

The project supports the objectives of the Department of Trnasport's Smarter Travel Policy 2009, to increase the number of people walking, cycling and using public transport and leaving their cars at home. This policy document is national policy and again constrains the overall solution in so far as the ultimate solution proposed must align and support this policy, and shall not undermine the policies therein.

4.17.2.8 Procedural & Legal Requirements

The 2010 NRA Project Management Guidelines (PMG) outline a procedural framework for the phased approach to the development, management and delivery of Major National Road Schemes in Ireland. The guidelines outline clear steps and highlight important milestones and statutory processes which are required throughout the development of a scheme in accordance with the 2007 Roads Act.

Actions required by Local Authorities, An Bord Pleanála, NRA and Consultant Design Teams are outlined in the PMG also so that phased scheduling of time and resources are allocated appropriately to the scheme.

Note that the PMG are only a guide as to how a scheme should progress. Deviations from the guide will be agreed and discussed with the NRA to confirm the most appropriate action for the scheme in question.

There is a requirement that the detailed design shall comply with all relevant design standards.

There is a legal requirement that detailed design of the preferred option shall comply with designing for safety in construction in accordance with the Safety, Health and Welfare at Work (Construction) Regulations 2013.

There is a legal requirement to ensure compliance with the various environmental directives, most critically in this case the EU Habitats Directive, given the extensive presence of the Natura 2000 network in the scheme study area.

4.17.3 Summary

Whilst there are numerous external parameters which are likely to constrain the overall scheme, the most critical are the legal constraints as the ultimate scheme must be deliverable within the law.

4.17.4 References

National Road Authority. *(NRA) Design Manual for Urban Roads and Bridges (DMRB)*

Deprtment of Transport's Design Manual for Urban Roads and Streets *(DMURS)*

5 Consideration of Alternatives

5.1 Introduction

As set out in **Chapter 2**, it is necessary to establish the extent of the existing problem for which a solution is sought prior to scheme development. Once the nature of the problem is understood, and the key constraints have been established as set out in **Chapter 4**, then it is possible to commence a review of possible alternatives available to resolve the problems whilst also delivering on the project objectives. This chapter sets out the alternatives which were considered as potential solutions, sets out the criteria under which these alternatives were assessed and outlines the analysis which concluded whether these alternatives were worthy of further assessment or not.

Not all alternatives are necessarily a variation of a road component as some of the alternatives involved minimal upgrade works and/or public transport. Regardless of which alternative is considered, some of the key constraints in this initial option development are suitable crossing points of the River Corrib within the Lough Corrib candidate Special Area of Conservation (cSAC), proximity to the Galway Bay Complex cSAC, the proximity to National Heritage Area (NHAs) and Special Protection Areas (SPA), proximity to known residential settlements and well established communities, topographical constraints and built infrastructure.

The alternatives which were considered are as follows:

- 'Do-Nothing' option;
- 'Do-Minimum' option;
- 'Do-Something Public Transport' option;
- On-line options (upgrade existing road); and
- Off-line options (build new road).

Some of these alternatives considered were discounted as not feasible. Other alternatives were deemed feasible and carried forward through the assessment process.

Section 5.2 outlines the alternatives considered that were deemed to be non-feasible and **Section 5.3** outlines the development of feasible options. A summary is presented in **Section 5.4** and the references are listed in **Section 5.5**.

5.2 Non-feasible Alternatives

This section outlines the alternatives considered during the option development stage, details the feasibility studies which were carried out to establish whether they met the project objectives and provides the reasons as to why they were not feasible options. These options include:

- 'Do-Nothing' **(Section 5.2.1)**;
- 'Do-Minimum'**(Section 5.2.2)**;
- 'Do-Something Public Transport' **(Section 5.2.3)**;
- Lough Corrib Route Options **(Section 5.2.4)**;

- Coastal Route Options **(Section 5.2.5)**; and
- Tunnel Over Full Extents.

5.2.1 'Do-Nothing'

One of the first steps in the option selection process was the consideration of the 'Do-Nothing' option.

The 'Do-Nothing' option comprised an examination of the existing transportation networks and infrastructure and its ability to meet future transportation demands, in the absence of any upgrade works other than routine maintenance. This option did not provide for any investment in the transportation networks and infrastructure of Galway City and its environs.

The option was assessed against the governments five key criteria set out in the Department of Transport's Guidelines on Common Appraisal Framework for Transport Projects and Programmes. This appraisal found that the 'Do-Nothing' option:

- Would not offer a positive economic benefit as it would not serve to reduce the existing congestion which is the cause of the journey time problems;
- Would result in a further decrease in efficiency of the transportation infrastructure over time;
- Would not offer any improvement to safety as it is essentially a continuation of the existing situation whereby many junctions make no provision for vulnerable road users;
- Does not involve any construction works, and therefore does not directly create significant benefits or dis-benefits to the environment. However, this scenario may lead to increased traffic congestion and its associated environmental impacts; and
- Would not benefit smart mobility/public transport initiatives as it does not facilitate any improvement on these fronts.

The 'Do-Nothing' option was further examined and various projects and plans were identified which are committed and likely to be implemented. The identification of these schemes rendered the 'Do-Nothing' option redundant and it was discounted from further consideration.

5.2.2 'Do-Minimum'

The 'Do-Minimum' option followed on from the 'Do-Nothing' option.

The traditional definition of the 'Do-Minimum' option could not be applied to the N6 Galway City Transport Project:

"The Do-Minimum alternative will generally comprise an investigation of the feasibility of an online upgrade of the existing route that would be capable of delivering the required levels of service and safety in accordance with the applicable design standards"

This definition had to be modified due to the planned and likely investment in transportation infrastructure. A more realistic 'Do-Minimum' option was one which

included planned and likely transportation schemes, including numerous smart mobility measures, and provided a realistic overview of the transportation networks of Galway City and its environs should major investment not be provided. In addition, the feasibility of an on-line upgrade of the existing route is assessed as a 'Do-Something' option and is excluded from the 'Do-Minimum' option.

Therefore, the 'Do-Minimum' option involved an examination of the existing transportation networks and infrastructure and existing policy and plans for Galway City and its environs. In this scenario, the existing transportation networks and infrastructure combined with likely and committed transportation schemes were examined to determine their ability to meet future transportation demands.

Likely and committed transportation schemes were identified following consultation with Galway City Council, Galway County Council, the National Transport Authority and the National Roads Authority and a listing of all schemes is included in the Traffic Modelling report in **Appendix A.3.1**. Transportation schemes included in the 'Do-Minimum' option include:

- Merlin Park Hospital Bus Access;
- N59 Dangan Upgrade;
- Kirwin Roundabout Upgrade;
- Terryland Right turn lane on the N6;
- Browne Roundabout Upgrade;
- Cross St -Middle St Pedestrianisation;
- Dock Road Corridor;
- Dublin Road Bus Lane;
- Monivea Road Corridor;
- M17 M18 Motorway; and
- N59 Maigh Cuilinn (Moycullen) Bypass.

This option was assessed against the government's five key criteria set out in the Department of Transport's Guidelines on Common Appraisal Framework for Transport Projects and Programmes. This appraisal found that the 'Do-Minimum' option:

- Would not offer a positive economic benefit as it would not serve to reduce the existing congestion which is the cause of the journey time problems;
- Would result in a further decrease in efficiency of the transportation infrastructure over time as in the 2034 Do-Minimum the total network delay in the morning peak hour rapidly increases by 70% relative to the Base Year, far more than the increase in trips, indicating capacity issues on the network;
- Would not offer a significant improvement to safety as traffic will continue to increase on the existing network without any release of capacity in the highly trafficked urban areas;
- Does not offer any significant benefit or dis-benefit to the environment as the schemes within the Do-Minimum are of a magnitude that will not involve significant impacts on the environment; and

- Would not benefit public transport/smarter travel initiatives as will stifle the possibility of any improvements to the public transport options as capacity will be restricted.

The 'Do-Minimum' option was discounted as a single overall transportation solution/option as it does not meet the project objectives outlined in **Chapter 1**, for the reasons noted above.

5.2.3 'Do-Something Public Transport'

The future year 'Do-Something' networks include the Do-Minimum plus the option(s) to be tested. The first Do-Something option developed is the 'Do-Something Public Transport' option. This option includes all measures, options and schemes identified by Galway City Council in conjunction with the National Transport Authority as a result of the recommendations of the Galway City Council study entitled *Galway Public Transport Feasibility Study* of 2010. It also includes smart mobility measures. This option comprises:

- A Bus Rapid Transit (BRT) operating at a 10 minute frequency from Knocknacarra to the West, through the city centre, to Oranmore in the East;
- All existing city bus services increased to 10 minute frequency;
- Bus priority measures at signalised junctions along the BRT corridor;
- Re-allocating road space on the Salmon Weir Bridge from general traffic to Public Transport only; and
- Smart mobility measures such as integrated fares, travel plans, integrated public transport information and demand responsive transport.

It should be noted that the Galway Public Transport Feasibility Study from 2010 assumed that the N6 Galway City Outer Bypass (2006) as proposed by the 2006 planning application was in place, thereby making it possible to consider reallocation of road space on the Salmon Weir Bridge. However, this Public Transport Alternative as modelled here does not include for such additional road infrastructure. The mode share analysis shows that there is a low public transport mode share of just 5.0% in the 2012 Base Year. This reduces slightly in the 2034 Do-Minimum due to increased car ownership offsetting the increase in congestion.

This option increases public transport mode share to 5.8% in 2034, which is a 17% increase in public transport trips relative to the Do-Minimum 2034. However due to the overall low public transport mode share, this represents less than a 1% reduction in car trips.

Full implementation of this option has a negative impact on the congestion and the key performance indicators identified to test performance vis-à-vis the project objectives. It results in a 2% increase of delay to every vehicle journey across the key routes identified as the key performance indicators as shown in **Table 7.2.2.16** in **Chapter 7** of this report, when compared to the 2019 Do-Minimum. It therefore fails to meet the project objectives when implemented in isolation.

Therefore, the 'Do-Something Public Transport' option, which includes smarter mobility measures, has been retained as a possible component of an overall solution as opposed to a solution in isolation. It has been carried forward for further testing as part of the ITMP as it could form a component of an overall solution.

As part of the Galway City Council study entitled *Galway Public Transport Feasibility Study* of 2010, a number of other public transport options were also examined including a light rail option. That study determined that a bus based solution was the most appropriate to meet Galway's public transport needs based on the existing and anticipated future transport demands.

5.2.4 Lough Corrib Route Options

An option of linking the eastern and western areas of County Galway by crossing the Lough Corrib on a viaduct was considered. Full details of this assessment is included in **Appendix A.5.1** Lough Corrib Route Options with a summary outlined below.

The ecological constraints associated with this option make crossing Lough Corrib by viaduct unattractive. The Lough Corrib has significant ecological importance and is an area of immense scenic amenity. Any crossing of this Lough would involve a significant structure making its incorporation into the landscape extremely difficult.

Traffic analysis shows a strong demand coming from all over the county to the city and back. It also highlights the fact that the further the proposed route option for a new road component is from the city, the less attractive it would potentially be to motorists and the less impact it would have on reducing the existing transportation issues of the city. Any proposal to introduce a viaduct across Lough Corrib would at a minimum be located 4.5km from the existing cross city route – the N6 and R338. There is therefore of limited benefit from a traffic perspective to locating a new west to east connection across Lough Corrib.

In addition, as a viaduct across Lough Corrib would primarily serve traffic from Galway County to bypass Galway City, the low population density of Galway County west of the River Corrib and Lough Corrib makes justification of such a crossing to facilitate travel for this population extremely difficult. In fact, Galway City dwellers west of the River Corrib, which represents approximately half of the overall Galway County population west of the river, would be forced to first travel northwest before travelling east to avail of such a crossing of Lough Corrib.

This could potentially increase journey times and journey distances for these users rather than reducing travel times and distances which is contrary to the project objectives outlined in **Chapter 1**.

Crossing Lough Corrib by viaduct would not meet the project objectives for the following reasons:

- The Lough Corrib option would not reduce journey times on key routes;
- The crossing of Lough Corrib may not provide a cost effective project;
- The crossing of Lough Corrib would likely have a significant impact on designated Natura 2000 sites;
- The proposed crossing of Lough Corrib would not take due cognisance of the importance of the existing landscape; and
- The proposed crossing of Lough Corrib may not support the development of critical mass regional population centres.

As alternatives are available which potentially have a lesser impact on the environmental constraints, which would have a higher patronage and provide a greater benefit to the local economy than a crossing of Lough Corrib, further examination of a viaduct crossing on Lough Corrib was discounted.

Full details of this option are contained in **Appendix A.5.1**.

5.2.5 Coastal Route Options

An option of linking the eastern and western areas of County Galway with a route option along the coastline was considered. Full details of this assessment is included in **Appendix A.5.2** Coastal Route Options with a summary outlined below.

The Coastal Southern Option requires a significant bridge structure across the mouth of Galway Harbour which is likely to impact on boat traffic and the operation of the harbour and docks area. The bridge would be elevated and visible from all areas surrounding the harbour including the Claddagh, South Park and the Spanish Arch, all of which comprises an area of immense scenic beauty and high amenity. It would impact visually on the landscape of both the city and Galway Bay and requires at least one crossing of the Dublin to Galway railway line.

The ecological constraints associated with this option also make the Coastal Option unattractive. Galway Harbour has environmental importance including Galway Bay Complex (cSAC), and Inner Galway Bay SPA.

This option does not meet one of the scheme objectives to provide a connection to some or all of the national roads leading into the city, namely the N59, N84, N17, and N6/M6 to the east, in order to create an integrated national road network around the city. This could potentially result in no improvement on journey times and journey time reliability which is another project objective.

Alternatives are available which potentially have a lesser impact on the environmental constraints whilst meeting the project objectives outlined in **Chapter 1** and hence, these options would all be preferable to a coastal route.

A Coastal Option would not meet the project objectives for the following reasons:

- This option would not provide journey time reliability on the key routes;
- The crossing of the harbour would likely have a significant impact on designated Natura 2000 sites; and
- The crossing of the harbour would not take due cognisance of the importance of the existing landscape.

As alternatives are available which potentially have a lesser impact on the environmental constraints, which would have a higher patronage and better meet the project objectives than a coastal option, further examination of this option was discounted.

Full details of this option are contained in **Appendix A.5.2**.

5.2.6 Tunnel Over Full Extents

Following on from the above options, an option of linking the eastern and western areas of County Galway with a tunnel from the N6 to the R336 was considered.

This option does not meet the scheme objectives to provide a connection to some or all of the national roads leading into the city, namely the N59, N84, N17, and N6/M6 to the east, in order to create an integrated national road network around the city. This would not show an improvement on journey times and journey time reliability which is another project objective. Equally, traffic demand does not justify the very significant cost of such a tunnel. Therefore, a tunnel from east to west was discounted as it is not deliverable and not justified. However, inclusion of shorter sections of tunnel to avoid significant constraints was considered worthy of further study in the option development process.

As alternatives are available which would have a higher patronage and better meet the project objectives than an east-west tunnel, further examination of this option was discounted.

5.3 Options Development

As can be seen above, the 'Do-Nothing' and 'Do-Minimum' options are not feasible solutions to address the existing transportation issues in Galway City and environs. Similarily, the 'Do-Something Public Transport' option which includes smarter mobility measures does not solve the problem in isolation. A combined solution incorporating a smart mobility component, public transport component and road component will be required.

As described in **Chapter 1**, the smart mobility and public transport components of the overall transportation solution will be developed as part of the Galway City Integrated Transport Management Programme (ITMP).

The options described from this point forward address the road component only part of the transportation solution.

Following on from above, the road alternatives deemed feasible and carried forward through this route selection assessment process consist of:

- On-line options (upgrade existing road); and
- Off-line options (build new road).

Whilst work was on-going in developing the traffic model in order to test multi-modal options, work commenced on development of potential corridors for potential road options. The options development followed the general outline of steps below:

- Design Team identified a number of route corridor options including the N6 Galway City Outer Bypass (2006) Route Option;
- Environmental Workshop No. 1;
- Detailed ecological survey of the scheme study area (refer to **Section 4.3.2.3**);
- Public Consultation No.1 – Constraints Study (refer to **Section 4.1.3**);
- Assessment of submissions received from Public Consultation No. 1;

- Assessment of alternatives in upgrading the existing infrastructure – on-line options;
- Engineering and ecological workshop to develop zones suitable for placement of route options;
- Environmental Workshop No. 2;
- Refinement of route options following Environmental Workshop No. 2;
- Environmental Workshop No. 3; and
- Refinement of route options and Stage 1 Assessment.

A brief summary of the steps involved in the development of the route options, as outlined above, is provided below.

5.3.1 Environmental Workshop No. 1

Environmental Workshop No. 1 was held on 8 May 2014. This involved gathering all the Design Team specialists together in the Project Office for a full day of interactive discussion focused on identifying key constraints for each individual discipline in order to establish optimum route corridor options whilst minimising the impacts on the receiving environment.

The engineering team had prepared a series of potential route corridor options in advance of this workshop, refer to **Figure 5.3.1.1** to **5.3.1.3**. As the workshop progressed, it became clear that there was significant knowledge and detail available on the N6 Galway City Outer Bypass (2006) Route Option in comparison to other options. As explained in **Section 5.2.6** it was impossible to complete a fair and equal assessment of all of the route options and rank other options when compared to the N6 Galway City Outer Bypass (2006) Route Option. Therefore, all work on developing options ceased at this time and extensive ecological surveys and traffic analysis were undertaken in advance of developing further options, so that all options could be assessed on an equal basis.

Geotechnical geophysics, including some boreholes at Rahoon and archaeological geophysics at Galway Racecourse were also undertaken prior to recommencing option development. Once these studies were complete at the end of October 2014, the optioneering process recommenced.

5.3.2 On-line Options

A full study was undertaken on the upgrading of existing road infrastructure and the development of an on-line route option, where the existing transportation networks and corridors are reused and enhanced where appropriate.

Full details on the constraints and option development for the on-line route option is contained in the On-line Route Selection Report in **Appendix A.5.3**. This includes a description of the route options discounted following assessment under the criteria of Engineering, Constructability, Safety, and Environment, which encompasses human beings.

The conclusion of the On-line Route Selection Report is a recommendation on the on-line option to carry forward.

This On-line Option commences at a signalised junction at the eastern end of Bearna Village. It proceeds north along new road alignments to join the existing Western Distributor Road at a proposed signalised junction at the existing Cappagh Road Roundabout. The On-line Option follows the existing Western Distributor Road to Bóthar Stiofáin and includes the replacement of all the existing roundabout junctions along Western Distributor Road with signalised junctions.

At the Rahoon area it connects via a tunnel from Bóthar Stiofáin, through a residential area in Rahoon, to the Seamus Quirke Road and is depressed underneath Seamus Quirke Road and Browne Roundabout via a cut and cover tunnel. It includes connectivity via a roundabout and slip roads at Gort na Bró. It continues east to the existing Quincentenary Bridge along the existing N6. The existing local road network is retained above the proposed mainline over the extents of the Seamus Quirke Road. The existing local road network is accommodated by provision of a second bridge crossing over the River Corrib immediately south of the existing bridge. The possibility of an additional River Corrib crossing by reusing the existing railway piers may be proposed as a complimentary measure.

To the east of the River Corrib, the On-line Option passes behind the existing shopping centre at Terryland and re-joins the existing N6 to the east of the N84 Junction at the Kirwan Roundabout. A split grade separated junction is provided between the existing N6 and the proposed On-line Option in this area, with west facing slips to/from the On-line Option immediately east of the river crossing and east facing slips to/from the On-line Option immediately east of the existing N84 Junction at Kirwan Roundabout.

The On-line Option utilises the existing N6 corridor to connect to the M6/N6 on the east side of Galway at Ardaun. It is depressed under the N17 and Ballybane Roads but has full connectivity to both roads via signalised diamond junctions. A full diamond grade separated junction is provided to the south of the existing Briarhill Junction, which is designed to accommodate Parkmore Industrial Park, Ballybrit Business Park and the Briarhill area of the city.

The On-line Option is deemed a feasible option and is carried forward as the **Red1 Route Option** for assessment as part of the route selection process.

5.3.3 Option Development Zones

Detailed ecological surveys were carried out between June 2014 and October 2014 (refer to **Section 4.3.2.3**). Following receipt of the results of the species and habitat ecological surveys, the ecological and engineering teams worked together in the Project Office for a number of days to define option development zones. See **Figure 5.3.2.** Option development zones are areas within the scheme study area which from an ecological perspective the least damaging route options could be developed and where route options would be least likely to result in significant direct or indirect impacts to key ecological receptors. It should be noted that all route options developed within these option development zones still had to be assessed by all other environmental specialists, which could further reduce the bands available for route option development.

Equally the situation may also arise where route options may need to be developed outside of these zones to reduce the impact on other key environmental constraints, such as human beings, archaeology etc. with the necessary ecological mitigation measures included in the design.

The key ecological receptors considered for establishing these option development zones are:

- designated areas for nature conservation (including European sites and proposed/full National Heritage Areas);
- Annex I habitats within designated areas for nature conservation; and
- Annex I habitats within the identified Ecological Sites.

These are referred to as key ecological receptors due to the statutory protection afforded to the designated sites, the conservation importance of Annex I habitat types at a national and European level, and the difficulty of mitigating direct impacts or habitat loss where such habitats are affected. In defining the option development zones, the primary aim was to avoid, where possible, the direct loss of these key receptors within the N6 Galway City Transport Project study area.

The following issues were also considered in defining the option development zones:

- Locations of plant species protected under the Flora (Protection) Order, 1999;
- Known breeding or resting places of Annex II/IV Habitats Directive, or Annex I Birds Directive; and
- Species and red listed Birds of Conservation Concern species (e.g. Barn owl and Red grouse, known bat hibernation sites, known breeding habitat of the Marsh fritillary butterfly, Freshwater pearl mussel catchments, known roost sites of Hen harrier, confirmed Barn owl nesting sites, potential Red grouse habitat etc.)

Although the potential to impact on ecological species was also considered in defining the option development zones, these did not weigh as highly in defining the option development zones; particularly in the cases of highly mobile species with relatively large ranges within the scheme study area boundary, as these species would likely be affected to a similar degree regardless of the location of the option development zones. Similarly species for which standard mitigation and good practice during construction would ensure avoidance of significant impacts had a lesser weighting in establishing option development zones.

Figure 5.3.2 illustrates the available option development zone through the Lough Corrib cSAC at the River Corrib crossing. A number of route options were then developed by the engineering team within the established option development zones commencing from the River Corrib crossing locations in so far as reasonably possible within the confines of engineering standards and all other constraints.

Given the urban environment and the presence of the European sites in the scheme study area, a horizontal and vertical alignment for each of the corridor options was designed. The vertical alignment for some of the route options included sections of tunnels in order to try to reduce a direct impact on key constraints identified.

These sections of tunnels included a tunnel in the Rahoon area to reduce the residual impact on the residential properties located here, a tunnel under the River Corrib to the north of the Quincentenary Bridge to avoid direct impact on residential and commercial properties, a tunnel under the Annex I habitat and Lough Corrib cSAC in the Menlough area at Lackagh Quarry and a tunnel through the Galway

Racecourse to reduce residual impact on the racecourse. The geology to the east of the N59 is karst limestone and the terrain undulating to the west which restricted the ability for additional sections of tunnel.

All route options developed were then assessed by the full Design Team at Environmental Workshop No. 2.

5.3.4 N6 Galway City Outer Bypass (2006)

Consultants were appointed in 1999 to undertake feasibility studies, route selection, design and planning for the N6 Galway City Outer Bypass. The resultant scheme including the Compulsory Purchase Order (CPO) and Environmental Impact Statement (EIS) was submitted to An Bord Pleanála (ABP) on 1 December 2006. This scheme consisted of 21.4km of mainline, 9km of link roads, associated intersections and a major bridge crossing of the River Corrib i.e. the N6 Galway City Outer Bypass (2006).

On 4 December 2006, an extension to the boundary of Lough Corrib cSAC was proposed by Ireland, which included a large portion of lands to the east of the River Corrib in the area of Menlough. This extension to the Lough Corrib cSAC boundary resulted in a significantly longer length of the N6 Galway City Outer Bypass (2006) traversing the cSAC.

On 28 November 2008, ABP delivered its decision in respect of the N6 Galway City Outer Bypass (2006). ABP granted approval for part of the scheme, the section from the N59 east to the existing N6, inclusive of both junctions at the N59 and the N6. In their decision, ABP noted their consideration of all data presented and granted approval as it considered that the part of the road development being approved would be an appropriate solution to the identified traffic needs of the city and surrounding area. ABP noted that there would be a localised severe impact on the Lough Corrib candidate Special Area of Conservation but that this did not adversely affect the integrity of this candidate Special Area of Conservation.

ABP refused permission for the section of the scheme from the R336 west of Bearna to the N59. ABP considered that the need for an outer bypass of Galway City connecting the N6 on the east to the 336 coast road as an essential part of the strategic transport network of the Galway area had been established. However, ABP was not satisfied with the section of the proposed road development through Tonabrocky Bog which is:

(a) part of the Moycullen Bogs Natural Heritage Area (NHA);

(b) an active Blanket bog listed as an priority habitat in Annex I of the EU Habitats Directive; and

(c) the site of a population of Slender cotton grass which is a legally protected and vulnerable species.

ABP refused the western section of the scheme on the basis that this part of the road development would not be in accordance with the preservation of the Tonabrocky habitat or that the significant adverse effect on the environment would not be avoidable or could not be better addressed by an alternative route[1].

[1] Reference ABP decision 07.ER.2056

An application was made by a third party to the High Court seeking leave to issue judicial review proceedings against the ABP decision which granted approval of the eastern section of the N6 Galway City Outer Bypass (2006). The basis for the request for a review was that ABP erred in its interpretation of Article 6 of the Habitats Directive in arriving at the conclusion that the effect of the road scheme on the Lough Corrib cSAC designated site would not constitute an adverse effect on the integrity of the site.

The High Court undertook a judicial review of the ABP decision. The High Court decision of 9 October 2009 upheld ABPs decision to approve the eastern part of the scheme. On 6 November 2009, the third party was granted leave to appeal to the Supreme Court against the High Court decision of 9 October 2009. The Supreme Court sought the opinion of the Court of Justice of the European Union (CJEU) on an interpretation of the Habitats Directive.

The judgment of the CJEU was delivered on the 11 April 2013[2]. The judgement initially sets out the definitions and the legal context of the Habitats Directive. It then notes how Irish Law implements the obligations of the Habitats Directive.

The sequence of events in relation to the timeline for the site boundary extension of the Lough Corrib cSAC in relation to the timeline of the N6 Galway City Outer Bypass (2006) application is as follows:

1. N6 Galway City Outer Bypass (2006) was lodged with ABP on 1 December 2006.
2. Member state proposed an enlargement of the extent of the Lough Corrib cSAC to include an additional area of Limestone pavement in the Menlough area on 4 December 2006. In doing so, Ireland included this as a potential site on a list of sites transmitted to the Commission.
3. ABP decision to grant approval was delivered on 28 November 2008 for eastern part of N6 Galway City Outer Bypass (2006).
4. The extended Lough Corrib site was formally classified by a Commission decision on 12 December 2008.

Thererfore, the extension to the site boundary of the Lough Corrib cSAC occurred post-submission of the planning application for the N6 Galway City Outer Bypass (2006).

The judgement concluded that as soon as a site is proposed by a Member State, that Member State is required to take protective measures to safeguard the ecological interest in that site.

The judgement set out the scale of the impact on the Lough Corrib cSAC. The N6 Galway City Outer Bypass (2006) road scheme involves the permanent loss within the cSAC (as extended) of approximately 1.47 hectares of Limestone pavement, which constitutes a priority habitat type referred to in Annex I to the Habitats Directive. ABP established that this loss would have a locally significant negative impact but decided that such an impact did not adversely affect the integrity of that site.

The judgement furthermore states that in order for the integrity of a site not to be adversely affected, the site needs to be preserved at a favourable conservation

[2] Case C-258/11

status. This entails the lasting preservation of the characteristics of the site which formed the justification for designation of the site in the first instance. Therefore, the competent authority cannot authorise projects where there is a risk of lasting harm which could bring about the disappearance or partial and irreparable destruction of a priority natural habitat type present in the site concerned.

The Lough Corrib cSAC is designated as a site hosting a priority habitat type because of the presence of Limestone pavement which is a natural resource which, once destroyed, cannot be replaced. The result of the judgement is that any project which leads to a loss of such Limestone pavement wihtin the cSAC will adversely affect the integrity of the site. This is contrary to maintaining or improving the favourable conservation status of the sites constituent characteristics, namely the presence of the Limestone pavement.

The conclusions which can be drawn from this judgement are as follows:

1. The N6 Galway City Outer Bypass (2006) would have a significant adverse impact on the integrity of the Lough Corrib cSAC due to the removal of 1.5ha of Limestone pavement; and
2. Given that the N6 Galway City Outer Bypass (2006) would have a significant adverse impact on the integrity of the cSAC, the correct planning process should be under Article 6(4) as opposed to Article 6(3).

Following receipt of the CJEU opinion, the Supreme Court quashed the earlier ABP decision.

The N6 Galway City Outer Bypass (2006) is presented as the first off-line route option in the N6 Galway City Transport Project option development process as it was previously progressed through planning. There was also significant knowledge and detail available on this route option (refer **Section 5.3.3** above and see **Figure 5.3.3**).

Given that data sufficient for full environmental impact assessment was available for the N6 Galway City Outer Bypass (2006) Route Option, it was impossible to fairly assess and rank other off-line options when compared to the N6 Galway City Outer Bypass (2006) Route Option.

Therefore, extensive ecological surveys and traffic analysis was undertaken in advance of developing further off-line options, so that all off-line route options could be assessed on an equal basis.

Full analysis showed that there are other alternatives which better meet the current project objectives in terms of capturing existing travel demand than the N6 Galway City Outer Bypass (2006) Route Option and which have a less damaging impact on the integrity of the Lough Corrib cSAC. When compared with the option development zones, i.e. areas within which from an ecological perspective options could be developed (refer **Section 5.3.3** below), it also was evident that the N6 Galway City Outer Bypass (2006) Route Option was located outside these zones over the majority of its length.

Given that there were less damaging alternatives available from the perspective of the integrity of the Lough Corrib cSAC, the N6 Galway City Outer Bypass (2006) Route Option was discounted from further consideration in October 2014, as in accordance with the Habitats Directive, it is only possible to advance a project

which has a significant adverse impact on the integrity of the cSAC in the absence of alternatives.

During option assessment in November 2014, the N6 Galway City Outer Bypass (2006) Route Option was reviewed again to establish whether it merited inclusion in the first iteration of route options, but again this was discounted as there were less damaging alternatives available.

An assessment for the N6 Galway City Outer Bypass (2006) Route Option is included in **Appendix A.5.4.**

5.3.5 Cyan Route Option

The ABP decision on the N6 Galway City Outer Bypass (2006) scheme was split, with a refusal on the western section from the N59 Clifden Road to the R336 An Spidéal Road and a granting of permission on the eastern section from the M6/N6 to the N59 Clifden Road.

An off-line option, Cyan Route Option, refer **Figure 5.3.4**, was developed which combined the eastern section of the N6 Galway City Outer Bypass (2006) Route Option with a revised section west of the N59 to minimise the impacts on the Tonabrocky Bog complex which was the issue identified by ABP in its refusal of this section. An additional grade separated junction is also included on the existing N17 in the vicinity of Twomileditch which was not included in the N6 Galway City Outer Bypass (2006) Route Option.

An assessment of this option showed that there are less damaging alternatives from the perspective of the integrity of the Lough Corrib cSAC available and this route option was discounted from further analysis.

Full details of this route option are contained in **Appendix A.5.5**.

5.3.6 Environmental Workshop No. 2

Environmental Workshop No. 2 took place in the Project Office on 13 November 2014. Each of the environmental specialists provided an update on their key constraints within the scheme study area based on the additional surveys carried out since the Environmental Workshop No. 1.

The workshop then focussed on the potential route options as shown on **Figures 5.3.4.1** to **5.3.4.3.**

Each route option was reviewed from beginning to end with an opportunity for all present to recommend further modifications to the route options in order to minimise the impacts to the receiving environment.

5.3.7 Environmental Workshop No. 3

The engineering team carried out revisions and modifications to the route options as outlined in Environmental Workshop No. 2. This resulted in the development of six feasible route options which were then circulated to the environmental specialists. A preliminary Stage 1 assessment was carried out by all of the environmental specialists on the six feasible route options. These options are described as follows:

- Red1 Route Option;
- Orange1 Route Option;
- Yellow1 Route Option;
- Blue1 Route Option;
- Pink1 Route Option; and
- Green1 Route Option

Each of the six route options were compared under the criteria of Environment, Economy and Engineering. These assessments are presented in **Chapter 6**.

At Environmental Workshop No. 3 which was held on 17 December 2014 each of the six route options were reviewed from beginning to end with an opportunity for all present to recommend further modifications or improvements to further minimise the impacts to the receiving environment, see **Figure 5.3.5.1** to **5.3.5.3.** The resulting route options were presented at Public Consultation No. 2, which was held on 28 and 29 January 2015, see **Section 6.2**.

5.4 Summary

Galway City and Galway County Council plan annually and further into the future for investment in transportation infrastructure and policy implementation. This was carefully considered when determining the composition of the 'Do-Nothing' and 'Do-Minimum' Scenarios.

The traditional definition of the 'Do-Nothing' option and that which is used for the N6 Galway City Transport Project is:

"The Do-Nothing alternative shall comprise an investigation of the existing road infrastructure and its ability to meet future demands for traffic and safety without any upgrade works"

The inability of the 'Do-Nothing' option to satisfy the project requirements, combined with planned and likely investment in transportation infrastructure rendered it redundant and it was discounted from further consideration.

The traditional definition of the 'Do-Minimum' option could not be applied to the N6 Galway City Transport Project:

"The Do-Minimum alternative will generally comprise an investigation of the feasibility of an online upgrade of the existing route that would be capable of delivering the required levels of service and safety in accordance with the applicable design standards"

This definition had to be modified due to the planned and likely investment in transportation infrastructure. A more realistic 'Do-Minimum' option was one which included planned and likely transportation schemes and provided a realistic overview of the transportation networks of Galway City and its environs should major investment not be provided. In addition, the feasibility of an on-line upgrade of the existing route is assessed as a 'Do-Something' option and is excluded from the 'Do-Minimum' option.

The inability of the 'Do-Minimum' option to satisfy the project objectives outlined in **Chapter 1** discounted it as a single final overall transportation solution option.

The ‘Do-Minimum’ option is used going forward as the benchmark for the analysis of options.

The ‘Do-Something Public Transport’ option, which includes smarter mobility measures, offers a further improvement on the ’Do Minimum’ but again it did not meet the project objectives if completed as a project on its own. However, it has been retained for consideration as one component of an overall solution as part of the ITMP.

Various options such as the Lough Corrib Route Options and the Coastal Route Options were also discounted as they did not meet the project objectives.

Once it was determined that the overall solution to the transport issues in Galway require the provision of a road component, option development began on various on-line and off-line route options, some of which were discounted as other alternatives presented as more preferable options.

At the conclusion of the route option development, six feasible options (Red1, Orange1, Yellow1, Blue1, Pink1 and Green1) were presented for Stage 1 assessment which is detailed in **Chapter 6**.

5.5 References

Department of Transport. *Guidelines on a Common Appraisal Framework for Transport Projects and Programmes*

National Roads Authority. *Project Appraisal Guidelines*

6 Stage 1 Preliminary Options Assessment

6.1 Description of Route Options identified

There were six route corridor options identified within the scheme study area, as shown on **Figure 6.1.1**, which were assessed according to Stage 1 of the route selection process outlined in the NRA PMGs 2010. The path followed by these route options, and the preliminary junction strategy for each of the route options, is outlined below. The corridors and node points outlined in this section are presented on **Figures 6.1.1** and **6.1.2**. Plan and profile drawings of these route options are present in **Figures 6.3.1.0** to **6.3.6.13**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

On the western side of the scheme study area, the route options are interchangeable from the point where they meet the existing R336 to Barr Aille Road and as such the assessment has been carried out based on two sections. Section 1 extends from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6 in the east of the city as shown on **Figures 6.1.1** and **6.1.2**. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.1.1 Red1 Route Option

The Red1 Route Option commences at point C on the R336 to the east of Bearna and proceeds northwards to point D. The Red1 Route Option then proceeds east along the Western Distributor Road to point I in Rahoon, where it enters a tunnel. It re-emerges from the tunnel at point J in the vicinity of Browne Roundabout in Newcastle, and then follows the existing N6, crossing the River Corrib at the existing Quincentenary Bridge. The Red1 Route Option goes off-line briefly at Terryland before it re-joins the existing N6, and terminates at point S in the townland of Coolagh. Refer to **Figure 6.1.1** and **Figures 6.3.1.0** to **6.3.1.9**

The Red1 Route Option ties into the existing R336 at a signalised junction at the eastern end of Bearna Village and proceeds north, generally in cut or shallow fill as far as Ballard Road. It incorporates some sections of steeper fill before joining with the existing Western Distributor Road at a proposed signalised junction replacing the existing Cappagh Road Roundabout. It follows the existing Western Distributor Road, at-grade, to Bóthar Stiofáin and includes the replacement of all the existing roundabout junctions along the Western Distributor Road with signalised junctions. The existing residential estate entrances are maintained as priority at-grade junctions along the extent of the Western Distributor Road.

A full grade separated junction is provided in the vicinity of Gort na Bró. A tunnel extends from Gort na Bró Road eastwards and is depressed underneath Seamus Quirke Road and Browne Roundabout via a cut & cover tunnel. The Red1 Route Option continues along on the existing N6 eastwards to the existing Quincentenary Bridge. The existing local road network functionality is maintained above the

proposed tunnel over the extent of Seamus Quirke Road. The provision of a second bridge crossing over the River Corrib immediately south of and parallel to the existing bridge provides for the existing local road network functionality of the Quincentenary Bridge for vehicles, pedestrians and cyclists. The Quincentenary Bridge will be maintained for mainline traffic.

To the east of the River Corrib, the Red1 Route Option rises on embankments, passing over the N84 Headford Road and around the rear of the existing shopping centre at Terryland on a viaduct structure. It re-joins the existing N6 National Primary route to the east of the N84 junction at Kirwan Roundabout at its existing level. A split grade separated junction is provided between the existing N6 and the proposed Red1 Route Option in this area, with west-facing slips to/from the Red1 Route Option situated immediately east of the river crossing and east-facing slips to/from the Red1 Route Option situated immediately east of the existing N84 junction at Kirwan Roundabout.

The Red1 Route Option utilises the existing N6 corridor to connect to the M6/N6 on the east side of Galway at Coolagh. It is depressed under the N17 and Ballybane Roads but has full connectivity to both roads via signalised diamond junctions and a parallel link road at the current road level. A full diamond grade separated junction is also provided to the south of existing Briarhill junction, which is designed to accommodate the industrial estates in the Parkmore area, Ballybrit Business Park and the Briarhill areas of the city.

6.1.2 Orange1 Route Option

The Orange1 Route Option commences at point C on the R336 to the east of Bearna and follows the path of the Red1 Route Option to point D. From point D the Orange1 Route Option travels through the townlands of An Chloch Scoilte and Na hAille to Point E at Mincloon, where it then proceeds eastwards to Point K in the townland of Letteragh. From Point K the Orange1 Route Option enters a tunnel, crossing under the River Corrib and emerging from the tunnel at point L. The Orange1 Route Option joins with the Red1 Route Option at point O and follows it to its termination point at S in Coolagh. Refer to **Figure 6.1.1** and **Figures 6.3.2.0** to **6.3.2.9**

The Orange1 Route Option ties into the existing R336 with a signalised junction at the eastern end of Bearna Village and proceeds north as per the Red1 Route Option to point D, generally in cut. On the Orange1 Route Option an at-grade roundabout is proposed with an associated link road, which provides a connection to the Cappagh Road and the Western Distributor Road. The Orange1 Route Option then continues, at approximately the existing ground level, to Letteragh where a grade separated junction is proposed. A new link road, the Orange1 N59 Link, is required to facilitate this junction; it commences at point F at Bothar Stiofáin and terminates at point G on the existing N59. The Orange1 Route Option is descending into cut in this area and the Orange1 N59 Link is approximately at existing ground level at their crossing point, with the link road continuing at-grade to the south, and in cut to the north.

The Orange1 Route Option enters a deep tunnel, to avoid direct impact on residential and commercial properites, to the east of the new junction in Letteragh

and crosses under the River Corrib towards the Terryland area. It emerges from the tunnel immediately adjacent to the existing Kirwan Roundabout on the existing N6 at Terryland. A three-level junction is located between Points L and O in the Terryland Park area which provides full movements between the proposed Orange1 Route Option and the existing N84. The Orange1 Route Option then follows the Red1 Route Option, utilising the exiting N6 and the same junction strategy as the Red1 Route Option until its termination point at Point S in Coolagh.

6.1.3 Yellow1 Route Option

The Yellow1 Route Option commences at point A at the R336 to the west of Bearna and proceeds in a north-easterly direction, keeping to the north of Bearna and passing through the townlands of Na Foraí Maola, An Chloch Scoilte, and Na hAille as far as point U. The Yellow1 Route Option then proceeds in a north-easterly direction through the townlands of Mincloon and Dangan as far as point M in the townland of Menlough. From this point the Yellow1 Route Option proceeds in a south-easterly direction through the townlands of Coolagh and Castlegar and joins the Red1 Route Option at point O. The Yellow1 Route Option then follows the Red1 Route Option to where it terminates at point S in Coolagh. Refer to **Figure 6.1.1** and **Figures 6.3.3.0** to **6.3.3.11.**

The Yellow1 Route Option ties into the existing R336 at an at-grade roundabout junction approximately 2km to the west of Bearna Village at point A. There are three at-grade roundabout junctions at approximately 2km spacing, on the Bearna to Moycullen road, at Cappagh Road and at Ballymoneen Road, with the Yellow1 Route Option generally in fill in this area. The Yellow1 Route Option then connects to a grade separated junction in the townland of Letteragh, where it descends briefly into cutting. A new link road, the Yellow1 N59 Link, is required to facilitate this junction; it commences at point F and terminates at point G. This new link road connects the N59 and Bóthar Stiofáin with the Yellow1 Route Option, and is approximately at existing ground level at their crossing point, with the link road remaining at-grade to the south, and in varying sections of cut and fill to the north.

The Yellow1 Route Option then crosses the River Corrib on a bridge structure. It continues on embankments and viaduct structures towards Coolagh, with sections of cut at high points in the terrain, and crosses over the N84. The Yellow1 Route Option travels southwards at point M to connect to the Red1 Route Option at Terryland. A grade separated junction with all movements is proposed in the Terryland Park area to connect the Yellow1 Route Option to the Red1 Route Option. This facilitates access in both an easterly and westerly direction onto the Yellow1 Route Option from the existing road network. The Yellow1 Route Option then follows the Red1 Route Option, utilising the exiting N6 and the same junction strategy as the Red1 Route Option, until its termination point at Point S in Coolagh.

6.1.4 Blue1 Route Option

The Blue1 Route Option commences at point B at the R336 on the western outskirts of Bearna and proceeds along the existing Bearna Relief Road, parallel to and north of the R336. The remainder of the Bearna Relief Road ties back to the existing R336 east of Bearna and is included as part of the Blue1 Route Option. From the relief

road the Blue1 Route Option proceeds in a north-easterly direction, passing through the townlands of An Chloch Scoilte, Na hAille, Mincloon and Dangan before crossing the River Corrib to the south of Menlo Castle. From there the Blue1 Route Option continues east towards Lackagh Quarry, entering a tunnel at point M and emerges from the tunnel immediately west of the existing N84, at point N. The Blue1 Route Option passes through the townlands of Castlegar and Ballybrit, crosses under Galway Racecourse in a cut and cover tunnel and terminates at point S on the existing N6 in Coolagh. Refer to **Figure 6.1.1** and **Figures 6.3.4.0** to **6.3.4.10**

The Blue1 Route Option ties into the existing R336 at a signalised junction at the western end of Bearna and proceeds along an existing relief road parallel to and north of the R336. Signalised junctions accommodate the two local roads intersecting this existing relief road of Bearna and the eastern tie in of the Bearna Relief Road to the R336 is provided via a signalised junction to the east of Bearna.

The Blue1 Route Option is generally in cut or at the existing ground level to the east of Cappagh Road. It then is mainly on embankments as far as the grade-separated junction in Letteragh, with an at-grade roundabout junction at Ballymoneen Road. A new link road, the Blue1 N59 Link, is required to facilitate the grade separated junction. It commences at point F and terminates at point G, connecting the N59 and Bothar Stiofáin with the Blue1 Route Option, and is at approximately the existing ground level at the crossing point, with the link road continuing mainly in fill to the south, and in varying sections of cut and fill to the north.

The Blue1 Route Option continues in sections of cut and fill, travelling over the N59, and coincides with the Yellow1 Route Option over the River Corrib on a bridge structure. To the east of the river, the Blue1 Route Option is generally on embankments or viaduct structures, before entering a section of cut preceding the tunnel at Lackagh Quarry. After exiting the tunnel, it continues on embankments and passes over the N84. A grade separated junction is provided to the east of the N84 and to the south of Ballindooley Lough to serve the N84. This also serves the N17 via a parallel road. The Blue1 Route Option crosses over the N17 without a direct connection. The Blue1 Route Option then proceeds into a tunnel below the Galway Racecourse and emerges to the east of the racetrack, still in cut. There is a further grade separated junction to the south-east of the existing Briarhill junction, which is at the existing ground level and is designed to accommodate the industrial estates in the Parkmore area, Ballybrit Business Park and the Briarhill areas of the city.

6.1.5 Pink1 Route Option

The Pink1 Route Option commences at point B to the west of Bearna, and follows the same path as the Blue1 Route Option through the townlands of An Chloch Scoilte, Na hAille, Mincloon, Dangan and Coolagh, and as far as point P in the townland of Castlegar. It then passes through the townland of Parkmore to the north of Galway Racecourse. The Pink1 Route Option then proceeds in a southerly direction towards the existing N6 and terminates at point S on the existing N6 at Coolagh. Refer to **Figure 6.1.1** and **Figures 6.3.5.0** to **6.3.5.10**.

Similar to the Blue1 Route Option, the Pink1 Route Option commences at a signalised junction at the western end of Bearna and follows the Blue1 Route Option with the same junction arrangement as far as point P in Castlegar. The Pink1 Route Option then proceeds in a cut and cover tunnel to the north of Galway Racecourse. On exiting the cut and cover tunnel, the Pink1 Option travels south towards point S, remaining in cut under the local roads. A full movement grade separated junction is provided to the south of the existing Briarhill junction, in the townland of Coolagh, to accommodate connectivity to the Parkmore Industrial Park, Ballybrit Business Park and the Briarhill areas of the city.

6.1.6 Green1 Route Option

The Green1 Route Option commences at point A on the R336 to the west of Bearna and proceeds in a north-easterly direction along the same path as the Yellow1 Route Option, keeping to the north of Bearna and passing through the townlands of Na Foraí Maola, An Chloch Scoilte, Na hAille, Keeraun, Tonabrocky and Bushypark before crossing the River Corrib to the north of Menlo Castle. The Green1 Route Option proceeds northeast through Menlough to Ballindooley and southeast through Twomileditch and Coolagh before it terminates on the existing N6 Galway to Dublin road at point T. Refer to **Figure 6.1.1** and **Figures 6.3.6.0** to **6.3.6.13**.

At point A the Green1 Route Option ties into the existing R336 with an at-grade roundabout junction approximately 2km to the west of Bearna village. There are three at-grade roundabout junctions at approximately 2km spacing, on the Bearna to Moycullen Road, at Cappagh Road and at Rahoon Road, with the Green1 Route Option generally in fill in this area. A grade separated junction is proposed at the crossing point of the N59 Galway to Clifden Road.

The Green1 Route Option crosses the River Corrib on a bridge structure and continues east on embankments and viaducts. To the east of the River Corrib, there is a grade separated junction to serve the N84 immediately west of the existing N84 in the townland of Ballindooley. A realignment of the existing N84 is included to facilitate this junction. The Green1 Route Option proceeds in an easterly direction and crosses over the N17 without a connection, in fill to the west of the N17 and in cut to the east. There is a further grade separated junction in the vicinity of Parkmore Road, which is designed to accommodate N17 traffic, the industrial estates in the Parkmore area, Ballybrit Business Park and the Briarhill area of the city.

6.2 Findings from Public Consultation No. 2

Public consultation sessions were held on Wednesday 28 and Thursday 29 of January 2015 in the Westwood Hotel, Dangan, from 2.00pm to 8.00pm, and on Tuesday 3 and Wednesday 4 of February 2015 in the Menlo Park Hotel from 2.00pm to 8.00pm. Over 1,450 people signed the attendance register over the four days of public consultation sessions.

These sessions formed part of the option selection process. Boards documenting the options examined to date and their feasibility were displayed, along with proposed solution options incorporating public transport, smarter travel and road-based components. Maps showing proposed road-based solutions with the constraints

gathered during the Constraints Stage were also displayed. Representatives of Arup and Galway County Council were available throughout the sessions to answer questions and explain the material on display as needed. The aim of the public consultation sessions was to receive feedback and suggestions from the public regarding the proposed solutions. Submissions from the public of suggestions of possible modifications to the options presented, or additional information on further constraints, which may not have been taken into account at Constraints Stage, were welcomed both during the consultation sessions and afterwards, until the 6 March 2015.

Individual meetings with landowners, stakeholders, business owners and residents within the scheme study area were held in the weeks following the formal consultation. These were held at the request of the private individuals and drawings were prepared for each one to show the proximity of their property to the proposed road component options. Feedback from these meetings and submissions received were noted and any further constraints were sent to the full design team including the environmental specialists for inclusion in their assessment.

The main findings from this public consultation are as follows:

- Greater importance given to the protection of environmental habitats over humans;
- Viability of going back to the 2006 GCOB scheme;
- Impacts of demolition to homes and businesses;
- Impact on the environement, noise and air pollution;
- Impact to communities and cultural heritage of many townlands e.g. Menlough, Castlegar, Coolagh, Rahoon, Dangan/Bushypark, Knocknacarra and Bearna;
- Impact on recreational amenities such as NUIG Recreational Facilities;
- Health and safety of primary school children in close proximity to proposed routes;
- Impact to commercial businesses and local economy of Galway; and
- Impementation of improved public transport and smarter mobility.

Full details of this consultation and submissions received from the public are included in **Appendix A.6.1**.

6.3 Engineering Assessment

6.3.1 Introduction

As part of the route selection process, an assessment of the engineering methods employed for the preliminary design of each route option is required to establish the most preferred route option from a purely engineering perspective. A number of criteria have been selected to assess route options based on engineering parameters.

This section details the Stage 1 assessment of the route options with respect to the engineering constraints identified in **Section 4.10 Engineering** of this report. Plans and profiles of these route options are included in **Figures 6.3.1.0** to **6.3.6.13**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.3.2 outlines the methodology that was used to carry out the study and **Section 6.3.3** details the options assessment. A summary is presented in **Section 6.3.4** and references are listed in **Section 6.3.5**.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road hAille and Section 2 is from Barr Aille Road to the N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.3.2 Methodology

The engineering assessment criteria have been identified under the following sub-headings: Geometry, Cross-Section, Length, Junction Strategy, Structures, Topography and Earthworks, Constructability, and Traffic. The various assessment methodologies employed under each of these sub-headings are outlined in **Section 6.3.3** below.

On the western side of the scheme study area, the route options are interchangeable from the point where they meet the existing R336 to Barr Aille Road and as such the engineering assessment has been carried out based on two sections. Section 1 extends from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6 in the east of the city. The cumulative ranking of each of the criteria was quantified, and based on this, the engineering ranking was given as Preferred (P), Intermediate (I) or Least Preferred (LP).

6.3.3 Stage 1 - Option Assessment

6.3.3.1 Geometry

All of the route options are at preliminary design stage. A preliminary mainline alignment with associated junctions and link roads has been designed for each of the route options. The geometric assessment has been carried out on the mainline alignment along the route travelled from where the route connects to the existing R336 to the tie in with the existing N6 Galway to Dublin Road. Using the preliminary alignment, a number of indicators which contribute to the geometric performance have been highlighted below.

The horizontal component of the geometric assessment comprises the calculation of the percentage of each option that achieves at least desirable minimum curvature.

The vertical geometric component has been assessed based on an assessment of the extent that each route option achieves at least desirable minimum vertical curvature.

The results of the horizontal and vertical alignment assessments have been categorised as P, I and LP. These results, as well as the overall assessment, are tabulated below. **Table 6.3.1** gives details of Section 1, west of Barr Aille Road and **Table 6.3.2** gives a summary of Section 2, east of Barr Aille Road.

Table 6.3.1 Geometric Assessment – Section 1

Route Option	Horizontal Alignment	Vertical Alignment	Assessment
Red1/Orange1	I	P	P
Green1/Yellow1	P	LP	I
Blue1/Pink1	LP	P	I

Table 6.3.2 Geometric Assessment – Section 2

Route Option	Horizontal Alignment	Vertical Alignment	Assessment
Red1	LP	LP	LP
Orange1	LP	P	I
Yellow1	LP	P	I
Blue1	I	I	I
Pink1	I	I	I
Green1	P	P	P

The Red1/Orange1 Route Option is the most preferred in Section 1 in terms of geometry.

In Section 2, the Green1 Route Option is the preferred option and the Red1 Route Option is the least preferred in terms of geometry.

6.3.3.2 Cross-Section

Full details of the typical cross-sections for each route option will be available after the cost benefit analysis has been completed. For the preliminary design a Type 2 dual carriageway cross-section has been assumed throughout on the Green1, Blue1, and Pink1 Route Options. The Red1 Route Option cross-section varies and is detailed in **Appendix A.5.3**. The Orange1 and Yellow1 Route Options utilise the Red1 Route Option cross-section in areas where they overlap, and are assessed as Type 2 dual carriageway in all other areas. Verge widths and lane widening will be amended at detailed design stage to suit full geometric requirements.

6.3.3.3 Length

The length parameter is a measure of each route option's length from its westernmost extent, where it connects to the R336 in the vicinity of Bearna, to the

tie-in with the existing N6 Galway to Dublin motorway. This is the distance which a vehicle would have to travel to go from the westernmost extent to the existing N6.

Table 6.3.3 Overall Route Option Length

Route Option	Mainline Length (m)
Red1	15073
Orange1	14862
Yellow1	17208
Blue1	16870
Pink1	16840
Green1	19643

A breakdown of the lengths of the route options in Section 1 is tabulated below.

Table 6.3.4 Route Option Length – Section 1

Route Option	Length (m)	Assessment
Red1/Orange1	1798	P
Green1/Yellow1	3448	LP
Blue1/Pink1	3100	I

The Red1/Orange1 Route Option in Section 1 is the shortest and the Green1/Yellow1 Route Option is the longest.

A breakdown of the length of the six route options in Section 2 is tabulated below, along with the assessment for each of the options.

Table 6.3.5 Route Option Length – Section 2

Route Option	Length (m)	Assessment
Red1	13275	P
Orange1	13064	P
Yellow1	13760	I
Blue1	13770	I
Pink1	13740	I
Green1	16195	LP

The Orange1 Route Option offers the shortest travel distance and consequently is the most preferable, closely followed by the Red1 Route Option, while the Green1 Route Option requires the greatest travel distance and is therefore the least preferable.

6.3.3.4 Junction Strategy

The assessment considers the number of junctions along each of the route options. At-grade junctions will cause delays on the mainline, with the delay increasing as the number of at-grade junctions increases. At-grade junctions also have the potential to increase traffic volumes and delay on the adjoining local road networks. However, it is vital to provide sufficient connectivity via junctions to attract traffic from the local networks.

Conversely, a higher number of grade separated junctions provides greater connectivity to the mainline with no significant delay experienced by the mainline traffic.

As there are no grade separated junctions in Section 1, the number of at-grade junctions was counted and route options were assessed in order of preference, where the most preferred option has the least number of junctions, causing delay, and the least preferred has the greatest number of junctions. A summary for the number of junctions Section 1 for each route option, along with the junction assessment, is tabulated below.

Table 6.3.6 Junction Assessment – Section 1

Route Option	Number of At-Grade Signalised Junctions or Roundabouts	Number of At-Grade Priority/Left In Left Out Direct Access Junctions	Number of Grade Separated Junctions	Assessment
Red1/Orange1	1	0	0	P
Green1/Yellow1	2	0	0	I
Blue1/Pink1	4	1	0	LP

For Section 2, the number of at-grade junctions along each route option was totalled. The route option with the lowest number of at-grade junctions was ranked as most preferred from a delay context. The number of grade separated junctions was also totalled along each route option and the route option with the greatest number of grade separated junctions was ranked as preferred, as providing greatest connectivity without delay impact. An additional factor of junction configuration was taken into account to allow for delay impact, as standard junction layouts are preferred from the point of view of driver comfort and safety. Non-standard or staggered junctions were deemed less preferable than standard layouts such as dumb-bell junctions or signalised diamond junctions.

The project objectives include a requirement to provide connectivity between the N6 and the three existing national secondary routes in the city; the N59, the N84 and the N17. A check has been carried out on each route option as to whether there is a direct connection between the route option and all three existing national routes, and the option ranked accordingly.

Table 6.3.7 Junction Assessment – Section 2

Route Option	Number of At-Grade Signalised Junctions or Roundabouts	Number of At-Grade Priority/Left In Left Out Direct Access Junctions	At-Grade Assessment	Number of Fully Grade Separated Junctions	Grade-Separated Assessment	Junction Configuration	Connectivity to National Routes	Overall Assessment
Red1	4	10	LP	4.75	P	I	P	P
Orange1	1	1	I	4	I	LP	P	I
Yellow1	2	1	I	3	LP	LP	I	LP
Blue1	1	0	P	3	LP	P	I	I
Pink1	1	0	P	3	LP	P	I	I
Green1	2	0	I	3	LP	I	LP	LP

For Section 2, the Red1 Route Option is the most favourable. The Orange1, Pink1 and Blue1 Route Options are intermediate. The Green1 and Yellow1 Route Options are the least favourable in terms of junction connectivity.

6.3.3.5 Structures

In the centre of the scheme study area lies the River Corrib and associated Lough Corrib candidate Special Area of Conservation (cSAC). All of the proposed route options cross the River Corrib. The Green1, Blue1, Yellow1 and Pink1 Route Options cross over the river with the mainline on a new bridge structure. The Orange1 Route Option crosses beneath the river in a tunnel. The Red1 Route Option utilises the existing Quincentenary Bridge for the mainline and requires a secondary bridge crossing of the river to cater for the local road network to the south of the existing bridge.

The total number of bridge structures along the mainline for each of the routes in Section 1 and Section 2 has been quantified. The route option with the least number of bridge structures was deemed most preferred due to having the lowest constructions costs, ongoing structural maintenance costs and the least impact on the overall overland drainage network. The route options with the greatest numbers of structures was ranked as least preferred.

For Section 1, the number of bridge structures includes the number of river and stream bridge crossings and the mainline crossing existing or associated proposed roads, either on an overbridge or in an underpass. The results are tabulated below.

Table 6.3.8 Structures Assessment – Section 1

Route Option	River/Stream Bridge	Mainline on Overbridge	Mainline in Underpass	Total Number of Bridges	Assessment
Red1/Orange1	1	0	3	4	I
Green1/Yellow1	1	4	0	5	LP
Blue1/Pink1	1	0	2	3	P

In addition to the number of bridge structures outlined for Section 1 above, an allowance has been made within Section 2 along each of the route options based on the nature and length of significant structures. In particular the length of the River Corrib bridge crossing, extents of viaducts, and extents of cut and cover, deep bored, and drill and blast tunnels were taken into account.

Table 6.3.9 Structure Assessment – Section 2

Route Option	River/Stream Bridge	Mainline on Overbridge	Mainline in Underpass	Total Number of Bridges	Number of Bridges Assessment	Major Structure Extents Assessment*	Overall Assessment
Red1	7	3	8	18	I	LP	LP
Orange1	5	0	9	14	P	LP	LP
Yellow1	4	12	5	21	LP	P	P
Blue1	3	15	5	23	LP	I	I
Pink1	3	15	4	22	LP	I	I
Green1	4	9	5	18	I	P	P

**Major structures include River Corrib bridge, viaduct and tunnel extents*

For Section 1, the Blue1/Pink1 Route Option is the most favourable for the structures assessment, while the Green1/Yellow1 Route Option is the least preferred.

For Section 2, the Yellow1 and Green1 Route Options are the most favourable. The Blue1, Red1 and Orange1 Route Options score poorest due to the extent and variety of structures on both options.

6.3.3.6 Topography and Earthworks

A preliminary assessment of the earthworks quantities has been carried out along the mainline for each of the route options. For the majority of the route options the mainline is in fill; however it is impractical to objectively assess the overall amount of cut and fill at this stage due to the proposal for tunnels along sections of some options. Therefore for the preliminary assessment the rank order of the route options with respect to Earthworks has been omitted from the overall matrix.

6.3.3.7 Constructability

Constructability of all of the route options will be complicated due to the extent of existing residential housing, commercial businesses, farms, local roads and accesses dotted along the length of the route options. Disruption to residents and local traffic will need to be minimised throughout the construction period. Detailed assessment of the impacts will be carried out in the Environmental Impact Study.

It follows that the route option with the greatest length of on-line construction, with either rehabilitation of the existing N6 and rehabilitation of existing roads, will be the most difficult to construct. The route options have been ranked based in general on the length of on-line construction expected, with the preferred option being the most straightforward to construct and the least preferred being the most difficult.

As the route options are almost entirely off-line in Section 1, they were ranked here according to the nature of the areas they pass through and the number of road crossings involved in this section. In Section 2, the complexity of constructing long structures, particularly tunnels, is also taken into account.

Table 6.3.10 Constructability Assessment – Section 1

Route Option	Assessment
Red1/Orange1	P
Green1/Yellow1	I
Blue1/Pink1	LP

Table 6.3.11 Constructability Assessment – Section 2

Route Option	Assessment
Red1	LP
Orange1	LP
Yellow1	I
Blue1	I
Pink1	I
Green1	P

6.3.3.8 Traffic

Detailed traffic models for all of the route options are not available at this point of the project. However based on a number of models that have been run to date a judgment has been made as to the route options which serve traffic more effectively.

The route options have been ranked based on their ability to meet the project objectives including providing connectivity from east to west across the city, the attractiveness of the route option to entice traffic away from local and street networks to the new road and the ability of a route option to provide relief to traffic congestion within the city centre. Therefore the route option closest to the existing road networks and centres of population are ranked as preferred and the route option furthest from these areas are least preferred.

Table 6.3.12 Traffic Summary – Section 1

Route Option	Assessment
Red1/Orange1	I
Green1/Yellow1	LP
Blue1/Pink1	P

Table 6.3.13 Traffic Summary – Section 2

Route Option	Assessment
Red1	P
Orange1	I
Yellow1	I
Blue1	I
Pink1	I
Green1	LP

6.3.4 Summary

The above assessment criteria under each of the sub headings for engineering have been summarised below. An overall ranking for each of the routes has been determined based on the criteria rankings and is also shown below.

Table 6.3.14 Summary Table - Section 1

Route Option	Geometry	Length	Junctions	Structures	Constructability	Traffic	Overall
Red1/Orange1	P	P	P	I	P	I	P
Green1/Yellow1	I	LP	I	I	I	LP	LP
Blue1/Pink1	I	I	LP	P	LP	P	I

Table 6.3.15 Summary Table - Section 2

Route Option	Geometry	Length	Junctions	Structures	Constructability	Traffic	Overall
Red1	LP	P	P	LP	LP	P	LP
Orange1	I	P	I	LP	LP	I	I
Yellow1	I	I	LP	P	I	I	I
Blue1	I	I	I	I	I	I	P
Pink1	I	I	I	I	I	I	P
Green1	P	LP	LP	P	P	LP	I

From an engineering perspective, the most preferred Option in Section 1 is the Red1/Orange1 Route Option followed in second place by the Blue1/Pink1 Route Option and the Green1/Yellow1 Route Option is least preferred.

From an engineering perspective, the Pink1 and Blue1 Route Options are the most preferred Options in Section 2. The Red1 Route Option is the least preferred.

6.4 Road Safety Impact Assessment

A Road Safety Impact Assessment (RSIA) was carried out for the Stage 1 assessment of the route options described in **Section 6.1**. A copy of the Road Safety Impact Assessment is included in **Appendix A.6.2.**

This study examined the impact all of the proposed route options would have on the existing road network of the scheme study area. The RSIA considers effects on the network as well as on the proposed options, and takes account of all road users, including vulnerable road users in order to ensure that the implications on road

safety of each route option are fully assessed as part of the route selection process. The assessment indicates the road safety considerations which shall contribute to the selection of the preferred route option.

Each area was examined in turn and a site visit undertaken. The impact of each option on each area was assessed and categorised as positive, negative or neutral from a safety perspective. Recommendations were made regarding possible improvements which could be taken into account in the design of the Stage 2 Route Options and possible opportunities afforded by the construction of a new road to improve road safety on the existing network.

The existing road networks of Galway City and its environs which would be affected by any proposed road-based transport solution currently experience a variety of safety issues. The off-line route options outlined in **Section 6.1** would result in the provision of a high quality and high safety route and thus enhance overall safety, but may not enhance or improve the safety of specific urban road sub-networks. However, the on-line and urban route options would upgrade the existing network and junction configuration, but limit the road space available and still keep all traffic in an urban environment, albeit grade-separated and with segregated traffic networks.

All of the proposed route options would be designed with the aim of removing and reducing the existing issues, and of avoiding introducing new safety issues. Good design practice and the standards outlined in **Appendix A.6.2** would be followed and all proposed solutions would have an acceptable standard of safety for road users.

6.5 Environmental Assessment

6.5.1 Ecology

6.5.1.1 Introduction

This section details the Stage 1 assessment of the route options with respect to the ecological constraints identified in **Section 4.3 Ecology** of this report. The route options as described in **Section 6.1** with the ecology constraints are presented in **Figure 6.5.1.1** to **6.5.1.20**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage route options.
Section 6.5.1.2 outlines the methodology that was used to carry out the study and **Section 6.5.1.3** details the options assessment. A summary is presented in **Section 6.5.1.4** and references are listed in **Section 6.5.1.5**.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.5.1.2 Methodology

The assessment of each route option with respect to the ecological environment was based on the alignments described in **Section 6.1** and presented on **Figures 6.3.1** to **6.3.20**.

Each route option was assessed in relation to the potential impacts likely to occur in relation to the identified key ecological receptors, as outlined below, where they were either confirmed or likely to occur within the overall scheme study area, and were deemed to be potentially at risk of impact from individual route options (discounting receptors where the risk of significant impacts is unlikely considering where the delivery of standard mitigation and best practice during construction is unequivocal and success is highly likely):

- Designated areas for nature conservation (Lough Corrib cSAC/SPA, Galway Bay Complex cSAC, Inner Galway Bay SPA, and Moycullen Bogs NHA) and their Qualifying Interests (QIs) or Special Conservation Interests (SCIs) (in the case of European sites);
- Ecological Sites (see **Section 4.3.3.3** in **Chapter 4**);
- Known or likely breeding places, and in some cases broad habitat requirements, of Habitats Directive Annex II/IV species (e.g. Otter[1], Lesser horseshoe bat[2], Freshwater pearl mussel, Marsh fritillary);

[1] Otter habitat as defined in the *Threat Response Plan: Otter (2009-2011)* document (NPWS, 2009)
[2]In the case of this species, known non-breeding sites were also included.

- Known or likely breeding and roost sites of certain Birds Directive Annex I species (e.g. Hen harrier, Peregrine falcon);
- Known or likely breeding and roost sites of certain red listed Birds of Conservation Concern species (e.g. Barn owl, Red grouse) and other raptors;
- Known locations of Flora (Protection) Order, 1999 species (*e.g.* Slender Cottongrass *Eriophorum gracile*, Small-white Orchid *Pseudorchis albida*, Chives *Allium schoenoprasum*); and
- Known important or sensitive wintering bird sites.

These ecological receptors were chosen based on the following criteria: habitats or species protected at a national or European level, of a high conservation value/concern at these levels, and, were considered particularly vulnerable to significant negative impacts from road development.

Where potentially significant, the likelihood for impacts to occur to other sensitive ecological receptors is also considered.

In ranking the route options, the highest weighting was given to potential impacts on European protected sites, particularly in relation to the Annex I habitats and Annex II species which are listed as qualifying interests (QIs) of affected European sites. In assessing the potential impacts on Lough Corrib cSAC, the habitat classifications described are based on their current condition. A high weighting was also given to potential impacts on nationally designated sites (*e.g*. Moycullen Bogs NHA).

Route options are ranked with respect to their impacts on the ecological environment as follows: Preferred (P), Intermediate (I), and Least Preferred (LP). These terms are used to comparatively assess route options in either Section 1 or Section 2 and should not be interpreted to compare the significance of impacts between those sections – i.e. by virtue of the fact that route options in Section 2 cross a European site whereas in Section 1 they do not, the LP route option(s) in Section 2 is likely to have a much greater impact on the ecological environment than the LP route option(s) in Section 1.

The terminology used when describing impact significance is per *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements)* (Environmental Protection Agency, 2003).

In accordance with the *Guidelines for Assessment of Ecological Impacts of National Road Schemes* (National Roads Authority, 2009), the levels of impact assigned to particular routes make the assumption that general mitigation measures will be implemented (i.e. where delivery is unequivocal and success is highly likely).

The habitat areas calculated within the cSAC boundary are based upon the intersection of the proposed route option alignments provided and the digital designated area boundaries downloaded from the NPWS website (revision 15/01/2015, downloaded in March 2015), and on an interpretation of the legal boundary, from the official Department of Arts, Heritage and the Gaeltacht

boundary maps for Lough Corrib candidate Special Area of Conservation: Sheets (082a and 082c)[3].

6.5.1.3 Options Assessment

Section 1

All of the route options in Section 1 avoid any direct impacts to designated areas for nature conservation and with best practice construction methodologies applied, are not likely to result in any indirect impacts that would affect designated sites generally or adversely affect the integrity of European sites (e.g. a significant reduction in water quality within the Galway Bay Complex cSAC/Inner Galway Bay SPA). All of the route options in Section 1 were also considered not likely to result in any significant impacts to Rare/protected plant species, Red grouse, Barn owl, or any other Annex I bird species known from the scheme study area. As such, these ecological receptors did not affect the ranking of the route options in Section 1.

The Red1 and Orange1 Route Options will result in the least amount of Annex I habitat loss (small area of Dry heath habitat [4030][4] in EC10), and will have the least impact on habitats of local importance (higher value) when compared with the other route options. The Blue1 and Pink1 Route Options will result in a greater loss of Annex I habitat (*c*.60m^2 of Wet heath [4010] habitat in EC17) and will have a greater impact on habitats of local importance (higher value) than the Red1/Orange1 Route Options. Finally, the Green1 and Yellow1 Route Options will have the greatest impact on Annex I habitats over multiple Ecological Sites (EC05, EC11, EC12, and EC14) and will result in greatest impact to locally important (higher value) habitats, when compared with the other route options.

All route options will result in some degree of habitat loss and severance in relation to the local bat populations; most notably in relation to a Whiskered bat *Myotis mystacinus* roost in Bearna, individuals of which have been recorded foraging to the north-west of Bearna woods, as far as the Lough Inch River. The longest route options (Green1/Yellow1 followed by Blue1/Pink1), which are also those furthest removed from the urban areas around Bearna, are more likely to result in a greater degree of habitat loss and severance than the Red1 and Orange1 Route Options.

All route options will result in the severance of Marsh fritillary breeding sites/suitable breeding habitat from the main metapopulation and although the effects of this are likely to be potentially greater for the longer route options (i.e. Green1/Yellow1), the effects of this are unlikely to be significant. The Green1 and Yellow1 Route Options will also result in the loss of suitable Marsh fritillary breeding habitat adjacent to a confirmed breeding site. In avoiding any

[3]the current versions of the digital designated area boundaries that can be downloaded from the NPWS website do not always accurately represent the legally defined boundaries,as shown on the official Department of Arts, Heritage and the Gaeltacht boundary maps, as they relate to features on the ground such as field boundaries, road margins etc. This is on account of the scale difference between the 6-inch maps used to originally define the European siteboundaries and current larger scale vector mapping/orthophotography.

[4]Annex I habitat codes, where given in parenthesis, are as per the *Interpretation Manual of European Habitats* (European Commission, 2007) and use the convention of denoting priority Annex I habitats with an *

watercourses, the Red1 and Orange1 Route Options have the least potential for impacting on the local Otter population.

The Red1 and Orange1 Route Options are the most preferred (P) route options in this section; having the least potential to impact on Ecological Sites, the local bat population, Marsh fritillary and Otter. The next preferred, are the Blue1 and Pink1 Route Options (Intermediate I); having a greater potential to impact on Ecological Sites, Bats and Otter than the Red1/Orange1 Route Options.

The Green1 and Yellow1 Route Options are the least preferred (LP); having the greatest impact on Annex I habitats within the Ecological Sites and a greater degree of severance in relation to bats, and Marsh fritillary than the other route options, given their greater length and that they are more removed from the urban areas around Bearna than the other route options.

Table 6.5.1.1 Section 1 – Ecology rankings of Route Options

Route Option	Ranking
Red1	P
Orange1	P
Yellow1	LP
Blue1	I
Pink1	I
Green1	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

Section 2

In determining the order of preference of the route options in Section 2, the highest weighting was given to the potential for impacts to European sites as this was the key ecological receptor within this section of the scheme study area.

Red1 Route Option

The Red1 Route Option avoids any direct impacts to Annex I habitats with the Lough Corrib cSAC. This option does however, require the construction of a new bridge spanning the River Corrib which would necessitate the installation of two supporting structures in the river channel (**Figure 6.5.1.3**). The construction of this element of the design has some potential to result in negative impacts to the following aquatic species listed as qualifying interests of the Lough Corrib cSAC: Otter, Atlantic salmon, Sea lamprey, and Brook lamprey. However, with best practice construction methodologies applied, and assuming that both during construction and operation the bridge would not result in any impediment to fish passage along the River Corrib channel, it is considered unlikely that construction would result in any negative impacts on these species that would adversely affect the integrity of Lough Corrrib cSAC.

The majority of this route option is online within the foraging area of the Menlo Castle lesser horseshoe bat roost[5]; although it is one of three route options that are in close proximity to the mating/hibernation site at Cooper's Cave in the Terryland River Valley. As such, is considered to be one of the least damaging route options with regard to this species provided that the integrity of Cooper's Cave is maintained.

The Red1 Route Option is considered to be the second most preferred route option.

Orange1 Route Option

The Orange1 Route Option avoids any direct impacts on the Lough Corrib cSAC (**Figure 6.5.1.3**). Tunnelling in a karst substrate does carry a risk of both construction and operation impacts to the movement of groundwater and there is the potential for indirect effects to wetland habitats within the Lough Corrib cSAC to the north, in the vicinity of the Coolagh Lakes. The risk of the tunnel affecting the existing hydrogeological regime is as low as reasonably practical by the application of modern tunnelling techniques and construction controls. Based upon these appropriate engineering tunnelling techniques and construction controls the tunnel is unlikely to result in any significant long-term effects on the conservation status of the qualifying interest habitats within Lough Corrib cSAC, or adversely affect the integrity of the site as a whole. Detailed geotechnical investigations would be required to fully quantify the associated risks if any.

The majority of this route option is either online or underground within the foraging area of the Menlo Castle Lesser horseshoe bat roost; although it is one of three route options that are in close proximity to the mating/hibernation site at Coopers Cave in the Terryland Stream Valley. As such, is considered to be one of the least damaging route options with regard to this species provided that the integrity of Cooper's Cave is maintained.

The Orange1 Route Option is considered to be the most preferred route option.

Yellow1 Route Option

The Yellow1 Route Option has potentially the greatest impact on habitats within the Lough Corrib cSAC. This route option impacts on the cSAC at three locations: at the proposed crossing point of the River Corrib; north-west of the Coolagh Lakes; and, along the Menlough Road.

As with the Blue1 and Pink1 Route Options, there is no Annex I habitat present at the proposed crossing point of the River Corrib and the proposed piers will be located in an area of (non-Annex) Calcareous grassland on the north bank of the river.

In the area north-west of the Coolagh Lakes and the area along the Menlough Road, the proposed Yellow1 Route Option is a viaduct structure within the cSAC boundary with none of the supporting structures sited within areas of Annex I habitat (and all accessible without having to cross any Annex I habitat). The non-

[5]Although a QI species for the Lough Corrib cSAC, the Lesser horseshoe bat is included as a QI for a roost at the northern end of Lough Corrib, *c*.30km away, and based on available information the roost at Menlough does not form part of the QI population of this species

Annex habitats are semi-natural woodland and calcareous grassland approaching the Menlough Road, and wetland habitats such as fen, reed swamp and wet grassland further east. However, there is a risk of indirect impacts during construction to habitats within the Lough Corrib cSAC given the close proximity of the Yellow1 Route Option to Annex I wetland habitats around the northern margins of the Coolagh Lakes, particularly an area of priority, qualifying interest habitat [*7210], and the lakes themselves which are an Annex I habitat type [3140] (e.g. adverse effects on the existing hydrological regime and how this interacts with these wetland habitats).

For the purposes of this assessment it is assumed that although the Annex I habitat is avoided, the construction works to install the piers, drainage etc., will impact directly on the areas of non-Annex habitat within the footprint of the proposed alignment and may also have indirect impacts on the Annex I habitats underneath the bridge structure (shading effects, for example) within the cSAC. The total corridor covered by this route option within the cSAC boundary is *c*.4.8ha.

This route option (both the mainline and the realigned Menlough Road) also passes through an area of non-designated Annex I Limestone pavement [*8240] and Calcareous grassland [6210], and an area of Residual alluvial forests [*91E0], between the Coolagh Lakes and Menlough Village, immediately adjacent to the Lough Corrib cSAC boundary (**Figure 6.5.1.17**). This area is considered to be of a high ecological value given that these habitats are contiguous with the same habitat types within the adjacent cSAC boundary, and are also comparable in terms of habitat quality. However, as the supporting structures along the viaduct through this section also avoid any Annex I habitat, the impacts are not likely to be significant.

This route option, along with the Blue1, Pink1 and Green1 Route Options, are potentially the most damaging with respect to the local lesser horseshoe bat population given the scale of habitat loss and severance likely to be associated with these route option within their core foraging area, and in the immediate vicinity of the maternity roost at Menlo Castle (*c*.280m from the mainline of the proposed alignment, with smaller scale works proposed within 200m).

The Yellow1 Route Option is considered to be the least preferred route option.

<u>Blue1 and Pink1 Route Options</u>

Both the Blue1 and Pink1 Route Options have an identical impact on the Lough Corrib cSAC at three locations: at the proposed crossing point of the River Corrib; north-west of the Coolagh Lakes; and, to the east of Lackagh Quarry.

There is no Annex I habitat present at the proposed Blue1 and Pink1 crossing point of the River Corrib and within the cSAC boundary, the proposed piers will be located in an area of (non-Annex) calcareous grassland on the north bank of the river. For the purposes of this assessment it is assumed there will be no works within the cSAC boundary on the south bank, and although the Annex I habitat is avoided, the construction works to install the piers, drainage etc., will impact directly on areas of non-Annex habitat within the footprint of the proposed alignment and the cSAC boundary (**Figure 6.5.1.17**) and may also have indirect impacts on these same non-Annex I habitats underneath the bridge structure (shading effects, for

example). The total corridor covered by the alignment of these route options within the cSAC boundary is *c*.1ha.

In the area north-west of the Coolagh Lakes, the embankment section of both options impacts on habitats within the cSAC boundary; non-Annex Semi-natural woodland and Calcareous grassland. The remainder of the proposed alignment, heading north-east, consists of a viaduct structure which will not place any of the supporting structures/piers within the cSAC boundary. Those supporting structures can be constructed without any impacts to Annex I habitats within Lough Corrib cSAC.

To the east of Lackagh quarry, these route options tunnel underneath the Lough Corrib cSAC; avoiding any direct impacts. However, as with the Orange1 Route Option, tunnelling in a karst substrate does carry a risk of both construction and operation impacts to the movement of groundwater and there is the potential for indirect effects to wetland habitats within the cSAC boundary to the south, in the vicinity of the Coolagh Lakes. The risk of the tunnel affecting the existing hydrogeological regime is as low as reasonably practical by the application of modern tunnelling techniques and construction controls. Based upon these appropriate engineering tunnelling techniques and construction controls the tunnel is unlikely to result in any significant long-term effects on the conservation status of the qualifying interest habitats within Lough Corrib cSAC, or adversely affect the integrity of the site as a whole. Detailed geotechnical investigations would be required to fully quantify the associated risks if any.

This route option also passes through an area of non-designated Limestone pavement [*8240], Calcareous grassland [6210], and Residual alluvial forest [*91E0] Annex I habitats, between the Coolagh Lakes and Menlough Village, outside of but immediately adjacent to the Lough Corrib cSAC boundary. These areas of Limestone pavement and Calcareous grassland are considered to be of a high ecological value given that these habitats are contiguous with the same habitat types within the adjacent cSAC boundary, and are also comparable in terms of habitat quality. The majority of the viaducts supporting structures/piers avoid direct impacts to any Annex I habitat in this area. However, one structure is located in an area surrounded by Limestone pavement [*8240] and a Turlough [*3180] and will need to be crossed to facilitate the construction works.

Limestone pavement is not part of the cSAC, and that with careful construction methodology it should be possible to access the site of this supporting structure/pier without permanently damaging the structure of the Limestone pavement, this impact is unlikely to be significant.

These route options, along with the Green1 and Yellow1 Route Options, are potentially the most damaging with respect to the local Lesser horseshoe bat population given the scale of habitat loss and severance likely to be associated with these route options within their core foraging area, and in the immediate vicinity of the maternity roost at Menlo Castle (both routes are *c*.280m from the mainline of the proposed alignment, with smaller scale works proposed within 200m).

The only significant difference between these route options, is the greater impact the Blue1 Route Option has on Annex I habitats within Ecological Site EC56; making the Pink1 Route Option marginally preferable over the Blue1 Route Option.

The Pink1 and Blue1 Route Options are the third and fourth preferred route options respectively (I), having a greater impact on the Lough Corrib cSAC than the Red1 and Orange1 Route Options but a lesser impact when compared with the Green1 and Yellow1.

Green1 Route Option

The Green1 Route Option impacts on the Lough Corrib cSAC directly at one location; the proposed crossing point of the River Corrib to the west of Menlough Village.

There is only one area of Annex I habitat within the area of the Lough Corrib cSAC within the corridor of the proposed alignment at this location; *c*0.9ha of Alkaline fen [7230], which is a listed qualifying interest habitat for the cSAC (**Figures 6.5.1.17** and **6.5.1.18**). This Annex I habitat will not be directly impacted as the bridge structure is on piers through the cSAC, with each pier located outside of the alkaline fen area. For the purposes of this assessment it is assumed that although the Annex I habitat is avoided, the construction works to install the piers, drainage etc., will impact directly on the areas of non-Annex habitat within the corridor of the proposed alignment and may also have indirect impacts on the Annex I Alkaline fen [7230] and other habitats underneath the bridge structure (shading effects, for example). The total footprint of this route option within the cSAC boundary is *c*.2.3ha. These include mainly non-Annex I wetland habitats on the west bank, which would be particularly vulnerable to indirect impacts from construction works, (fen, wet grassland, and reed swamp) and, woodland, grassland, scrub, and reed swamp on the east bank.

This route option also passes through an area of non-designated Annex I Limestone pavement [*8240] and Calcareous grassland [6210] at Kiloughter, *c*.50m north of the Lough Corrib cSAC boundary. Although not part of the cSAC, the loss on Annex I habitats at this location is considered of note, given that these habitats are contiguous with the same habitat types within the cSAC boundary at such close proximity, and are also comparable in terms of habitat quality.

This route option, along with the Blue1, Pink1 and Yellow1 Route Options, are potentially the most damaging with respect to the local lesser horseshoe bat population given the scale of habitat loss and severance likely to be associated with these route option within their foraging area, and in the immediate vicinity of the maternity roost at Menlo Castle (*c*.330m from the mainline of the proposed alignment).

The Green1 Route Option overlaps with the boundary of the Moycullen Bogs NHA, at the western margin of the site where an agricultural field grades into reed swamp surrounding a small dystrophic lake [3160]. Given the close proximity of the lake to the proposed alignment, there is the potential for indirect impact to water quality during construction, and potentially effects on the underlying hydrology.

The Green1 Route Option is the fifth preferred route option (LP), with only the Yellow1 Route Option having a greater potential impact on the Lough Corrib cSAC.

Table 6.5.1.2 Section 2 – Ecology ranking of Route Options

Route Option	Ranking
Red1	I
Orange1	P
Yellow1	LP
Blue1	I
Pink1	I
Green1	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.1.4 Summary

In identifying the least damaging of the six route options described, a key factor in determining the order of preference was the potential for each of the route options to impact on the Lough Corrib cSAC, given that it is the sole European designated site that all route options must cross within the scheme study area, and given the legal constraints that apply in relation to European protected sites under Article 6(3) of the EU Habitats Directive 92/43/EEC. In addition to considering the potential impacts on Lough Corrib cSAC in ranking the route options, other ecological impacts to other ecological receptors were also considered in determining the order of preference.

The Orange1 Route Option is the most preferred as it avoids direct impacts on the QI habitats and species of Lough Corrib cSAC, followed by the Red1 Route Option which, although it avoids direct impacts to Annex I habitats within the cSAC, will require some works within the River Corrib channel. However, it is unlikely to result in any permanent long-lasting effects on the designated site post-construction. Both of these route options are also likely to result in the least impact to the local lesser horseshoe bat population and the local Barn owl population.

The Pink1 and Blue1 Route Options are the next preferred as they have a greater impact on habitats (although not QI or Annex I habitats) within the Lough Corrib cSAC compared with Red1 or Orange1 Route Options but less than that associated with Yellow1 and Green1 Route Options. The Pink1 and Blue1 Route Options, are also likely to result in a significant impact to the local lesser horseshoe bat population, and the local Barn owl population.

The Green1 Route Option is next in the order of preference, having a greater potential for habitat loss within the Lough Corrib cSAC than the Pink1 and Blue1 Route Options but less than the Yellow1 Route Option. This route option, is also likely to result in a significant impact to the local lesser horseshoe bat population, and the local Barn owl population.

The Yellow1 Route Option is the least preferred route option as it has the greatest potential for habitat loss within the Lough Corrib cSAC and, given its close proximity to the Coolagh Lakes, and an associated risk of indirect impacts to aquatic habitats within the designated site. This route option, is also likely to result in a

significant impact to the local lesser horseshoe bat population, and the local Barn owl population.

Table 6.5.1.3 Summary of Ecological ranking of Route Options

Route Option	Section 1	Section 2
Red1	P	I
Orange1	P	P
Yellow1	LP	LP
Blue1	I	I
Pink1	I	I
Green1	LP	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.1.5 References

Commission of the European Communities. (2013) *Interpretation manual of European Union Habitats EUR28. European Commission, DG Environment.*

Environmental Protection Agency. (2003) *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements).* Environmental Protection Agency. Wexford.

National Roads Authority. (2009) *Guidelines for Assessment of Ecological Impacts of National Roads Schemes: Revision 2. National Roads Authority*.

National Parks and Wildlife Service. (2009) *Threat Response Plan: Otter (2009-2011) National Parks & Wildlife Service, Department of the Environment, Heritage & Local Government, Dublin.*

6.5.2 Soils and Geology

6.5.2.1 Introduction

This section details the stage 1 assessment of the route options with respect to the soils and geology constraints identified in **Section 4.4 Soils and Geology** of this report. The route options as described in **Section 6.1** with the soils and geology constraints presented in **Figure 6.5.2.1** to **6.5.2.10**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.2.2 outlines the methodology used to undertake the study and **Section 6.5.2.3** details the assessments. A summary is presented in **Section 6.5.2.4** and references are listed in **Section 6.5.2.5**.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille and Section 2 extends from Barr Aille to the existing N6 tie-in at Coolagh, Briarhill. The assessments take cognisance that these route options could be realigned within their corridors and therefore, the overall impact of the route corridor is assessed in order to identify possible impacts within the 150m wide corridor for these route options.

6.5.2.2 Methodology

The NRA Guidelines for the assessment and treatment of geology, hydrology and hydrogeology for National Road schemes forms the basis for the preparation of this section.

The soils and geology constraints for the scheme study area have been compiled and are presented in **Section 4.4**. Each route option, with respect to soils and geology is assessed using the available published information from the sources listed throughout this chapter together with the additional sources of information included in **Section 6.5.2.5**.

The impacts from each route option are assessed as follows:

Cut and fills – the locations of areas of cut and fill along each route option are analysed as part of the assessment. The significance and impact of each cut and fill area is determined as follows:

- **Low** where the cut or fill is between 0 to 5m and 5 to 10m;
- **Medium** where the cut or fill is 10 to 15m; and
- **High** where there is greater than 15m of cut or fill.

The occurrence of the following constraints within a cut or fill area influences the area significance and impact:

- the extent of the cutting or embankment;
- route options proposing tunnels;

- the presence of soft soils;
- the presence of potential karst features; and
- the average height or depth of the cutting/embankment relative to the maximum depth/height.

The level of impact of each cut and fill section is governed by the constraint with the highest ranking.**Tunnels** - A number of the route options incorporate tunnels in their preliminary designs. The proposed tunnel construction methodologies vary from cut and cover to bored. Soil and geology characteristics have a significant impact on the method of tunnelling. The impact has been assessed as follows:

- Cut and cover tunnels would likely be excavated to approximately 12m below ground level. The excavation would likely be supported by retaining walls in the overburden/weathered rock. The retaining options for excavations in competent rock would be assessed during detailed design. This method is assessed as having a **High** impact; and
- Bored tunnels would likely be excavated using a tunnel boring machine (TBM), roadheader or other excavation methods such as drill and blast. For bored tunnels in limestone, an assessment of the impact on the karst environment, on groundwater control and on controlling deformations during construction would be required. The impact of factors such as vertical alignment, potential for rapid recharge of groundwater from water courses, the potential to encounter geological hazards (voids, dykes etc.), surface settlement criteria and tunnel length is assessed for each route option. The impact of bored tunnels is assessed as **High** due to the level of uncertainty associated with subterranean construction.

Soft ground – The impact of soft ground on the route options is based on the possible technical solution. As the depth and extent of soft ground is unknown, until it is established during the site investigation for the detailed design stage, where soft ground is present the impact is assessed **High**.

At this time it is assumed that soft ground could be excavated and replaced with rockfill, improved with a ground improvement technique or structural solutions such as a piled raft, piled embankment or a retained cut or embankment.

Features in Karst Limestone Areas - A range of solution features found within the scheme study area are presented in **Section 4.4**. Where identified in an area of cut or fill the impact assessment is based on geological considerations only and their ranking is presented in **Section 4.4**. The hydrogeology associated with the karst features is discussed in greater detail in **Section 6.5.3**. Potential geohazards such as sinkholes opening up during construction or the design life of the road are also considered in the assessments of the stage 1 route options.

The duration of these impacts is considered to be permanent. The location of the cuts and fills are shown on **Figures 6.5.2.11** and **6.5.2.12.**

Along with cut and fill, each of the route options are also assessed under the following headings:

- Ground conditions including features in Karst Limestone Areas;

- Historical Land use;
- Economic Geology; and
- Geological Heritage Areas.

This assessment is based on the information available at this stage of the project. Further non-intrusive (e.g. geophysical) and intrusive investigations (boreholes, trial pits, etc.) are required at detailed design stage.

6.5.2.3 Options Assessment

Overview of Stage 1 Route Options

Cut and fill

Each route option has been separated into a series of cuttings and embankments shown on **Figure 6.5.1.11** and **6.5.1.12**. The impact of each section is assessed considering the magnitude of the cut and fill section, the presence of soft soils, the presence of potential karst features and the average height or depth of the cutting /embankment relative to the maximum depth/height.

Principle cuttings and embankments are tabulated for each route option. Areas with a max cutting or embankment depth less than 5m and an overall impact of **Low** are illustrated on **Figure 6.5.1.11** and **6.5.1.12** and excluded from principle cutting and embankment tables.

Red1 Route Option

The Red1 Route Option has a number of significant geotechnical challenges. The impact of each principal cut and fill sectin is assessed and presented in

Tables 6.5.2.1 and **6.5.2.2** and are shown on **Figure 6.5.1.11** and **6.5.1.12**.

Table 6.5.2.1 Principal cuttings along the Red1 Route Option

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
1	Red1 C1	Bearna	630	5 - 10	Low
2	Red1 C12	Rahoon to River Corrib	3420	10 - 15	High[1]
2	Red1 C14	Castlegar	140	0 - 5	High[2]
2	Red1 C15	Castlegar	100	0 - 5	High[2]
2	Red1 C16	Castlegar to Ballybane	1370	5 - 10	High[3]
2	Red1 C17	Ballybrit to N6	2858	10 - 15	High[4]

In addition to the max cutting depth the location impact is influenced by:

1. Length of cutting and the presence of soft ground;
2. Presence of soft ground;
3. Length of cutting and presence of a number of Karst Features including K89; and
4. Length of cutting.

Table 6.5.2.2 Principal embankments along the Red1 Route Option

Section	Name	Location	Length (m)	Max Embankment Height (m)	Level of Impact
2	Red1 E4	Ballard East	430	5 - 10	High[1]
2	Red1 E12	River Corrib to Terrland	870	10 - 15	High[1]
2	Red1 E13	Ballinfoyle	380	5 - 10	High[1]
2	Red1 E14	Castlegar	200	0 - 5	Medium[1]
2	Red1 E15	Castlegar	100	0 - 5	High[1]
2	Red1 E16	Castlegar	110	0 - 5	Medium[1]

Note: In addition to the max embankment depth the location impact is influenced by;

1 Presence of soft ground

The following are features which are associated with the principle cuttings and embankments and associated infrastructure provision for the Red1 Route Option.

This Red1 Route Option commences in a cutting in the Bearna area which is up to 8.5m deep with excavation of peat, glacial deposits and granite likely.

There is a proposed cut and cover tunnel and open cut commencing in the Rahoon area and finishing near the Upper Newcastle Road/N6 Junction. This would involve extensive deep excavations along the Seamus Quirke Road, Bishop O'Donnell Road, the Western Distributor Road and a large residential area at Rahoon. The tunnel would be approximately 1,300m long. The overburden material would likely consist of glacial till and weathered rock and competent granite at depth. Soft, organic deposits are a possibility and were encountered during previous site investigation works in the area of the junction of Bishop O'Donnell Road and the Seamus Quirke Road (Peters et al., 2012).

A new bridge would be constructed downstream of the Quincentenary Bridge and would require new embankments to be constructed. The embankment on the east side of the river would be constructed over soft ground deposits. The thickness of the soft, compressible deposits varies from 2m to approximately 15m in the vicinity of the Terryland River in Ballinfoyle. Further investigation of the ground along this alignment would be required. There would be a potential impact on the settlement profile and stability of the existing embankment and this would need further assessment. Solutions such as lightweight fill, piled embankments or ground improvement could be used where adverse settlements are predicted.

The Red1 Route Option is elevated on a viaduct over the former Bodkin Roundabout and would travel across, adjacent to and along the route of the Terryland River before connecting to the existing N6. This structure would likely require rock socketed piles to carry the structural loads. Due to the extensive deposits of soft ground in this area, particular attention to the temporary works would be required in order to minimise the risk of instability in the working platform for the piling works.

There is a high embankment over deep deposits of soft ground following on from the viaduct. This embankment would likely require piled foundations or extensive ground improvement to ensure that stability and settlement requirements would be achieved.

The Red1 Route Option runs over an area close to the Coopers Cave, Karst Feature K89, to the rear of Glenanail residential estate. There is a potential impact on the cave complex due to karstic features in their vicinity. The Red1 Route Option enters a cut in the vicinity of the cave complex travelling between the N17 and City East Business Park Junctions. The geology in this area is likely to consist of glacial till over limestone.

Following the cutting between the N17 and City East Business Park Junctions the route follows the existing ground profile before entering a deep cutting at Briarhill which would be approximately 2,000m long and then connects to the existing N6. This cutting would likely be in glacial till and limestone and the depth of the cutting would be up to 15m.

Further investigation would be required in order to determine the geological profile of Red1 Route Option.

Orange1 Route Option

The Orange1 Route Option includes a tunnel beneath the River Corrib and contains a number of significant geotechnical challenges. The principal cuttings and embankments are described in **Tables 6.5.2.3** and **6.5.2.4** and are shown on **Figures 6.5.2.11** to **6.5.2.12**.

Table 6.5.2.3 Principal cuttings along the Orange1 Route Option

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
1	Orange1 C1	Bearna	640	5 - 10	Low
1	Orange1 C3	Ballard West	1170	5 - 10	Medium[1]
2	Orange1 C5	Ballard to Ballyburke	1570	10 - 15	High[1]
2	Orange1 C12	Letteragh	1010	> 15	High[1]
2	Orange1 C13	Terryland	750	10 - 15	Medium
2	Orange1 C14	Glenanail	90	0 - 5	High[2]
2	Orange1 C15	Glenanail to Ballybane	1400	5 – 10	High[3]
2	Orange1 C16	Coolagh to N6	2865	10 - 15	High[4]

Note: In addition to the max cutting depth the location impact is influenced by:

1. *Length of cutting*
2. *Presence of soft ground*
3. *Length of cutting and presence of a number of Karst Features including K89*
4. *Length of cutting*

Table 6.5.2.4 Principal embankments along the Orange1 Route Option

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
2	Orange1 E12	Glenanail	290	0 - 5	High[1]
2	Orange1 E13	Glenanail	110	0 - 5	High[1]

Note: In addition to the max embankment depth the location impact is influenced by:

1 *Presence of soft ground*

The following features are associated with the principle cuttings and embankments and associated infrastructure provision for the Orange1 Route Option.

This Orange1 Route Option commences in a cutting in the Bearna area which would be up to 8.5m deep with the excavation of peat, glacial deposits and granite likely.

Further cuttings up to 8m deep would be required in the western extent of this route option approaching the proposed tunnel portal.

In areas where the option is close to grade in the western extent of the route option, it is possible that peat and other soft deposits may need to be excavated and replaced with materials to support the roadbed.

This route option enters a deep cutting in the Letteragh area to form a junction with the proposed N59 link road. The cutting would increase to a maximum depth of 30 – 35m to form the tunnel entrance. This depth of cutting is significantly deeper and more extensive than any existing road cutting in Ireland. This cutting would likely incorporate a series of benches to ensure that the stability of the face is satisfactory or alternative construction methodologies could be considered.

This route option enters a tunnel at Letteragh and emerges in Terryland Park area. It is envisaged that this tunnel would be formed using a tunnel boring machine for a number of reasons, namely:

- The tunnel would travel under residential areas at Newcastle and Castlelawn Heights where settlement control may be more onerous than under greenfield sections;
- The tunnel would travel under mixed face conditions between the differing bedrock types. A tunnel boring machine (TBM) would be able to control tunnelling operations to a greater extent; and
- The tunnel would travel through karstic limestone under the River Corrib, consequently groundwater control measures would need to be given high consideration during the construction and design life of the tunnel.

Additional ground investigation would be required in order to develop tunnelling solutions. It is noted that the geological risks associated with tunnelling can only be partly mitigated by pre-works ground investigation. Modification to the works may be required depending on the results of probing and ground investigation during the works.

The Orange1 Route Option emerges from the tunnel in the Terryland Park area into an area of soft ground with outcrops of glacial till. A deep excavation supported by a retaining wall would likely be required. The impact of the cutting on the existing N6 would need to be carefully assessed during the design stage. Where the road is shown as a shallow cut it is likely that ground improvement may still be required in order to ensure post construction displacements would be tolerable.

There is an interchange proposed in the Terryland Park area over deep deposits of soft ground. The embankments associated with this interchange would likely require piled foundations or extensive ground improvement to ensure that stability and settlement requirements would be achieved.

The Orange1 Route Option traverses an area close to the Coopers Cave complex Karst Feature K89. There would be a potential impact on the Cave complex due to karstic features in their vicinity.

Following the cutting between the N17 and City East Business Park Junctions, the route follows the existing ground profile before entering a deep cutting, up to 15m, at Briarhill which is approximately 2,800m long.

Further investigation would be required in order to determine the geological profile of Orange1 Route Option.

Yellow1 Route Option

The Yellow1 Route Option has a number of significant geotechnical challenges. The impact of each cut and fill section is assessed and presented in **Tables 6.5.2.5** and **6.5.2.6** and shown on **Figure 6.5.2.11** to **6.5.2.12.**

Table 6.5.2.5 Principal cuttings along the Yellow1 Route Option

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
2	Yellow1 C7	Ballyburke	170	5 - 10	Low
2	Yellow1 C10	Dangan	490	10 - 15	Medium
2	Yellow1 C12	Coolagh	490	5 - 10	Low
2	Yellow1 C13	Ballybrit	1280	5 - 10	High[1]
2	Yellow1 C14	Coolagh to N6	2857	10 - 15	High[2]

Note: In addition to the max cutting depth the location impact is influenced by:

1. *Length of cutting and the presence of a number of Karst Features including K89*
2. *Presence of Karst Features*

Table 6.5.2.6 Principal embankments along the Yellow1 Route Option

Section	Name	Location	Length (m)	Max embankment height (m)	Level of impact
1	Yellow1 E3	Na Foraí Maola Thiar to Thoir	1410	10 - 15	High[1]
1/2	Yellow1 E4	Trusky Thiar to Thoir	2410	10 - 15	High[2]
2	Yellow1 E7	Ballyburke	600	5 - 10	Low
2	Yellow1 E8	Keeraun	1160	10 - 15	High[1]
2	Yellow1 E9	Keeraun	180	5 - 10	Low
2	Yellow1 E10	Letteragh	670	5 - 10	Low
2	Yellow1 E11	Upper Dangan	1200	10 - 15	High[2]

Section	Name	Location	Length (m)	Max embankment height (m)	Level of impact
2	Yellow1 E12	River Corrib to Coolagh	1480	> 15	High[2]
2	Yellow1 E14	Ballinfoyle to Castlegar	980	10 - 15	High[3]

Note: In addition to the max embankment depth the location impact is influenced by:

1. *Length of embankment*
2. *Length of embankment and the presence of soft ground*
3. *Presence of soft ground*

The following features are associated with the principle cuttings and embankments and associated infrastructure provision for the Yellow1 Route Option.

In areas where the Yellow1 Route Option is close to grade in the western extent of this route option, it is possible that peat and other soft deposits may need to be excavated and replaced with materials to support the roadbed.

High embankments are required on this option to accommodate various bridges. There is a deep cutting in the Dangan area on the Yellow1 Route Option. The maximum depth of this cutting is approximately 14m and would likely be partly in Errisbeg Granite.

The Yellow1 Route Option is on embankments up to 14m high in Upper Dangan before crossing the River Corrib. Boreholes in the vicinity of the proposed bridge suggest that competent limestone is located at 5m – 10m below ground level.

East of the River Corrib in the Menlough area, this route option, outside viaduct areas, is on embankment. The foundation soils are largely glacial till over limestone bedrock. Potential geohazards from karst in the limestone need further investigation. **Figure 6.5.2.6** shows the option being underlain by alluvium for a short section. The nature and extent of these deposits would need further assessment.

This route option enters a cutting in the Coolagh area before emerging onto embankment again in the Ballinfoyle area. This route option impacts on residential developments in the area where there is a low potential for encountering contaminated ground associated with the construction of the development.

This route option is on high embankment in a soft ground area adjacent to the Terryland River Valley in Ballinfoyle. The embankments associated with this junction would likely require piled foundations or extensive ground improvement to ensure that stability and settlement requirements would be achieved.

Similar to the Red1 and Orange1 Route Options the Yellow1 Route Option runs over an area close to the Karst feature K89, Coopers Cave complex and a deep cutting, up to 15m, at Briarhill which is approximately 2,800m long and connects to the existing N6.

Further investigation is required in order to determine the geological profile of Yellow1 Route Option

Blue1 Route Option

The Blue1 Route Option includes tunnels beneath the Lough Corrib cSAC and Galway Racecourse and include a viaduct in the Menlough area. The impact of each cut and fill section is assessed and presented in in **Tables 6.5.2.7** and **6.5.2.8** and are shown on **Figures 6.5.4.11** to **6.5.4.12**.

Table 6.5.2.7 Principal cuttings along the Blue1 Route Option

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
1/2	Blue1 C1	An Chloch Scoilte to Aille	950	5 - 10	Low
2	Blue1 C4	Keeraun	310	10 - 15	Medium
2	Blue1 C8	Barnacranny to Dangan Upper	500	10 - 15	Medium
2	Blue1 C9	Menlough to Coolagh	320	> 15	High
2	Blue1 C10	Coolagh	50	5 - 10	Low
2	Blue1 C11	Lackagh Quarry	150	> 15	High
2	Blue1 C13	Castlegar	520	5 - 10	Low
2	Blue1 C14	Parkmore to N6	3170	> 15	High[1]

Note: In addition to the max cutting depth the location impact is influenced by:

1. *Length of cutting and presence of Karst Features*

Table 6.5.2.8 Principal embankments along the Blue1 Route Option

Section	Name	Location	Length (m)	Max embankment height (m)	Level of impact
1	Blue1 E1	Trusky East	1305	5 - 10	Medium[1]
2	Blue1 E2	Aille	110	5 - 10	Low
2	Blue1 E3	Aille to Ballnahown East	1190	10 - 15	High[1]
2	Blue1 E6	Keeraun to Mincloon	1020	10 - 15	High[1]
2	Blue1 E7	Rahoon	180	5 - 10	Low
2	Blue1 E8	Rahoon Barnacranny	660	5 - 10	Low
2	Blue1 E9	Dangan Upper to River Corrib	1210	10 - 15	High[2]
2	Blue1 E10	Menlough	580	> 15	High[2]
2	Blue1 E11	Menlough	120	0 - 5	Medium[3]
2	Blue1 E12	Lackagh Quarry	370	10 - 15	Medium

Section	Name	Location	Length (m)	Max embankment height (m)	Level of impact
2	Blue1 E13	Ballindooley to Castlegar	680	> 15	High[4]
2	Blue1 E14	Castlegar	310	10 - 15	Medium
2	Blue1 E15	Cappanabornia	460	10 - 15	Low[5]

Note: In addition to the max embankment depth the location impact is influenced by:

1. *Length of Embankment*
2. *Presence of soft ground and karst features*
3. *Presence of karst features*
4. *Presence of soft ground*
5. *Embankment is generally less than 10m*

The following features are associated with the principle cuttings and embankments and associated infrastructure provision for the Blue1 Route Option.

In areas where the option is close to grade in the western extent of the scheme, it is possible that peat and other soft deposits may need to be excavated and replaced with materials to support the roadbed.

The route option enters a cutting in the Chloch Scoilte area. The maximum depth of the cutting would be approximately 9m and the excavation would extend into the granite.

The option proceeds on embankment and enters a cutting in the Ballyburke area with a maximum depth of approximately 11m. The option is supported on embankments with occasional shallow cuts until the option enters a deep cutting in the Dangan area. The maximum depth of this cutting would be approximately 14m and would likely be partly in Errisbeg Granite.

This route option is on embankments up to 14m high in Upper Dangan before crossing the River Corrib. Boreholes in the vicinity of the proposed bridge suggest that competent limestone is located at 5m – 10m below ground level in this area. It is likely that rock socketed piles would be used to support the bridge foundations.

This route option, outside viaduct areas in the Menlough area is on embankment. The foundation soils in this area are largely glacial till over limestone bedrock. Potential geohazards from karst in the limestone would need further investigation at detailed design stage.

A tunnel is proposed adjacent to Lackagh Quarry and underneath the Lough Corrib cSAC. This tunnel is proposed to avoid significant impacts on areas of environmental importance. The tunnel would likely be formed using either, drill and blast, roadheader or a tunnel boring machine. There are a greater number of options for forming the tunnel for this option than the tunnel for the Orange1 Route Option for the following reasons:

- The tunnel would be at a higher elevation than the River Corrib, groundwater control measures during the construction and design life of the tunnel may not be as problematic as the Orange1 Route Option; and
- Visual exposure of the limestone is available at Lackagh Quarry. The bedding of the rock appears favourable although the presence of faults in the rock face is evident. Support from rock bolts could be used to mitigate these unfavourable conditions.

The tunnel will emerge into the Lackagh Quarry and be supported on an embankment as the vertical alignment rises. A combination of cuttings against the quarry face on the southern side and embankment on the northern side of the route option would be used. The stability of the existing quarry face would require closer assessment and some remediation such as rock netting, rock traps or rock bolts.

This route option enters a cut and cover tunnel at the Galway Racecourse. This tunnel would likely involve excavation of glacial till and limestone bedrock. Surface reinstatement requirements would have to be determined through discussions with the Galway Racecourse.

Following the cut and cover tunnel the route enters a deep cutting through Briarhill which is approximately 3,000m long and connects to the existing N6. This cutting would likely be in glacial till and limestone and the depth of the cutting would be up to 15m.

Further investigation is required in order to determine the geological profile of Blue1 Route Option.

Pink1 Route Option

The Pink1 Route Option includes tunnels beneath the Lough Corrib cSAC and north of Galway Racecourse and a viaduct in the Menlough area. The impact of each cut and fill section is assessed and presented in **Tables 6.5.2.9** and **6.5.2.10** and are shown on **Figures 6.5.5.11** and **6.5.5.12**.

Table 6.5.2.9 Principal cuttings along the Pink1 Route Option from Lackagh Quarry to the N6

Section	Name	Location	Length (m)	Max cutting depth (m)	Level of impact
1-2	Pink C3	An Chloch Scoilte	900	5 - 10	Low
2	Pink C6	Ballyburke	320	10 - 15	Low[1]
2	Pink C10	Letteragh	490	10 - 15	Medium
2	Pink C11	Coolagh	310	10 - 15	Medium
2	Pink C12	Lackagh Quarry	60	5 - 10	Low
2	Pink C13	Lackagh Quarry	150	> 15	High
2	Pink C15	Castlegar	600	5 - 10	Low
2	Pink C16	Cappanabornia to N6	3110	10 - 15	High[2]

Note: In addition to the max cutting depth the location impact is influenced by:

1. *Cutting is generally less than 10m*
2. *Length of cutting and presence of karst features.*

Table 6.5.2.10 Principal embankments along the Pink1 Route Option from Lackagh Quarry to the N6

Section	Name	Location	Length (m)	Max embankment height (m)	Level of impact
1	Pink E1	Bearna	330	5 - 10	Low
2	Pink E4	Ballard East	100	5 - 10	Low
2	Pink E5	Cappagh Road	1190	5 - 10	Medium[1]
2	Pink E8	Ballyburke to Rahoon Road	1010	10 - 15	High
2	Pink E9	Letteragh	180	5 - 10	Low
2	Pink E10	Letteragh	670	5 - 10	Low
2	Pink E11	Dangan	1200	10 - 15	High[2]
2	Pink E12	Menlough	280	10 - 15	High[3]
2	Pink E14	Lackagh Quarry	360	10 - 15	Medium
2	Pink E15	Ballindooley	680	> 15	High[3]
2	Pink E16	Castlegar	300	10 - 15	Medium
2	Pink E17	Cappanabornia	390	5 - 10	Low

Note: In addition to the max embankment depth the location impact is influenced by:

1. *Length of embankment*
2. *Length of embankment, presence of soft ground and presence of karst features*
3. *Presence of soft ground*

The following features are associated with some of the principle cuttings and embankments and associated infrastructure provision for the Pink1 Route Option.

In areas where the option is close to grade in the western extent of the scheme, it is possible that peat and other soft deposits may need to be excavated and replaced with materials to support the roadbed.

There is a deep cutting in the Dangan area on the Pink1 Route Option. The maximum depth of this cutting is approximately 15m – 20m and would likely be partly in Errisbeg Granite.

This route option is on embankments up to 15m high in Upper Dangan before crossing the River Corrib. Boreholes in the vicinity of the proposed bridge suggest that competent limestone is located at 5m – 10m below ground level in this area.

This route option, outside viaduct areas in the Menlough area is on embankment. The foundation soils in this area are largely glacial till over limestone bedrock.

Potential geohazards from karst in the limestone would need further investigation at detailed design stage.

A tunnel is proposed adjacent to Lackagh Quarry and underneath the Lough Corrib cSAC. This tunnel is proposed to avoid significant impacts on areas of environmental importance. The tunnel would likely be formed using either, drill and blast, roadheader or a tunnel boring machine. There are a greater number of options for forming the tunnel for this option than the tunnel for the Orange1 Route Option for the following reasons:

- The tunnel would be at a higher elevation than the River Corrib groundwater control measures during the construction and design life of the tunnel may not be as problematic as the Orange1 Route Option;
- Visual exposure of the limestone is available at Lackagh quarry. The bedding of the rock appears favourable although the presence of faults in the rock face is evident. Support from rock bolts could be used to mitigate these unfavourable conditions.

The tunnel emerges into Lackagh Quarry and is supported on an embankment as the alignment rises. Acombination of cuttings against the quarry face on the eastern side and embankment on the western side would be used. The stability of the existing quarry face would require closer assessment and remediation such as rock netting, rock traps or rock bolts.

This route option enters a cut and cover tunnel north of Galway Racecourse. This tunnel would likely involve excavation of glacial till and limestone bedrock. Reinstatement requirements would have to be determined through discussions with the Galway Racecourse and relevant stakeholders.

Following the cut and cover tunnel the route enters a deep cutting connecting to the proposed interchange with the existing N6. The ground conditions consist of a thin covering of glacial till over limestone bedrock. No soft ground would be anticipated at this junction. Some karst features in the form of springs are noted on the mapping but are not evident in the field. Additional ground investigation would be required at detailed design stage in order determine if karst features are present.

Further investigation is required in order to determine the geological profile of Pink1 Route Option

Green1 Route Option

The Green1 Route Option is the longest route option presented. The route option does not contain a tunnel but the river crossing is located in a challenging location in terms of soils and geology. The impact of each cut and fill section is assessed and presented in **Tables 6.5.2.11** and **6.5.2.12** and are shown on **Figure 6.5.6.11** to **6.5.6.12**.

Table 6.5.2.11 Principal cuttings along the Green1 Route Option

Section	Name	Location	Length	Max cutting depth (m)	Level of impact
1	Green C4	Trusky East	80	0 - 5	High[1]
2	Green C11	Ballyburke	100	5 - 10	Low
2	Green C15	Páirc na gCapall	660	10 - 15	Low[2]
2	Green C18	Ballygarraun	470	5 - 10	Low
2	Green C19	Ballygarraun	130	5 - 10	Low
2	Green C20	Parkmore to Breanloughaun	3050	> 15	High
2	Green C21	Garraun North	40	0 - 5	Medium[3]

Note: In addition to the max cutting depth the location impact is influenced by:

1. *Presence of soft ground*
2. *Cutting is generally less than 10m*
3. *Karst features present*

Table 6.5.2.12 Principal embankments along the Green1 Route Option

Section	Name	Location	Length	Max embankment height (m)	Level of impact
1	Green E1	Na Foraí Maola Thoir	1300	5 - 10	Medium[1]
1	Green E3	Troscaigh East	130	0 - 5	High[2]
1	Green E4	Troscaigh East	30	0 - 5	High[2]
1 / 2	Green E6	Ballard West	1510	10 - 15	High[1]
2	Green E9	Ballyburke	640	5 - 10	Low
2	Green E11	Keeraun	640	5 - 10	Low
2	Green E14	Keeraun	1030	10 - 15	High[3]
2	Green E15	Páirc na gCapall to River Corrib	1370	> 15	High[4]
2	Green E16	River Corrib to Menlough	2530	10 - 15	High[4]
2	Green E17	Menlough to Killoughter	730	5 - 10	Low
2	Green E19	Ballindooley	1120	> 15	High[4]
2	Green E20	Ballygarraun	230	5 - 10	Low
2	Green E21	Cappanabornia	450	5 - 10	Low

Note: In addition to the max embankment depth the location impact is influenced by:

1. *Length of embankment*
2. *Presence of soft ground*

3. *Length of embankment and presence of soft ground*
4. *Length of embankment, presence of soft ground and presence of Karst Features*

The Green1 Route Option commences at the most western commencement point of the route options at this Stage and follows the same profile as the Yellow1 Route Option until the townland of Mincloon when the alignment moves north towards Tonabrocky.

The route option is supported on a mixture of cuttings and embankments. Peat and soft ground may need to be excavated and replaced with competent fill to meet long term settlement and stability criteria where encountered.

The route option enters a cutting in Páirc na gCapall and the maximum depth of the cutting is approximately 15m. The cutting is likely to encounter the Erris Beg granite. Further information on the stratification is required for this area.

The route option rises onto embankment at Bushypark and crosses over the N59. The approach embankment to the River Corrib Bridge is likely to encounter peat and other soft deposits in the flood plain of the river. The high embankment is likely to require pile foundations or extensive ground improvement to meet the settlement and stability criteria.

The proposed bridge foundations are likely to require pile foundations. Previous studies at a proposed river crossing north of the Green1 Route Option crossing suggested that there is a buried glaciated channel. The extent of the glaciated channel has not been determined. If the channel is present under the proposed river crossing longer and/or more piles are likely to be required to support the bridge.

The need to use a piling rig also brings impacts in terms of getting the heavy plant safely into position. It may be necessary to consider options such as a temporary piled structure or placing a heavily reinforced working platform on the soft ground to accommodate the weight of the piles, piling rig and any cranes and beams required to construct the bridge. Alternatively a barge may be moored into position at the foundations to accommodate the foundation equipment.

On the east side of the river the option is supported on embankments typically founded on glacial till overlying limestone bedrock. Shallow peaty deposits are likely to be encountered in depressions. A very high embankment (*c.*21m) will span across the low lying area near Ballindooley Lough. Ground investigation is required to determine the presence of soft ground in this area.

The route option enters a cutting in limestone in Ballygarraun where the maximum depth of the cutting is approximately 9m. It is likely that karst features will be encountered in the limestone. Further investigation using inclined boreholes and optical televiewers would be required to inform the designers on the optimum slope cutting angle.

The route option goes through the Roadstone Quarry on a 5-10m high embankment with one section of cutting.

The route option enters a deep cutting (maximum depth of approximately 24.4m) between the N17 Junction to the townland of Breanloughaun. The cutting is located

to the north of the Galway Racecourse and decreases gradually in depth from the north-west to the south-east.

Ground Conditions and Features in Karst Limestone Areas

Each of the route options passes into the limestone region in the vicinity of the existing N59 west of the River Corrib. The eastern part of the scheme study area from the N59 is underlain by clean limestone where karstification has occurred. A range of solution features were found within the scheme study area which are presented and ranked in **Section 4.4**.

Desk and field surveys were undertaken in order to identify and classify the karstic features. The report for these surveys is appended to this report (**Appendix A.4.4 Karst Study Report)** and includes tables and figures detailing the type and location of the features identified.

Given the frequent occurrence of karst features mapped within the scheme study area which were identified during the desk and field surveys, the limestone formations along the options would require further investigation for karstic behaviour during the site investigation for the detailed design stage. It has been assumed that the limestone bedrock is karstified until proven otherwise by ground investigation techniques. The absence of solution features, identified in **Section 4.4** in the limestone bedrock does not necessarily indicate that the rock is not karstified.

Where karst features were identified close to an option the impact assessment is based on geological considerations only. The nature of the karst feature and the potential impact on the route options is considered on an individual basis and a suitable impact level is assigned. The hydrogeology associated with the karst features is discussed in greater detail in **Section 6.5.3**.

The potential impacts are considered to have a permanent duration. Potential geohazards such as sinkholes opening up during construction or the design life of the road are also considered in the following assessments of the stage 1 route options.

Each route is assessed based on the karst feature rankings presented in **Section 4.4.**

<u>Red1 Route Option</u>

The Red1 Route Option travels predominantly through the urban landscape of Galway City. As a result of the highly modified landscape the identification of karst landforms was limited.

In the Terryland area the route option passes through an area where karst is likely to be encountered. A series of enclosed depressions are located within 20m of the option and 80m of the Terryland River swallow hole. The Coopers Cave complex, Karst Feature K89, is present in the area and further non-intrusive and intrusive investigations would be required in order to verify the magnitude of the impact on the cave complex.

At the eastern end of the Red1 Route Option the option passes directly over an enclosed depression and a spring in the area of the N17 Tuam Road. It also passes

within 25m of another potential spring. The impact on the springs would likely be minimal as they could not be located and are currently not in use.

The impact of karst on the Red1 Route Option is assessed as **High**.

Orange1 Route Option

The Orange1 Route Option extends via a tunnel beneath the River Corrib and the limestone bedrock in Terryland. It is possible that the tunnel would encounter karstic features such as caves or preferential flowpaths within the limestone bedrock.

In the Terryland area the route option passes through an area where karst is likely to be encountered. A series of enclosed depressions are located within 20m of the option and 80m of the Terryland River swallow hole. The Coopers Cave complex, Karst Feature K89 is present in the area and further non-intrusive and intrusive investigations would be required in order to verify the magnitude of the impact on the cave complex.

At the eastern end of the Orange1 Route Option, the option passes directly over an enclosed depression and a spring in the area of the N17 Tuam Road. It also passes within 25m of another potential spring. The impact on the springs would likely be minimal as they could not be located and are currently not in use.

The impact of karst on the Orange1 Route Option is assessed as **High**.

Yellow1 Route Option

In the Terryland area the route option passes through an area where karst is likely to be encountered. A series of enclosed depressions are located within 20m of the option and 80m of the Terryland River swallow hole. The Coopers Cave complex, karst Feature K89 is present in the area and further non-intrusive and intrusive investigations would be required in order to verify the magnitude of the impact on the cave complex.

At the eastern end of the Yellow1 Route Option the option passes directly over an enclosed depressions and a spring in the area of the N17 Tuam Road. It also passes within 25m of another potential spring. The impact on the springs would likely be minimal as they could not be located and are currently not in use.

The impact of karst on the Yellow1 Route Option is assessed as **High**.

Blue1 Route Option

The Blue1 Route Option passes through a turlough north of the Coolagh Lakes on a viaduct. The route option also includes a cutting in the area close to the turlough where karstic features may be encountered.

The extent of karst in the proposed tunnels and deep cuttings would require further investigation at detailed design stage as karst features may be present which do not manifest at surface level.

At the eastern end of the Blue1 Route Option, in the Castlegar area the option passes two springs. The impact on the springs on the the route would likely be minimal as they could not be located during the field survey and are currently not in use.

No other karst landforms have been identified directly along the Blue1 Route Option.

The impact of karst on the Blue1 Route Option is assessed as **Medium**.

Pink1 Route Option

The Pink1 Route Option passes through a turlough north of the Coolagh Lakes. The route option also includes a cutting in the area close to the turlough where karstic features may be encountered.

The extent of karst in the proposed tunnels and deep cuttings would require further investigation at detailed design stage as karst features may be present which do not manifest at surface level.

At the eastern end of the Pink1 Route Option in the Castlegar area the option passes two springs. The impact on the springs on the route would likely be minimal as they could not be located during the field survey and are currently not in use.

The impact of karst on the Pink1 Route Option is assessed as **Medium**.

Green1 Route Option

An enclosed depression is located on the Green1 Route Option alignment to the east of the River Corrib in the Upper Dangan area which may indicate the presence of karst. However as the route alignment would be on embankment it would be unlikely that karst would be encountered and the impact due to the presence of karst would likely be minimal.

The Green1 Route Option is the most northerly option and passes to the north of Ballindooley Lough. To the north of Ballindooley Lough the alignment passes directly over an enclosed depression. Although a number of enclosed depressions have been identified in this section, indicating the presence of karst, the route would be on embankment north of Ballindooley Lough, limiting the influence from the underlying karst.

The Green1 Option N84 Link road to the west of Ballindooley Lough passes directly through a turlough. Further non-intrusive and intrusive investigations would be required at detailed design phase to assess the presence of further karstic features which may affect the option.

The impact of karst on the Green1 Route Option is assessed as **Medium**.

Overview of Historical Land Use

Land use within the scheme study area ranges from agricultural to commercial. OSI historical mapping demonstrates the significant development activity within the scheme study area over the past 20 years.

Land use in the western extents of the route options was and is primarily agricultural and residential, whereas, land use to the east of the River Corrib has changed from agricultural to commercial, industrial and residential use in recent years.

The impact of disused and active quarries is assessed in Economic Geology.

The following are historical land use features of the Stage 1 Route Options.

Red1 Route Option

Land use in the western extents of the Red1 Route Option was and is primarily agricultural and residential.

The Red1 Route Option runs predominantly in an urban environment. The area along the Terryland River Valley has not been fully developed, partly due to the presence of soft ground. Historical maps show that this area was prone to flooding. This flooding was alleviated by flood protection works that commenced in the 19th century.

The impact of historical land use on this route option is assessed as **Low** although further investigation at detailed design stage would be required.

Orange1 Route Option

Land use in the western extents of the Orange1 Route Option was and is primarily agricultural and residential.

The area along the Terryland River Valley has not been fully developed, partly due to the presence of soft ground. Historical maps show that this area was prone to flooding. This flooding was alleviated by flood protection works that commenced in the 19th century.

Much of the land use to the east of the River Corrib has changed from agricultural to commercial, industrial and residential use in recent years.

The impact of historical land use on this route option is assessed as **Low** although further investigation at detailed design stage would be required.

Yellow1 Route Option

Land use in the western extents of the Yellow1 Route Option was and is primarily agricultural and residential.

Much of the land use to the east of the River Corrib has changed from agricultural to commercial, industrial and residential use in recent years.

The impact of historical land use on the route is assessed as **Low** although further investigation at detailed design stage would be required.

Blue1 Route Option

Land use in the western extents of the Blue1 Route Option was and is primarily agricultural and residential.

The Blue1 Route Option traverses Lackagh Quarry which is no longer active, the quarry has extended into the surrounding agricultural land. The land use between the Lackagh Quarry and Galway Racecourse is predominantly agricultural and residential. There are a series of commercial properties with an adjacent storage yard housing construction equipment in the N84 area. Additional investigations would be required in this area in order to determine if contaminants are present.

This route option passes existing commercial buildings adjacent to the N17 before entering Galway Racecourse lands. Much of the land use to the east of the River Corrib has changed from agricultural to commercial, industrial and residential use.

The impact of historical land use is assessed as **Low** although further investigation at detailed design stage in order to determine if contaminants are present would be required.

Pink1 Route Option

Land use in the western extents of the Pink1 Route Option was and is primarily agricultural and residential.

The Pink1 Route Option traverses Lackagh Quarry which is no longer active, the quarry has extended into the surrounding agricultural land. The land use between the Lackagh Quarry and Galway Racecourse is predominantly agricultural and residential. There are a series of commercial properties with an adjacent storage yard housing construction equipment in the N84 area. Additional investigations would be required in this area in order to determine if contaminants are present.

This route option passes existing commercial buildings adjacent to the N17 before entering Galway Racecourse lands. Much of the land use to the east of the River Corrib has changed from agricultural to commercial, industrial and residential use.

The impact of historical land use is assessed as **Low** although further investigation at detailed design stage in order to determine if contaminants are present would be required.

Green1 Route Option

Land use in the western extents of the Green1 Route Option was and is primarily agricultural and residential.

Green1 Route Option has a largest footprint of the options conceded area and a greater loss of arable soils in the eastern section of the route option.

The Roadstone Quarry on the Tuam Road has extended its footprint into the surrounding agricultural lands in recent years, the impact of the active quarry is assessed in Economic geology

The impact of historical land use on the Green1 Route Option is assessed as **Low** although further investigation at detailed design stage would be required.

Overview of Economic Geology along each route corridor

Economic geology within the study area is a collective name for man-made features which include pits, quarries, contaminated sites, landfills and licensed industrial and agricultural facilities.

Red1 Route Option

The following are economic geology features of the Red1 Route Option.

The Red1 Route Option, at its western connection to the R336 is within approximately 70m of an area which contains Iron (Fe), Molybdenum (Mo) and Copper (Cu) mineral resources. (**Figure 6.5.2.1**).

Red1 Route Option traverses two small historic quarries located close to the N6/N84 Junction, through a number of historical quarries in the Terryland River Valley area and two historical quarries at the N6/N17 junction. (**Figure 6.5.2.1** and **6.5.2.2**).

The impact of the Red1 Route Option on Economic Geology is **Low**

Orange1 Route Option

The Orange1 Route Option in part is within approximately 70m of an area which contains Iron (Fe), Molybdenum (Mo) and Copper (Cu) mineral resources.

At the N6/N59 Junction the route passes approximately 80m from an area identified as containing granite mineral resources.

Similar to the Red1 Route Option the Orange1 Route Option traverses through a number of historic quarries located close to the N6/N84 Junction, the Terryland River Valley area and the N6/N17 Junction. (**Figure 6.5.2.1** and **6.5.2.2**).

The impact of the Orange1 Route Option on Economic Geology is **Low**.

Yellow1 Route Option

The Yellow1 Route Option passes within 100m of CU, Fe and Mo mineral resources at the western tie-in to the R336 (**Figure 6.5.2.1**).

The Yellow1 N59 Link Option passes within 60m of a historical quarry and an area which contains granite mineral resources.

The route traverses historical quarries where Yellow1 Route Option joins the existing N6 near the Terryland River. The route passes through a larger historical quarry at the N6/N17 Junction. .

The impact of the Yellow1 Route Option on Economic Geology is **Low**.

Blue1 Route Option

The Blue1 Route Option at the western tie in of the Bearna Relief Road is within approximately 70m of an area which contains Fe, Mo and Cu mineral resources. (**Figure 6.5.2.1**).

The Blue1 N59 Link Option passes within 60m of a historical quarry and an area which contains granite mineral resources.

The Blue1 Option traverses Lackagh Quarry which is no longer active.

The impact of the Blue1 option on Economic Geology is **Low**.

Pink1 Route Option

Similar to the Blue1 Route Option the Pink1 Route Option passes within approximately 70m of an area which contains Fe, Mo and Cu mineral resources, within 60m of a historical quarry and an area which contains granite mineral resources. (**Figure 6.5.2.1**).

The Pink1 Route Option traverses Lackagh Quarry which is no longer active.

The impact of the Pink1 Route Option on Economic Geology is **Low**.

Green1 Route Option

The Green1 Route Option at its western tie in to the R336 is within 100m of CU, Fe and Mo mineral resources (**Figure 6.5.2.1**).

The alignment goes directly through the active Roadstone Quarry at Twomileditch. According to historical OSI aerial photography, between 2000 and 2005 the quarry has been extended to the south east to include the area traversed by the Green1 Route Option. The impact of the route option on the quarry would be high as the route would sterilise a significant working area of the quarry.

The impact of the Green1 Route Option on Economic Geology is **High** due to the impact on the Roadstone Quarry, Twomileditch.

Geological Heritage Assessment

The geological heritage constraints within the scheme study area have been identified in **Section 4.4** and are detailed on **Figures 6.5.2.1** and **6.5.2.2**. Potential impacts are based on the proximity of the option to the sites and the classification thereof.

Red1 Route Option

The Barna Drumlin Swarm is a County Geological Site (CGS) is located within 500m of the Red1 Route Option and is therefore, unlikely to be impacted by the road or provide geological heritage benefits to the road users.

This route option would involve deep excavations in bedrock across the city and would expose a variety of bedrock types. These temporary exposures would provide greater information on the bedrock geology of Galway City which could be considered as a beneficial impact of this route option.

The impact of the Red1 Route Option on geological heritage is assessed as **Low**.

Orange1 Route Option

The Barna Drumlin Swarm is located within 500m of the Orange1 Route Option and is therefore, unlikely to be impacted by the road or provide geological heritage benefits to the road users.

This route option would involve deep excavations in bedrock across the city and would expose a variety of bedrock types. These temporary exposures would provide greater information on the bedrock geology of Galway City which could be considered as a beneficial impact of this route option.

The impact of the Orange1 Route Option on Geological Heritage is assessed as **Low**.

Yellow1 Route Option

There are no geological heritage sites on the Yellow1 Route Option. The impact on geological heritage is **Low**.

Blue1 Route Option

The Barna Drumlin Swarm located within 500m of the Blue1 Route Option and is therefore, unlikely to be impacted by the road or provide geological heritage benefits to the road users.

The Lackagh Quarry is not a designated geological heritage site according to the GSI. However, The Blue1 Route Option would enter Lackagh Quarry and present panoramic views of extensive rock cuttings on a scale not present on any Irish road.

This route option would involve deep excavations in bedrock across the city and would expose a variety of bedrock types. These temporary exposures would provide greater information on the bedrock geology of Galway City which could be considered as a beneficial impact of this route option.

The impact of the Blue1 Route Option on geological heritage is assessed as **Low**

Pink1 Route Option

The Barna Drumlin Swarm is located within 500m of the Pink1 Route Option and is therefore, unlikely to be impacted by the road or provide geological heritage benefits to the road users.

The Pink1 Route Option would also enter Lackagh Quarry and present panoramic views of extensive rock cuttings.

This route option would involve deep excavations in bedrock across the city and would expose a variety of bedrock types. These temporary exposures would provide greater information on the bedrock geology of Galway City which could be considered as a beneficial impact of this route option.

The impact of the Pink1 Route Option on geological heritage is assessed as **Low**.

Green1 Route Option

The Roadstone Quarry at Twomileditch is a designated county geological site (CGC) due to its national/local geological heritage importance. The quarry contains clay wayboards, equivalent to the Ailween Member (terraced limestones) of the Burren formation. The Green1 Route Option would traverses the quarry, opening up the quarry and extensive exposure of the bedrock to the public.

A second CGS is located approximately 250m from the Green1 Route Option near Menlough. This feature is a mushroom rock which, along with other similar rocks nearby, indicates former lake levels. The impact of the Green1 Route Option on this site is assessed as negligible.

The impact of the Green1 Route Option is assessed as **High** due to the partial loss of the quarry face.

6.5.2.4 Summary

The impact for the route options have been assessed and ranked based on

- Cut and fill;
- Ground conditions including features in Karst Limestone Areas;
- Historical Land use;
- Economic Geology; and
- Geological Heritage Areas.

The route option preference is presented in **Table 6.5.2.13** for Section 1 and 2 as outlined in **Section 6.1**.

Table 6.5.2.13 Summary of Soils and Geology ranking of Route Options

Route Option	Section 1	Section 2
Red1	P	LP
Orange1	P	LP
Yellow1	LP	I
Blue1	P	I
Pink1	P	I
Green1	I	P

Note: Preferred (P), Intermediate (I) or Least Preferred (LP)

Section 1

The Green1 and Yellow1 Route Options have the largest footprint and therefore would likely require the greatest volume of peat to be removed. In addition, Yellow1 Route Option has an embankment greater than 10m. The rest of the options are very similar. The Blue1 and Pink1 Route Options have marginally larger footprints than Red1 and Orange1 Route Options. The differences between the Red1, Orange1, Blue1 and Pink1 options are marginal and all are deemed acceptable.

Section 2

The Green1 Route Option is marginally preferable to Yellow1, Blue1 and Pink1 Route Options from a soils and geology perspective. The route option does not involve a bored or cut and cover tunnel and the risks associated with tunnelling. However, the river crossing is located at a soft ground area and a piled embankment or staged construction would be required. The bridge foundations may be more complex than other options further downstream due to the presence of an in-fill valley feature and the very soft, compressible soils on the approaches to the bridge. The footprint of the route option is the longest. However, the vertical profile contains modest cuts similar to those used on many other Irish schemes in limestone

and granite. The Green1 Route Option has the highest impact on land use, Geological Heritage and Economic Geology.

The Yellow1 Route Option has a more preferable river crossing than the Green1 Route Option and the approach embankments would likely be constructed using conventional construction techniques. The Yellow1 Route Option avoids the tunnel used in the Blue1 or Pink1 Route Options and the surface option would be deemed as more preferable. The route option will pass over deep deposits of soft, compressible soils in the Terryland River Valley and comes close to Karst feature K89, Coopers Cave. The cut and cover tunnel will involve excavation of glacial till and limestone and presents less risk than a bored tunnel.

The Pink1 Route Option has a more favourable river crossing location than the Green1 Route Option. The tunnel section carries more risk at this stage than surface options or cut and cover tunnels. However, the tunnel will be launched from an existing quarry, avoiding the need for a deep launch shaft, and does not pass under a water body, reducing the risk from groundwater inundation considerably. The western section of the route option contains some large cuttings which would generate aggregate for the construction of the route option. The exposure of the rock and enhancement of the geological heritage would be considered as a mitigating measure. The Pink1 Route Option adopts a cut and cover tunnel to the north of the Galway Racecourse.

The Blue1 Route Option is similar to the Pink1 Route Option. The cut and cover tunnel under the Galway Racecourse is adopted and would require excavations in glacial till and limestone rock. The reinstatement of the ground over the tunnel would take time to achieve a satisfactory surface for the Galway Racecourse.

The Red1 Route Option is mostly in an urban environment and the vertical profile of the road lowered along long sections of the route option. The Red1 Route Option has a tunnel in a residential area which could be constructed using a bored option or a cut and cover option. The cut and cover tunnel along the R338 would likely require excavation of granite and metasediments to achieve the appropriate depth of excavation. The route option passes over the River Corrib and is routed through very soft, compressible soils in the Terryland River Valley. Pile foundations or significant ground improvement measures are likely to be required along much of the route option in the soft ground areas.

The Orange1 Route Option is the least preferred option from a soils and geology perspective. The route option involves the construction of a bored tunnel through a variety of bedrock conditions. The tunnel will be launched on the west side in granite bedrock. Blasting would be required to lower the road profile to a sufficient depth to commence boring. A tunnel boring machine is likely to be required to form the tunnel under the residential areas in Newcastle. The progress through the hard granite and Metasediments/Metagabbro/Othogneiss rocks is likely to be slower than in the limestone. The tunnel will pass through a series of contact regions between Granite and Metagabbro/Orthogneiss and then the limestone and Metagabbro/Orthogneiss which presents challenges to the tunnelling operations. The tunnel will pass under the River Corrib ingress of water into the tunnel which would be a high concern and appropriate equipment and controls would need to be assessed. The limestone is rich in karstic features which present challenges in terms

of control of the excavation when voids are encountered and groundwater control. The tunnel also passes under residential areas in Terryland where settlement control under the tunnel alignment may necessitate grouting and other mitigation measures. The tunnel portal would likely be constructed somewhere close to the N84/N6 Junction. The mainline alignment would need to be lowered in an area of soft, compressible ground to enter and exit from the tunnel. The impact of these works on the adjacent N6 road networks would need careful examination.

6.5.2.5 References

National Road Authority. (2009) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.*

Peters, M., Wilkins, A and O'Brien, A. (2012) *'Role of geotechnical temporary works on infrastructure construction in Ireland', Proc. Geotechnics on Irish Roads, 2000 – 2010:* A decade of achievement, Geotechnical Society of Ireland. Pp.110 to 136.

6.5.3 Hydrogeology

6.5.3.1 Introduction

This section details the stage 1 assessment of the route options with respect to the hydrogeology constraints identified in **Section 4.5 Hydrogeology**. The route options as described in **Section 6.1** with the hydrogeology constraints presented in **Figure 6.5.3.1** and **6.5.3.2** for water dependant receptors. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.3.2 outlines the methodology that was used to carry out the study and **Section 6.5.3.3** details the options assessment. Principal cuttings referred to in **Section 6.5.3.3** are presented in **Figures 6.5.2.11 and 6.5.2.12.** A summary is presented in **Section 6.5.3.4** and references are listed in **Section 6.5.3.5**.

6.5.3.2 Methodology

The assessment is undertaken in line with NRA (2008) Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.

This stage 1 assessment involved the assessment of each route option using data presented in the constraints study to identify potential impacts on water dependant receptors, which include water dependent habitats and groundwater abstractions. This assessment highlights those water dependant receptors considered to be at risk from the route options presented but at this time data is not available to quantify risk and for this stage qualitative assessments are provided.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

Overview of Hydrogeology

The hydrogeological characteristics between west and east scheme study area are substantially contrasting. In the west with granite and orthogneiss are classified as a poor aquifer with groundwater being a limited resource, whilst in the east the Visean Undifferentiated limestone is considered a regionally important aquifer. The characteristics of both aquifers are summarised below.

The main features of groundwater flow in the granite and orthogneiss are summarised as follows:

- Groundwater levels in the granite bedrock are generally shallow and within 3m of ground level;
- The groundwater table generally correlates with the surface topography;
- Groundwater flows towards the coast i.e. southwards and south eastwards;

- The aquifer has a generally low permeability, except for local zones where there is weathering and fracturing near fault lines; and
- The major groundwater pathway will be in the weathered zone, which may be deeper along faults and fractures where the permeability can be higher.

The main features of groundwater flow with the productive limestone aquifer are as follows:

- Groundwater levels in the scheme study area are generally flat lying with the dept to groundwater being deeper below higher ground and close to surface where the ground is lower, especially in topographic depressions such as Ballindooley and Coolagh lakes. There is likely to be significant seasonal and storm event variability to water levels;
- The groundwater level contours in karst aquifers tend not to reflect the surface topography. The triple hydraulic properties of karst aquifers (matrix, fracture flow and conduit flow) can generate interactions between pathways that can be complex. However, analyses can give good insight to characterise the aquifer as to which pathway is dominant;
- Comparable with the western part of the scheme study area the regional groundwater flow direction is towards Galway Bay coastline, i.e. to the south and south west;
- Although the regional groundwater flow is in a south or south west direction, local variation in the groundwater flow direction exists; and
- The complexity of the groundwater flow is influenced by:
  - Conduit system in the epikarst within which the groundwater moves rapidly; and
  - Smaller fissures where groundwater flow is slower and is usually linked to the main conduit system.

6.5.3.3 Option Assessment

On the west of the River Corrib the granite and orthogneiss is classified as a Poor Aquifer (Pl) and is generally of low permeability except for weathered and fractured zones near faults where permeability is locally higher. Although the weather zone is likely to be shallow it may locally extend deeper along fracture lines. Groundwater pathways are expected it be of limited connectivity. Water strikes in excavations are likely but inflows moderate to low. A number of WDTE are present on the granite and orthogneiss and an assessment was undertaken to determine impact from each route option.

The flow regime in the regionally important Visean limestone on the east of the River Corrib is dominated by fracture flow as well as conduits. Although the primary permeability is low the fracture and conduit connectivity can provide very high connectivity and storage. Flow pathways can be complicated and potentially can extend over large areas.

Groundwater is likely to be intercepted in excavations and dewatering is likely to be required. Site investigations are required to further develop the understanding of

the hydrogeology and in particular the dependency of water dependent terrestrial ecology (WDTE) on groundwater and their risk from dewatering thereof.

Red1 Route Option

The Red1 Route Option includes an additional bridge over the River Corrib to the south of the existing Quincentenary Bridge and cuttings on both west and east sections. The cuttings will likely intercept groundwater in both western and eastern sections. The cuttings by location are summarised in **Table 6.5.3.1.** As this route option is largely urban it is likely that contaminated ground will be encountered.

Table 6.5.3.1 Cutting location, length and depth range for the Red1 Route Option

Section	Name	Location	Length (m)	Depth Range (m)
1	Red1 C1	Bearna	630	5 - 10
1	Red1 C2	Knocknacarra	20	0 - 5
1	Red1 C3	Ballard West	50	0 - 5
1	Red1 C4	Ballard East	600	0 - 5
2	Red1 C5	Cappagh Road	20	0 - 5
2	Red1 C6	Cappagh Road	40	0 - 5
2	Red1 C7	Cappagh Road	20	0 - 5
2	Red1 C8	Cappagh Road	50	0 - 5
2	Red1 C9	Western Distributor Road	170	0 - 5
2	Red1 C10	Western Distributor Road	180	0 - 5
2	Red1 C11	Western Distributor Road	360	0 - 5
2	Red1 C12	Rahoon to River Corrib	3420	10 - 15
2	Red1 C13	Castlegar	30	0 - 5
2	Red1 C14	Castlegar	140	0 - 5
2	Red1 C15	Castlegar	100	0 - 5
2	Red1 C16	Castlegar to Ballybane	1370	5 - 10
2	Red1 C17	Ballybrit to N6	2858	10 - 15

The western part of the Red1 Route Option (Section 1) commences in rural land and turns eastward skirting up gradient of Annex I wetland habitat. From this point the Red1 Route Option is essentially urban (Section 2), nearing the River Corrib there is a cutting of approximately 9m in depth. This route option bridges over the river and then remains at grade or on embankment. The route makes two crossings of the Terryland River before passing close to where it sinks. There is an 8-16m cutting to the east of Terryland (Ecological Site EC41) and then a further cutting before returning to at-grade when passing the Galway Racecourse. Further east there is another cutting just before the tie-in with the existing N6.

There are four private abstraction wells along the eastern section of the Red1 Route Option, in Sections 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

Excavations along the Red1 Route Option are likely to have inflows but those in the east are more likely to be significant. Ground investigation is required to determine the groundwater dependence of individual WDTE and to quantify if groundwater impacts from the proposal have the potential to impact on these habitats. Additionally, with excavations being urban it is likely that some inflows will be contaminated and as such appropriate treatment will be required prior to being discharged.

Orange1 Route Option

The Orange1 Route Option tunnels beneath the River Corrib. Cuttings are required on the western and eastern sides of the River Corrib through urban areas, with deep cuttings on at the tunnel portals. The cuttings by location are summarised in **Table 6.5.3.2**. As this route is largely urban it is likely that contaminated ground will be encountered.

Table 6.5.3.2 Cutting location, length and depth range for the Orange1 Route Option

Section	Name	Location	Length (m)	Depth Range (m)
1	Orange1 C1	Bearna	640	5 - 10
1	Orange1 C2	Knocknacarra	50	0 - 5
1	Orange1 C3	Ballard West	1170	5 - 10
2	Orange1 C4	Ballard East	160	0 - 5
2	Orange1 C5	Ballard to Ballyburke	1570	10 - 15
2	Orange1 C6	Keeraun	160	0 - 5
2	Orange1 C7	Keeraun	40	0 - 5
2	Orange1 C8	Keeraun	70	0 - 5
2	Orange1 C9	Keeraun	40	0 - 5
2	Orange1 C10	Letteragh	160	0 - 5
2	Orange1 C11	Letteragh	50	0 - 5
2	Orange1 C12	Letteragh	1010	> 15
2	Orange1 C13	Terryland	750	10 - 15
2	Orange1 C14	Glenanail	90	0 - 5
2	Orange1 C15	Glenanail to Ballybane	1400	5 - 10
2	Orange1 C16	Coolagh to N6	2865	10 - 15

It is noted that the footprint of the Orange1 Route Option lies on the periphery of the WDTE EC17-19 and crosses WDTE EC20 as a cutting with a maximum depth of 11.5 m. Water strikes in the cutting are likely but inflows moderate to low.

The desk study indicates that these habitats are likely fed by subsoil groundwater rather than bedrock.

The tunnel extends through a fault zone which may provide an important local groundwater flow pathway. Most of the groundwater movement will be in weathered zone which tends to be shallow but can deepen where fractured. Groundwater pathways are expected to be relatively short with low storage.

The construction of the tunnel has the potential to impact groundwater levels and water quality in the scheme study area. The water table may be impacted by drawdown due to dewatering but also by groundwater rise caused by impoundment of groundwater by the restriction of a flow path. Features in closest proximity to the tunnel are Coolagh Lakes (0.5km) and Ballindooley Lough (2km) both of which are located on the Visean undifferentiated limestones. Further site specific investigation would be necessary to establish the extent of the impact on the hydrogeology and in particular surface water and groundwater interactions at the WDTE. The tunnel emerges into a cutting on the eastern side of the River Corrib. The cutting may have the potential to lower the groundwater levels locally.

East of the tunnel the Orange1 Route Option makes two crossings of the Terryland River. The land use remains urban until the Galway Racecourse, of which it passes to the south at-grade.

There are four private abstraction wells along the eastern part of the Orange1 Route Option, in Section 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

In summary, the tunnel is in close proximity and down gradient of Coolagh Lakes and Ballindooley Lough. Ground investigation is required to determine the groundwater dependence of individual WDTE and to quantify potential groundwater impacts on these habitats. Additionally, with excavations being urban it is likely that some inflows will be contaminated and as such appropriate treatment will be required prior to being discharged.

Yellow1 Route Option

The Yellow1 Route Option skirts around the west of the city and crosses the River Corrib near Coolagh Lakes. On the east of the River Corrib the route option passes to the north of Coolagh Lakes and then across to Terryland where it connects to the existing N6 and follows this road for the remainder of its path. Much of the route option west of the River Corrib is on embankment with three sections of cutting. To the east of the River Corrib this route option has a number of longer cuttings. The cuttings by location are summarised in **Table 6.5.3.3**.

Table 6.5.3.3 Cutting location, length and depth range for the Yellow1 Route Option

Section	Name	Location	Length	Cut Depth Range
1	Yellow1 C1	Na Foraí Maola Thiar	30	0 - 5
1	Yellow1 C2	Na Foraí Maola Thiar	280	0 - 5
1	Yellow1 C3	Troscaigh West	50	0 - 5
2	Yellow1 C4	Ballard East	20	0 - 5
2	Yellow1 C5	Ballard East	20	0 - 5
2	Yellow1 C6	Ballyburke	170	0 - 5
2	Yellow1 C7	Ballyburke	170	5 - 10
2	Yellow1 C8	Keeraun	120	0 - 5
2	Yellow1 C9	Keeraun	20	0 - 5
2	Yellow1 C10	Dangan	490	10 - 15
2	Yellow1 C11	Coolagh	40	0 - 5
2	Yellow1 C12	Coolagh	490	5 - 10
2	Yellow1 C13	Ballybrit	1280	5 - 10
2	Yellow1 C14	Coolagh to N6	2857	10 - 15

The footprint of the Yellow1 Route Option crosses the WDTE EC11 (Section 1) in a small cutting (c.2.5 m) which is unlikely to have significant inflows. The route option also crosses EC18 on embankment and lies on the periphery of WDTE EC12 and EC14 (Section 1 and 2). As the route option passes through the WDTE EC20 it consists of a cutting approximately 10 m which has groundwater inflow and lower groundwater levels. The desk study indicates that these habitats are likely fed by subsoil groundwater rather than bedrock.

This route option is mainly on embankment but there are cuttings in the vicinity of Coolagh Lakes and Terryland River. East of the Coolagh Lakes the Yellow1 Route Option makes two crossings of the Terryland River. The land use remains urban for the remainder of the route.

There are six private abstraction wells along the eastern part of the Yellow1 Route Option, in Section 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

In summary, the Yellow1 Route Option is likely to have a localised impact on the water dependant habitats that it runs close to in the west of the scheme study area and the interaction between surface water and groundwater will require quantification in these areas if this route option was selected. In the east localised impacts will occur in the main cuttings specifically at Terryland but also Coolagh Lakes and these will require assessment.

Blue1 Route Option

The Blue1 Route Option skirts around the west of the city and crosses the River Corrib near Coolagh Lakes. On the east side of the River Corrib the route passes to

the north of Coolagh Lakes where it enters a tunnel that emerges in Lackagh Quarry. This route option then passes to the south of Ballindooley Lough on embankment, and goes into a cutting in Castlegar and into a cut and cover tunnel beneath the racetrack of Galway Racecourse. The cuttings by location are summarised in **Table 6.5.3.4**.

Table 6.5.3.4 Cutting location, length and depth range for the Blue1 Route Option

Section	Name	Location	Length	Cut Depth Range
1	Blue1 C1	An Chloch Scoilte to Aille	950	5 - 10
2	Blue1 C2	Aille	30	0 - 5
2	Blue1 C3	Keeraun	40	0 - 5
2	Blue1 C4	Keeraun	310	10 - 15
2	Blue1 C5	Keeraun	20	0 - 5
2	Blue1 C6	Mincloon	120	0 - 5
2	Blue1 C7	Rahoon	20	0 - 5
2	Blue1 C8	Barnacranny to Danagn Upper	500	10 - 15
2	Blue1 C9	Menlough to Coolagh	320	> 15
2	Blue1 C10	Coolagh	50	5 - 10
2	Blue1 C11	Lackagh Quarry	150	> 15
2	Blue1 C12	Ballindooley	180	0 - 5
2	Blue1 C13	Castlegar	520	5 - 10
2	Blue1 C14	Parkmore to N6	3170	> 15

The footprint of the Blue1 Route Option crosses WDTE EC20 on embankment and then enters a cutting north of EC20. Water strikes in excavations are likely but inflows moderate to low. The route option also lies on the periphery of EC17 and EC18. The desk study indicates that these habitats are likely fed by subsoil groundwater rather than bedrock.

East of the Coolagh Lakes the Blue1 Route Option descends passing into a tunnel that dips to 0.9m above meters sea level (msl) at its deepest point, which is c.16m below the Coolagh Lakes and c.18m below Ballindooley Lough. From Lackagh Quarry the route option emerges in a cutting and then crosses the lowland at Ballindooley Lough on embankment and goes into cutting again at Castlegar before entering a cut and cover tunnel beneath the racetrack of Galway Racecourse.

Construction of the tunnels and cuttings into the Visean undifferentiated will likely have significant groundwater inflows. Construction phase impacts are possible if dewatering is required from driving the tunnel or excavating the cuttings. There may also be a construction phase from dewatering if permanent drains are required or from impoundment if flow paths are intercepted and sealed.

There are four private abstraction wells along the eastern part of the Blue1 Route, in Section 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

In summary the Blue1 Route Option has a tunnel at Lackagh Quarry and Galway Racecourse as well as cutting entrances to both tunnels. The cuttings and tunnels are likely to encounter groundwater inflows and these will likely have an impact on groundwater levels locally. Additional studies are required to determine the degree of impact on groundwater and these need to be quantified in terms of potential indirect impact on WDTE.

Pink1 Route Option

The Pink1 Route Option follows the same path as the Blue1 Route Option as far as Castlegar. It then deviates from the Blue1 Route Option crossing beneath Galway Racecourse to the north of the racetrack itself. The cuttings by location are summarised in **Table 6.5.3.5**.

Table 6.5.3.5 Cutting location, length and depth range for the Pink Route Option

Section	Name	Location	Length	Depth Range
1	Pink1 C1	Ballard West	20	0 - 5
1	Pink1 C2	Ballard West	20	0 - 5
1	Pink1 C3	An Chloch Scoilte	900	5 - 10
1	Pink1 C4	Ballard East	40	0 - 5
2	Pink1 C5	Ballyburke	40	0 - 5
2	Pink1 C6	Ballyburke	320	10 - 15
2	Pink1 C7	Ballyburke	20	0 - 5
2	Pink1 C8	Letteragh	120	0 - 5
2	Pink1 C9	Letteragh	20	0 - 5
2	Pink1 C10	Letteragh	490	10 - 15
2	Pink1 C11	Coolagh	310	10 - 15
2	Pink1 C12	Lackagh Quarry	60	5 - 10
2	Pink1 C13	Lackagh Quarry	150	> 15
2	Pink1 C14	Ballindooley	190	0 - 5
2	Pink1 C15	Castlegar	600	5 - 10
2	Pink1 C16	Cappanabornia to N6	3110	10 - 15

The footprint of the Pink1 Route Option crosses WDTEs EC18 and EC20 on embankments and then enters a cutting north of EC20. The desk study indicates that these habitats are likely fed by subsoil groundwater rather than bedrock.

East of the Coolagh Lakes the Pink1 Route Option passes into a tunnel that dips to 0.9m above msl at its deepest point, which is c.16m below the Coolagh Lakes and c.18m below Ballindooley Lough. Note that as this is the proposed finished road

level the excavation depth may be 5m deeper. From Lackagh Quarry the route option emerges into a cutting and crosses the lowland at Ballindooley Lough on embankment and goes into cutting again at Castlegar before entering a cut and cover tunnel to the north of the racetrack of Galway Racecourse.

Construction of the Lackagh tunnel as well as cuttings in the Visean undifferentiated will likely have significant groundwater inflows. It is likely that there will be a construction phase impact from the tunnel drilling due to dewatering of groundwater intercepted. The construction may have operational impacts and these should be assessed and mitigated against at the design phase to account for potential from impoundment of groundwater if flow paths are intercepted and sealed.

There are eight private abstraction wells along the eastern part of the Pink1 Route Option, in Section 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

In summary the Pink1 Route Option includes a tunnel and cutting in the Visean undifferentiated limestone. These will likely intercept groundwater and these inflows have the potential to impact on groundwater levels during both the construction and operation phase. The design will need to accommodate groundwater flows around the tunnel so that the flow pathway has minimal deviation. Additional studies are required to determine the degree of impact on groundwater and these need to be assessed in terms of potential indirect impact on WDTE. These studies are also required to guide appropriate mitigation measures should this route be selected.

Green1 Route Option

The Green1 Route Option remains mostly at grade or on embankment in the western section of the scheme study area and crosses the River Corrib immediately south of Coolanillaun Wetlands. On the east side of the Corrib the route passes to the north of Lough Corrib cSAC and continues north of Ballindooley Lough on embankment. Continuing to the east the route option passes north of the Galway Racecourse in a cutting. The cuttings by location are summarised in **Table 6.5.3.6**.

Table 6.5.3.6 Cutting location, length and depth range for the Green1 Route Option

Section	Name	Location	Length	Depth Range
1	Green1 C1	Na Foraí Maola Thiar	510	0 - 5
1	Green1 C2	Troscaigh West	220	0 - 5
1	Green1 C3	Troscaigh West	40	0 - 5
1	Green1 C4	Troscaigh East	80	0 - 5
1	Green1 C5	Troscaigh East	40	0 - 5
1	Green1 C6	Troscaigh East	40	0 - 5
2	Green1 C7	Ballard East	30	0 - 5
2	Green1 C8	Ballard East	20	0 - 5
2	Green1 C9	Ballard East	160	0 - 5

Section	Name	Location	Length	Depth Range
2	Green1 C10	Ballyburke	30	0 - 5
2	Green1 C11	Ballyburke	100	5 - 10
2	Green1 C12	Keeraun	100	0 - 5
2	Green1 C13	Keeraun	20	0 - 5
2	Green1 C14	Keeraun	60	0 - 5
2	Green1 C15	Páirc na gCapall	660	10 - 15
2	Green1 C16	Ballindooley	30	0 - 5
2	Green1 C17	Ballindooley	50	0 - 5
2	Green1 C18	Ballygarraun	470	5 - 10
2	Green1 C19	Ballygarraun	130	5 - 10
2	Green1 C20	Parkmore to Breanloughaun	3050	> 15
2	Green1 C21	Garraun North	40	0 - 5
2	Green1 C22	Garraun North	25	0 - 5

The Green1 Route Option is mostly on embankment or at-grade west of the River Corrib with the exception of three cuttings, none of which are within WDTEs and are unlikely to have significant inflows. The route footprint crosses the WDTEs EC11, EC14 and EC20 and lies on the periphery of EC12, EC13, EC17 and EC18. Water strikes in excavations are likely but inflows moderate to low. The desk study indicates that these habitats are likely fed by subsoil groundwater rather than bedrock.

The Green1 Route Option passes north of Ballindooley Lough (EC39) on embankment and then enters a cutting. There are a number of cuttings at the eastern end of the scheme where it passes to the north of the Galway Racecourse. These cutting at its maximum depth would be c.24m deep and is likely to have significant inflows.

There are seven private abstraction wells along the eastern part of the Green1 Route Option, in Section 2, which have the potential to be impacted in terms of quality and quantity of the groundwater resource.

In summary the Green1 Route Option is largely at-grade or on embankment, with one significant cutting in the east of the route option. Cuttings in the east are likely to encounter groundwater these are likely to have significant inflows. Further assessment will be required should this route be selected in order to determine likely impact of the construction and operation phases.

6.5.3.4 Summary

The hydrogeology of the western and eastern sections to the scheme study area have their own characteristics based upon the underlying bedrock, subsoils and soils. In the west the poor bedrock aquifers tend to have limited flow paths and cause ponding above rock head and in the subsoils. In the east the limestone is a regionally

important aquifer and all recharge goes to ground. In this regard there is significant storage in the limestones of the east and a relatively low storage in the granites of the west. As the limestone aquifer is karstic there is also a high connectivity via fracture and conduit pathways and these also include surface landforms such as springs, turloughs, seasonal lakes and enclosed depressions.

All available hydrogeology data for the route options has been assessed. The route option assessments have been made based on this data which include data from the ecologists and geologist. This available data allows a qualitative review of the risks for each route option but there are gaps in the data knowledge that restrict quantification of these risks. Due to these data gaps a conservative approach has been taken that all WDTE identified are groundwater dependant.

These assessments have taken into account the length and depth of cuttings and tunnels for each route option and their proximity to WDTE as well as locations of likely flow paths and connectivity. However, in the absence of quantification of groundwater surface water interactions the assessment remains conservative on the assumption that all water dependant receptors are entirely dependent on groundwater alone.

On this basis then all route options in the western section of the scheme study area rank closely, with the Orange1 and Red1 Route Options ranking as slightly greater risk due to cuttings on those route options. For the route options in the eastern section the Green1 Route Option is considered likely to have the least impact on hydrogeology due to it mainly being at grade or on embankment near the WDTE. However, the Orange1, Blue1 and Pink1 routes all have a greater risk due to the extent and depth of cutting/tunnel in proximity to the WDTE. In particular the proximity of the tunnel on the Blue1 and Pink1 Route Options at Lackagh Quarry to Coolagh Lakes and Ballindooley Lough will need to be quantified. On this basis the Blue1 and Pink1 Route options are considered to be least preferred.

A summary table ranking the route options based upon the data available at this time is presented below. This summary assesses the number of cuttings on each route option, their depth and proximity to water dependant habitats. At this time no weighting factors are applied as to the importance of the water dependant features (either habitat or abstraction wells). These shall be factored in to the Stage 2 assessment.

Table 6.5.3.7 Summary of Hydrogeology rankings of the Route Options

Route Option	Section 1	Section 2
Red1	LP	I
Orange1	LP	I
Yellow1	P	I
Blue1	I	LP
Pink1	I	LP
Green1	P	P

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.3.5 References

National Roads Authority. (2008) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes.*

Ordnance Survey Ireland. (2015) *Current and historical maps, available*; http://maps.osi.ie/publicviewer/#V1,591271,743300,0,10, accessed 23/3/2015.

Geological Survey of Ireland. (2014) *Bedrock Geology 1:100,000, Bedrock Boreholes, Karst Features, Groundwater Aquifers, National Draft Generalised Bedrock map (Groundwater Rock units), National Vulnerability and National Groundwater Recharge maps, available;* www.dcenr.gov.ie, accessed 23/3/2015.

Department of the Environment and Local Government (DELG), the Environmental Protection Agency (EPA) and the Geological Survey of Ireland (GSI). (1999), *Protection Schemes Guidelines, available; http://www.gsi.ie/Programmes/Groundwater/Projects/Protection+Schemes+Guidelines.htm#summary*, accessed 23/3/2015.

6.5.4 Hydrology

6.5.4.1 Introduction

This section details the Stage 1 assessment of the route options with respect to the surface water hydrology constraints identified in **Section 4.6 Hydrology** of this report. The route options as described in **Section 6.1** with the hydrology constraints are presented on **Figures 6.5.4.1** and **6.5.4.2**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.4.2 outlines the methodology that was used to carry out the study and **Section 6.5.4.3** details the options assessment. The impact on each route from west to east for both Section 1 and Section 2 is also described. A summary is presented in **Section 6.5.4.4** and references are listed in **Section 6.5.4.5**.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.5.4.2 Methodology

The assessment has been carried out according to Stage 1 of the route selection process outlined in the NRA PMGs 2010. The hydrology assessment examines the six proposed route corridor options described in **Section 6.1** in respect to potential impacts to the Surface Hydrology within the scheme study area. The options are evaluated and ranked based on the following hydrological criteria:

- River Corrib crossing potential channel and flood plain encroachment;
- Watercourses and lake (permanent and seasonal loughs) crossings and floodplain encroachments and water quality impacts;
- Road Drainage Issues - urbanised area, pumping of tunnel, lack of surface drains in eastern section of the scheme study area and proximity to streams for outfalling;
- Flood Risk Area (pluvial, fluvial, groundwater and coastal flood sources);
- Public Water Supply – Galway City Council's Terryland Water Treatment Plant drinking water abstraction; and
- Hydro-ecology impacts aquatic habitats and species such as Wet heath, Blanket bog, Transmission mires, Calcareous fens, Salmonid waters and the Natura 2000 sites (Lough Corrib cSAC and the Galway Bay Complex cSAC).

Table 6.5.4.1 has been extracted from the Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes and defines the impacts levels.

Table 6.5.4.1 Definition of Impact Assessment Criteria

Impact level	Description
Imperceptible	An impact capable of measurement but without noticeable consequences
Slight	An impact that alters the character of the environment without affecting its sensitivities
Moderate	An impact that alters the character of the environment in a manner that is consistent with existing or emerging trends
Major	An impact, which by its character, magnitude, duration or intensity alters a sensitive aspect of the environment.
Profound	An impact which obliterates all previous sensitive characteristics

6.5.4.3 Options Assessment

A detailed description for each of the route options is described in **Section 6.1**. The assessment of impacts on the hydrological attributes, as outlined in the hydrological constraints **Section 4.4**, is provided below for each of the routes.

Section 1

For Section 1, each of the route optons are assessed under the following headings:

- Flood Risk and Watercourses;
- Water Quality; and
- Hydro-Ecology.

Flood Risk and Watercourses

Refer to **Figures 6.5.4.3** to **6.5.4.6** for the route options overlain with the extents of flood risk zones. Within this Section 1 the streams intercepted are the Sruthán na Liberiti and Trusky Streams. These streams are minor streams having small catchment areas of 1.5km^2 and 3km^2 respectively. These streams are generally poorly defined, overgrownand are not well maintained.

The Flood Zones for these streams are not particularly extensive given the small catchment areas and lie immediately adjacent to the stream channel. The Trusky stream has been identified as posing a potential Flood Risk to the Spiddal Road and a section of Bearna Village due to existing undersized road culverts. This will have implications on the potential to discharge storm water to this stream requiring full attenuation to be provided.

The streams encountered by the various corridor options are small and generally unmaintained channels and generally have existing undersized road and field culverts. Their floodplain area is not well defined. Culverting and diverting these watercourses as part of the drainage works for the road scheme is unlikely to give rise to any significant impacts on Flood Risk both locally or downstream. Road drainage discharges to these streams will require stormwater attenuation to minimise any adverse impact on downstream flooding.

The overall impact on flooding and watercourse hydrology for all options is likely to represent slight to moderate local negative impact.

Red1 and Orange1 Route Option

The most preferred in respect to hydrology is the Red1/Orange1 Route Option as it does not cross any of the watercourses described and avoids encroaching the floodplain areas also. The Red1 and Orange1 Route Option will have to outfall to surface waters which is expected to be to the Trusky Stream, as groundwater infiltration will not be possible given the poor drainage characteristics of the overburden and bedrock in this section. The Trusky Stream discharges to the sea at Bearna Quay. A moderate flood risk from the Trusky Streams exists at Bearna Village. The impact on the stream hydrology and flood risk can be reduced to slight to imperceptible through the implementation of a stormwater SuDS management system of attenuation and controlled discharge and appropriate culvert design for the crossing.

Yellow1 and Green1 Route Option

The Yellow1 and Green1 Route Option cross both the Sruthán na Libeirti and the Trusky Streams with potentially three crossings in total. The potential encroachment of floodplain by this option is significantly less than the Pink1 and Blue1 Route Option. The road drainage discharge for the Yellow1 and Green1 Route Options can be spread over a wider area discharging to both streams and resulting in a lesser impact on the downstream flow and flood risk than the other options. The impact on the stream hydrology and flood risk can be reduced to slight to imperceptible through the implementation of a storm water SuDS management system of attenuation and controlled discharge and appropriate culvert design for the crossing.

Blue1 and Pink1 Route Option

The least preferred option is the Pink1 and Blue1 Route Option which incorporates the Bearna Relief Road to the north of Bearna Village as this route has potentially five crossings of the Trusky Stream channel and its tributaries and which is upstream of the Bearna flood risk area. This option potentially encroaches for a significant distance on the identified fluvial Flood Risk zone of the Trusky Stream based on the Office of Public Works (OPW) National Preliminary Flood Risk Assessment Mapping (PFRA). This route option will potentially outfall to the Trusky Stream system which is upstream of the Bearna Flood Risk Area. The impact on the stream hydrology and flood risk can be reduced to slight to imperceptible through the implementation of a storm water SuDS management system of attenuation and controlled discharge and appropriate culvert design for the crossing.

Water Quality

These watercourses mentioned above are not hydrologically very sensitive and outfall to Galway Bay west of the Galway Bay Complex cSAC. The potential operational impact by the road scheme on these streams is expected to represent a slight local impact with construction works expected to have the potential for causing a temporary moderate local impact.

The potential water quality impact to the Galway Bay Complex cSAC given the mixing available in the receiving coastal waters off Bearna is considered to be slight to imperceptible both under construction and operational phases.

Red1 and Orange1 Route Option

The Red1 and Orange1 Route Option has the shortest corridor length and thus the least volume for discharge to the Trusky Stream. In this section the road is likely to concentrate its discharge to the Trusky Stream which outfalls to the sea at Bearna Quay, which is located 1.5km west of the Galway Bay Complex cSAC. This option through normal drainage mitigation can reduce potential impact on water quality to an impact magnitude of slight and an imperceptible impact on the Galway Bay Complex cSAC.

Yellow1 and Green1 Route Option

The road drainage discharge for the Yellow1 and Green1 Route Option will be spread over a wider area with an ability to discharge to the Sruthán na Liberiti and the Trusky Systems, resulting in a lesser effect on the downstream flow and water quality than the other options and therefore this is ranked first. This option through normal drainage mitigation can reduce potential impact on water quality to an impact magnitude of slight and an imperceptible impact on the Galway Bay Complex cSAC.

Blue1 and Pink1 Route Option

The least preferred route option are the Pink1 and Blue1 Route Options as they include a northern distributor road and similar to the Red1 and Orange1 Route Option concentrates all road runoff to the Trusky Stream and whose sea outfall is closest to the Galway Bay Complex cSAC. This option through normal drainage mitigation can reduce potential impact on water quality to an impact magnitude of slight and an imperceptible impact on the Galway Bay Complex cSAC.

Hydro-Ecology

This section assesses the potential impact of the corridor on the hydrology of surrounding aquatic sensitive habitats, namely the Annex I habitat Blanket bog [7130] Annex I habitat Transition mire and Quaking bogs habitat [7140], Annex I habitat depressions on peat substrates [7150], Annex I habitat northern Atlantic wet heaths [4010], locally important Wet heaths and Wet grassland habitats.

Red1 and Orange1 Route Option

The Red1 and Orange1 Route Options generally avoids aquatic sensitive Annex I habitat and encounters the least area of Wet heath and Wet grassland of the other route options. To the north of Ballard it passes to the north of a large Annex I habitat Wet heath habitat but is sufficiently remote not to cause significant impact. The impact level on hydro-ecology is considered to represent a locally slight permanent impact. The Red1 and Orange1 Route Options are the preferred options with the Green1 and Yellow1 Route Options the least preferred.

Yellow1 and Green1 Route Option

The Green1 and Yellow1 Route Options encounter and are in close proximity over a large section of their route to locally important Wet grassland and Wet heath and is in close proximity to Annex I habitat Blanket bog and Annex I habitat Wet heath. Within the corridor identified there is sufficient room to avoid or mitigate potential impacts both direct and indirect to the Annex I habitats. These route options come potentially closest to a Blanket bog section near the Sruthán na Libeirti crossing point (EC11, EC12, EC13). These route options are unlikely to impact on it considering the proposed road alignment, the distance from the Blanket bog and the presence of Dry heath separating the route from the bog. The impact level on hydro-ecology is considered to represent a locally slight to moderate permanent impact.

Blue1 and Pink1 Route Option

The Pink1 and Blue1 Route Options generally avoid aquatic sensitive Annex I habitats except at two locations where it encounters Annex I Wet heath habitat. Theses corridors encounter a significant area of Wet grassland along their route to the south of Na hAille. Within the corridor identified there is sufficient room to avoid completely Annex I habitat habitats. The impact level on hydro-ecology is considered to represent a locally slight to moderate permanent impact.

Summary of Section 1 Assessment

The impact of the route options on hydrology has been assessed based on impact to water quality, flood risk and water course hydrology and on hydro-ecology.

Table 6.5.4.2 below outlines the order of preference for the hydrological aspects with respect to each of the route options. The route options have been ranked from 1 to 3 with 1 being the most favourable and 3 being the least favourable in terms of hydrological impacts along each of the route options. Assessment rankings have been assigned under the following headings: Flood Risk, Hydro-Ecology and Water Quality. The sum of the rankings for each route option was calculated and the order of preference for the route options was assigned.

The assessment indicates that all of the route options considered are acceptable and will not result in any significant hydrological impact that cannot be mitigated for. The Red1 and Orange1 Route Option are the preferred route options with the Yellow1 and Green1 Route Options being the least preferred.

Table 6.5.4.2 Section 1 Hydrology Assessment

Route	Flood Risk and watercourse crossings	Water Quality	Hydro-ecology	Total Score	Rank	Preference
Red1	1	2	1	4	1st	P
Orange1	1	2	1	4	1st	P
Yellow1	2	1	3	6	3rd	I
Blue1	3	2	2	7	2nd	I/LP
Pink1	3	2	2	7	2nd	I/LP
Green1	2	1	3	6	3rd	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

Section 2

For Section 2, each of the route options are assessed under the following headings:

- River-Corrib Crossing;
- Watercourse Crossings;
- Water Quality; and
- Hydro-Ecology.

River Corrib Crossing

Red1 Route Option

The River Corrib crossing on the Red1 Route Option is likely to have supports adjacent to the existing piers at Quincentenary Bridge. In terms of changes to the hydrological regime and flood risk for the Red1 Route Option the placement of piers is likely to have only local minor impacts.

This option has the potential to impact on flow conveyance, velocities, and water levels and local changes to the bed morphology as a result of the placement of piers within the floodplain and within the flow channel. The associated constructional impacts involving temporary works to construct such piers could temporarily impact the flow conveyance and give rise to sediment release and potential for spillages of grout and concrete during the construction of such piers.

The flow conveyance in the River Corrib at the Red1 Route Option crossing point, even under extreme flooding conditions, is confined to the channel with overbank flows of limited extent and of little assistance to flood flow conveyance. The loss of flood storage as a result of the crossings will be inconsequential given the large storage capacity within the upstream lakes and within the catchment, and damped nature of the flood hydrograph.

The impact of the proposed Red1 Route Option River Corrib crossing on the hydrology of the Lough Corrib cSAC is considered to be localised having a moderate impact magnitude based on the River Corrib having an extremely high attribute value. This moderate impact applies to both construction and operational phases. The new piers and abutments are to be aligned with the existing piers and abutments of the Quincentenary Bridge which will minimise the disturbance to the River Corrib flows and upstream afflux.

The Red1 Route Option is the least preferred option of the six route options in respect to potential impact to the Hydrology of the River Corrib. This is due to the requirement for in stream piers and associated construction works.

Orange1 Route Option

The Orange1 Route Option involves a deep tunnel which avoids any encroachment of the River Corrib during both the operational and constructional phases. This ensures that the Orange1 Route Option is the most preferred route option in respect to the River Corrib crossing having no constructional or operational impacts on the hydrology of the River Corrib.

Yellow1 Route Option

The River Corrib crossing for the Yellow1 Route Option involves a viaduct structure to minimise direct impact to the Lough Corrib cSAC and to avoid encroachment into the river channel. This route option is designed to provide a full span of the River Corrib channel which avoids any in stream constructional works. The river bridge is to be designed to ensure no constraint to boat passage and therefore the soffit level of the bridge will be well elevated above the design flood level of the river.

The flow conveyance in the River Corrib at the crossing point, even under extreme flooding conditions, is confined to the channel with overbank flows of limited conveyance capacity at the crossing point. The loss of flood storage as a result of the bridge piers will be inconsequential given the large storage capacity within the upstream lakes and catchment, the damped nature of the flood hydrograph and the small volume associated with the support piers.

During construction of the bridge there will be temporary works within and close to the flood plain but with no works within the river channel.

The impact magnitude of the proposed river crossing option for the Yellow1 Route Option is classified as a slight constructional and operational impact assuming good construction management for works within the floodplain area and no temporary works within the river channel. Where temporary in-stream works are required to construct the long bridge span of approximately 130m then the construction impact level increases be a temporary moderate impact.

Blue1 Route Option

The River Corrib crossing for the Blue1 Route Option involves a viaduct structure to minimise direct impact to the Lough Corrib cSAC and to avoid encroachment into the river channel. This route option is designed to provide a full span of the River Corrib channel which avoids any in stream constructional works. The river crossing is to be designed to ensure no constraint to boat passage and therefore the soffit level of the bridge will be well elevated above the design flood level of the river.

The flow conveyance in the River Corrib at the crossing point, even under extreme flooding conditions, is confined to the channel with overbank flows of limited conveyance capacity at the crossing point. The loss of flood storage as a result of the bridge piers will be inconsequential given the large storage capacity within the upstream lakes and catchment, the damped nature of the flood hydrograph and the small volume associated with the support piers.

During construction of the bridge there will be temporary works within and close to the flood plain but with no works within the river channel associated with the pier construction.

The impact magnitude of the proposed crossing for the Blue1 Route Option is classified as a slight constructional and operational impact assuming good construction management for works within the floodplain area and no temporary works within the river channel. Where temporary in-stream works are required to construct the long bridge span of approximately 130m then the construction impact level increases be a temporary moderate impact.

Pink1 Route Option

The River Corrib crossing for the Pink1 Route Option involves a viaduct structure to minimise direct impact to the Lough Corrib cSAC and to avoid encroachment into the river channel. This route option is designed to provide a full span of the River Corrib channel which avoids any in stream constructional works. The bridge is to be designed to ensure no constraint to boat passage and therefore the soffit level of the bridge will be well elevated above the design flood level of the river.

The flow conveyance in the River Corrib at the crossing point, even under extreme flooding conditions, is confined to the channel with overbank flows of limited conveyance capacity at the crossing point. The loss of flood storage as a result of the bridge piers will be inconsequential given the large storage capacity within the upstream lakes and catchment, the damped nature of the flood hydrograph and the small volume associated with the support piers.

During construction of the bridge there will be temporary works within and close to the flood plain but with no works within the river channel associated with any pier construction.

The impact magnitude of the proposed viaduct crossing option for the Pink1 Route Option is classified as a slight constructional and operational impact assuming good construction management for works within the floodplain area and no temporary works within the river channel. Where temporary in-stream works are required to

construct the long bridge span of approximately 130m then the construction impact level increases be a temporary moderate impact.

Green1 Route Option

The River Corrib crossing for the Green1 route represents the widest section of floodplain area of all six options measuring some 460m width with the river channel approximately 130m wide. The proposed road crossing involves a long bridge structure to minimise direct impact to the Lough Corrib cSAC and to avoid any encroachment into the river channel. This route option is designed to provide a full span of the River Corrib channel which avoids any in stream constructional works associated with piers and foundations. The bridge is to be designed to ensure no constraint to boat passage and therefore the soffit level of the bridge will be well elevated above the design flood level of the river.

The flow conveyance in the River Corrib at the crossing point, even under extreme flooding conditions, is confined to the channel with overbank flows of limited conveyance capacity at the crossing point. The loss of flood storage as a result of the bridge piers will be inconsequential given the large storage capacity within the upstream lakes and catchment, the damped nature of the flood hydrograph and the small volume associated with the support piers.

During construction of the bridge there will be temporary works within and close to the flood plain but with no works within the river channel associated with any pier construction.

The impact magnitude of the proposed river crossing for the Green1 Route Option is classified as a slight constructional and operational impact assuming good construction management for works within the floodplain area and no temporary works within the river channel. Where temporary in-stream works are required to construct the long bridge span of approximately 130m then the construction impact level increases to a temporary moderate impact.

River Corrib Crossing Summary

The Red1 Route Option is the least preferred route option due to the requirement for in-stream piers and associated construction works. The Orange1 Route Option is considered to be most preferred as it avoids through tunnelling the watercourse and its floodplain. The remaining Green1, Blue1, Pink1 and Yellow1 Route Option river crossings are all ranked equally as second as they avoid any piers within the sensitive water course and have a narrow flood plain crossing width than the Green1 Route Option which is ranked fifth.

Watercourse Crossings

To the west of the River Corrib a number of small hill slope drains and streams are encountered which form part of the Knocknacarra and the Bearna Streams. These are minor streams and unlikely to result in any significant flood risk concerns or impacts as a result of the route options. Overall the watercourse crossings and floodplain encroachments are considered to represent a slight negative impact on flooding, flow hydrology and flood risk.

The Terryland River represents the only watercourse within the scheme study area to the east of the River Corrib and this is a sensitive watercourse as it disappears underground at the Castlegar swallow holes. Within the scheme study area Ballindooley Lough is also present but none of the route options directly encroach the permanent lough area with the Green1 Route Option crossing its potential flood area to the north of Ballindooley and the Pink1 Route Option and Blue1 Route Option crossing closely to the south.

Red1 Route Option

To the west of the River Corrib the Red1 Route Option crosses three minor tributaries of the Bearna Stream and four tributaries of the Knocknacarra Stream. These waterbodies discharge to the Galway Bay Complex cSAC and can be classified as medium and low value watercourses with the Knocknacarra Stream highly urbanised and all tributaries already culverted under the existing distributor road. The potential impact magnitude of these crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design will be required (i.e appropriate drainage design).

To the east of the River Corrib the Red1 Route Option significantly encroaches along the Terryland River Basin and will potentially involve a viaduct structure to avoid significant impact to the Terryland River channel and floodplain. The Terryland River is classified as a low value river in respect to fishery potential as it disappears underground near Castlegar and is believed to emerge somewhere in Inner Galway Bay. The swallow-hole capacity is likely to be highly sensitive to release of construction sediment into the Terryland River. Any sediment could result in reduced flow capacity and potential blockage within the underground conduit. The constructional and operational impacts of the Red1 Route Option on the Terryland River are classified as a potentially moderate and slight impacts respectively.

Orange1 Route Option

The Orange1 Route Option crosses three minor tributaries of the Bearna Stream and four tributaries of the Knocknacarra Stream. These waterbodies discharge to the Galway Bay SAC and can be classified as medium and low value watercourses with the Knocknacarra Stream highly urbanised and all tributaries already culverted under the existing distributor road. The potential impact magnitude of these crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design will be required (i.e appropriate drainage design).

To the east of the River Corrib the Orange1 Route Option on emerging from its tunnel encroaches into the Terryland River Basin and potentially will involve construction of an embankment within the floodplain area and the culverting/bridging of the stream channel. The Terryland River is classified as a low value river in respect to fishery potential as it disappears underground near

Castlegar and is believed to emerge somewhere in Inner Galway Bay. The swallow-hole capacity may be limited and potentially very sensitive to sediment released during construction that could cause blockages within the underground conduit system. Therefore the both the construction and operational impacts of the Orange1 Route Option on the Terryland River is classified as a potentially moderate impact.

Yellow1 Route Option

The Yellow1 Route Option crosses three minor tributaries of the Bearna Stream and passes to the north of Knocknacarra Stream channel. The Bearna Stream discharges to the Galway Bay Complex cSAC and can be classified as medium value watercourse. The potential impact magnitude of these crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design may be required (i.e full spanning bottomless culvert/small bridge).

To the east of the River Corrib the Yellow1 Route Option encroaches the floodplain extents of the Coolagh Lakes and crosses drainage channel that conveys spring flow to the Coolagh Lakes near Coolagh Village. It also passes in close vicinity to a second spring and drainage channel that supplies the lake on the north side closer to the River Corrib. The Coolagh Lake system which includes its floodplain and contributing drainage channels has an extremely high attribute value given its ecology value and being part of the Lough Corrib cSAC. The proposal is to provide a bridge crossing within the cSAC with support piers only encroaching within the cSAC boundary. The flood extent for the Coolagh Lakes area defined by the CFRAM draft mapping does not overlap exactly with the cSAC boundary and indicates a potential for road embankment to be placed within the flood zone A and flood zone B. The potential impact of Yellow1 Route Option including constructional works within and close to the flood zone of the Coolagh Lakes and the potential for permanent encroachment within the flood zone of the lake is considered to represent a moderate permanent impact.

The Yellow1 Route Option crosses the Terryland floodplain and stream channel and will involve construction of an embankment within the floodplain area and the culverting/bridging of the stream channel. The Terryland River is classified as a low value river in respect to fishery potential as it disappears underground near Castlegar and is believed to emerge somewhere in Inner Galway Bay. The swallow-hole capacity may be limited and potentially very sensitive to sediment release during construction that could cause blockages within the underground conduit system. Therefore both the construction and operational impacts of the Yellow1 Route Option on the Terryland River is classified as a potentially moderate impact.

Blue1 Route Option

The Blue1 Route Option crosses three minor tributaries of the Bearna Stream and passes to the north of Knocknacarra Stream channel. The Bearna Stream discharges to the Galway Bay Complex cSAC and can be classified as medium value watercourse. The potential impact magnitude of these crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and

implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design may be required (i.e appropriate drainage design).

To the east of the River Corrib the Blue1 Route Option avoids the Coolagh Lakes floodplain area and the Terryland River Basin. The route option passes to the south of Ballindooley Lough just avoiding the flood zone of this lake.

Pink1 Route Option

The Pink1 Route Option crosses three minor tributaries of the Bearna Stream and passes to the north of Knocknacarra Stream channel. The Bearna Stream discharges to the Galway Bay Complex cSAC and can be classified as medium value watercourse. The potential impact magnitude of these crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design may be required (i.e appropriate drainage design).

To the east of the River Corrib the Pink1 Route Option avoids the Coolagh Lakes floodplain area and the Terryland River Basin. The route option passes to the south of Ballindooley Lough just avoiding the flood zone of this lake.

Green1 Route Option

The Green1 Route Option crosses three tributaries (including the Tonabrocky Stream) of the Bearna Stream and passes to the north of Knocknacarra Stream drainage channels. The route option crosses again the Tonabrocky Stream and passes close to Lough Nabrocky. The Bearna Stream discharges to the Galway Bay Complex cSAC and can be classified as medium value watercourse. The potential impact magnitude of these four crossings and potential outfall discharges is considered to represent a permanent moderate impact that can be reduced to slight permanent impact through the appropriate culvert design and implementation of storm water management (SuDS). The Bearna Stream has fishery potential and fishery friendly culvert design may be required (i.e appropriate drainage design). However at the crossing point the streams are steep hillside channels and unlikely to be salmonid.

To the east of the River Corrib the Green1 Route Option avoids the Coolagh Lakes floodplain area and the Terryland River Basin. The route option passes to the north and within the flood zone and recharge zone of Ballindooley Lough. This lough is classified as high attribute value and the potential impact to this lough is rated moderate from potential road runoff discharge, encroachment within the flood zone and potential for interference with groundwater recharge.

Flood Risk

Refer to **Figures 6.5.4.3** to **6.5.4.6** for the route options overlain with the extents of flood risk zones. The streams and flood risk areas encountered to the west of the River Corrib are considered to be minor and localised to immediate surrounding channel banks and present little difference in impact level in respect to flood risk and flood impact. The principal flood risk area are the crossing of the River Corrib

and encroachment within the Terryland River Basin which is shown to be a defended area in the CFRAM study.

The flood risk has been assessed using combination of local flood information (flood incidents), the OPW pFRAM mapping which includes coastal, fluvial, pluvial and groundwater preliminary flood risk areas and the recent more detailed Draft CFRAM mapping of fluvial and coastal flood risk for the River Corrib and its tributary the Terryland River. The impact level for each of the route options is determined based on the length of the route option that encroachs a flood risk area, the potential flood risk to the development and potential impact on existing flood risk.

Red1 Route Option

The Red1 Route Option involves a bridge crossing option of the River Corrib adjacent to the existing Quincentenary Bridge which represents the shortest crossing point of the River Corrib floodplain of all six route options. This route option however, does involve a considerable encroachment distance (1.4km) through the defended flood zone of the Terryland River Basin. The most significant risk is the potential impact to the Terryland River and the potential blockage to its swallow holes, posed by the construction of the Red1 Route Option. The Terryland system is defended by flood embankment along the Dyke Road from the River Corrib and should the Terryland River swallow holes become blocked the flood level in the area will revert to that of the River Corrib flood level. The proposal is for the construction of a viaduct supported on piers up through the Terryland River Basin which will reduce the potential impact of flooding and flood risk from major to moderate.

The Red1 Route Option which is primarily an online option avoids the majority of the Pluvial Flood risk areas based on the OPW pFRAM mapping. In the Westside/Newcastle area pluvial flooding is indicated in vicinity to the Red1 Route Option. This area has urban drainage that discharges to the Distillery Stream through NUI Galway and such pluvial flooding risk is unlikely to be realised.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Orange1 Route Option

The River Corrib floodplain is avoided by the proposed bored tunnel. The most significant risk is the potential impact to the Terryland River and the potential blockage to its swallow holes, posed by the construction of the Red1 Route Option. The Terryland system is defended by flood embankment along the Dyke Road from the River Corrib and should the Terryland River swallow holes become blocked the flood level in the area will revert to that of the River Corrib flood level. The proposal is for the construction of a viaduct supported on piers up through the Terryland River Basin which will reduce the potential impact of flooding and flood risk from major to moderate.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Yellow1 Route Option

The Yellow1 Route Option crosses the River Corrib downstream of Menlo Castle similar to the Pink1 and Blue1 Route Option having a total floodplain/flood zone width of 220m and a channel width of *c.*130m. The Yellow1 Route Option is a proposed viaduct crossing of the River Corrib and floodplain with no proposed in-stream piers.

The Yellow1 Route Option then encroaches into the River Corrib flood zones to the northwest and north of the Coolagh Lakes for a distance of 240m and then crosses the defended flood zone of the Terryland River.

To the west of the river, in the limestone basin, there are no surface watercourses present with generally only pluvial and groundwater flood risk being identified for a number of small local depressions.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Blue1 Route Option

The Blue1 Route Option crosses the River Corrib downstream of Menlo Castle similar to the Pink1 and Yellow1 Route Options having a total floodplain/flood zone width of 220m and a channel width of *c.*130m. The Blue1 Route Option is a proposed viaduct crossing of the River Corrib with no proposed in-stream piers. This route option avoids the Coolagh Lakes Flood Area and the Terryland River Basin. It does pass close to the Ballindooley Lough flood area to the south of the lake.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Pink1 Route Option

The Pink1 Route Option crosses the River Corrib downstream of Menlo Castle similar to the Blue1 and Yellow1 Route Option having a total floodplain/flood zone width of 220m and a channel width of *c.*130m. The Pink1 Route Option is a proposed viaduct crossing of the River Corrib with no proposed in-stream piers. This route option avoids the Coolagh Lakes flood area and the Terryland River Basin. It does pass close to the Ballindooley flood area to the south of the Lake.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Green1 Route Option

The Green1 Route Option represents the widest crossing length of the River Corrib floodplain and flood zones having an encroachment distance of 460m within the River Corrib Flood Zone. This route option is shown to encroach slightly the Flood Zone area surrounding Ballindooley Lough to the north.

To the east of the river, in the limestone basin, there are no surface watercourses encountered with generally only pluvial and groundwater flood risk being identified for a number of small local depressions which are considered insignificant.

The flood risk impacts on the minor watercourses to the west of the River Corrib are small and have been included for in the assessment of watercourses above.

Flood Risk Summary

In terms of Flood Risk and watercourse impacts the least preferred is the Yellow1 Route Option which crosses the River Corrib downstream of Menlo Castle similar to the Pink1 and Blue1 Route Option but then encroaches the River Corrib Flood Zones again to the northwest and north of the Coolagh Lakes for a distance of 240m and then crosses the defended flood zone of the Terryland River.

The Blue1 and Pink1 Route Options are the most preferred route options as the River Corrib flood zone crossing width is reasonably modest having a total width of 220m, with the main channel width some 130m. These route options avoid the flood areas surrounding the Coolagh Loughs and the Terryland River Basin.

The Orange1 Route Option is ranked third representing a deep tunnel crossing of the River Corrib but does encroach into the defended flood zones of the Terryland River Basin.

The Green1 Route Option is ranked fourth and represents the widest crossing of the River Corrib floodplain and flood zones having encroachment distance of 460m within the River Corrib flood zone. This route option also crosses flood zone of the Ballindooley Lough and has a number of minor pluvial flood risk zones along its route option.

The Red1 Route Option which is ranked fifth involves a bridge option adjacent to the existing Quincentenary Bridge which represents the shortest crossing point of the River Corrib floodplain of all six route options. This route option however, does involve a considerable encroachment distance (1.4km) through the defended flood zone of the Terryland River basin.

Hydro-Ecology

Detailed ecological habitat mapping has been carried out along all of the proposed route options and based on this mapping and site walkovers an assessment of the impact to hydro-ecology of the various route options has been carried out. The main impacts in relation to hydrology are the potential for hydrological regime change and potential for changes to water quality and water chemistry of aquatic habitats. These impacts could be as a result of the road development; through its drainage networks and outfall discharges, potential for localised dewatering, and potential for flooding or water quality impact. To the west of the River Corrib the ecological habitat mapping shows the proposed route options avoiding Annex I habitats such as Blanket bog [7130], Transition mires and Quaking bogs [7140] and Wet heath [4010] with a number of the route options passing within close proximity of such habitats. Refer to **Section 4.3 Ecology** for the ecology constraints and **Section 6.5.1** for the ecological assessment of the route options.

To the east of the River Corrib the habitats change due to the limestone bedrock with sensitive habitats of Calcareous fens with Cladium mariscus and species of the Caricion davallianae surrounding the Coolagh Lakes off the River Corrib. The assessment identified the routes most proximal to these habitats and whether they were upstream of downstream of them.

The River Corrib as a Salmonid water and with the downstream Galway Bay Complex cSAC were not included under this assessment as they were included under water quality.

Red1 Route Option

East of the River Corrib the Red1 Route Option avoids impact to all of the identified aquatic habitats primarily as it follows an existing on-line route. The Red1 Route Option will require in-stream works in Lough Corrib cSAC for proposed bridge support piers (two piers likely to be proposed) which is considered to represent a moderate to high magnitude impact due to the sensitivity of the Lough Corrib cSAC Salmonid waters.

Orange1 Route Option

To the east of the River Corrib the Orange1 Route Option crosses through section of Wet and Dry heath associated with Ecological Sites EC19 and EC20 which have attribute values of low to high. The Wet heath complex is sensitive to hydrological regime changes through drainage and potential dewatering effects caused by constructing the route option. The potential impact of the route option on this receptor is classified as moderate to high and through appropriate drainage design this impact can be reduced to slight to moderate.

The Orange1 Route Option avoids impact direct and indirect to the Lough Corrib cSAC through tunnelling.

Yellow1 Route Option

To the east of the River Corrib the Yellow1 Route Option crosses through section of Wet and Dry heath associated with Ecological Sites EC19 and EC20 which have attribute values of low to high. The Wet heath complex is sensitive to hydrological regime changes through drainage and potential dewatering effects caused by constructing the road. The potential impact of the route option on this receptor is classified as moderate to high and through appropriate drainage design this impact can be reduced to slight to moderate. The Yellow1 Route Option link road to the N59 passes through an extensive area of Wet grassland adjacent to the Moycullen Bog NHA (Ecological Site EC25) which is given a local high attribute value. The edge of the corridor comes to within 40m of Annex I habitat Blanket bog habitat. Within the corridor it is likely that the route option can be kept 100m from the Blanket bog habitat which will ensure that drainage and dewatering impacts are imperceptible. The impact on the Wet grassland habitat is classified as a moderate impact.

To the west of the River Corrib the Yellow1 Route Option crosses through a section of the Coolagh Lakes/fen flood area and Lough Corrib cSAC area. The proposal is to provide a viaduct crossing so as to minimise direct impact to the Lough Corrib cSAC. It is recommended that this viaduct be extended to bridge the full flood risk/flood plain area. Potential drainage discharge and local placement of support piers for the viaduct have the potential to result in a hydrological impact to this habitat both during construction and operation, which given its attribute importance of extremely high represents a high impact magnitude.

Blue1 Route Option

To the east of the River Corrib the Blue1 Route Option crosses through section of Wet and Dry heath associated with EC19 and EC20 which have attribute values of low to high. The Wet heath complex is sensitive to hydrological regime changes through drainage and potential dewatering effects caused by constructing the road. The potential impact of the route option on this receptor is classified as moderate to high and through appropriate drainage design this impact can be reduced to slight to moderate. The link road to the N59 associated with the Blue1 Route Option passes through an extensive area of Wet grassland adjacent to the Moycullen Bog NHA (Ecological Sites EC25) which is given a local high attribute value. The edge of the route option corridor comes to within 40m of Annex I habitat Blanket bog. Within the corridor option it is likely that the route can be kept 100m from the Blanket bog habitat which will ensure that drainage and dewatering impacts are imperceptible. The impact on the Wet grassland habitat is classified as a moderate impact.

To the west of the River Corrib there is little impact to hydro-ecological receptors with only slight direct impact to Ballindooley Lough Complex ecological site EC39 with a small section of the corridor option just encroaching Annex I Molinia meadows habitat. Within the corridor there is ample width to avoid encroaching this habitat. A potential indirect impact may arise on this habitat and Ballindooley Lough Complex from road drainage discharge which can be mitigated through appropriate storm drainage treatment and discharge control. The impact magnitude on Ballindooley Lough Complex EC39 is considered to be a moderate magnitude impact.

The Blue1 Route Option passes through the recharge zone of the Coolagh Loughs which could impact on the Calcareous fens surrounding the lough. This impact is dealt with and accounted for within the Hydrogeology assessment (**Section 6.5.3**).

Pink1 Route Option

To the east of the River Corrib the Pink1 Route Option crosses through section of Wet and Dry heath associated with Ecological Sites EC19 and EC20 which have attribute values of low to high. The Wet heath complex is sensitive to hydrological regime changes through drainage and potential dewatering effects caused by constructing the road. The potential impact of the route option on this receptor is classified as moderate to high and through appropriate drainage design this impact can be reduced to slight to moderate. The link road to the N59 associated with the Pink1 Route Option passes through an extensive area of Wet grassland adjacent to the Moycullen Bog NHA (Ecological Site EC25) which is given a local high attribute value. The edge of the corridor comes to within 40m of Annex I Blanket bog habitat. Within the corridor it is likely that the route option can be kept 100m from the Blanket bog habitat which will ensure that drainage and dewatering impacts are imperceptible. The impact on the Wet grassland habitat is classified as a moderate impact.

To the west of the River Corrib there is little impact to hydro-ecological receptors with only slight direct impact to Ballindooley Lough Complex ecological site EC39 with a small section of the Pink1 Route Option just encroaching Annex I Molinia meadows habitat. Within the corridor there is ample width to avoid encroaching

this habitat. A potential indirect impact may arise on this habitat and Ballindooley Lough Complex from road drainage discharge which can be mitigated through appropriate storm drainage treatment and discharge control. The impact magnitude on Ballindooley Lough Complex EC39 is considered to be a moderate magnitude impact.

The Pink1 Route Option passes through the recharge zone of the Coolagh Loughs which could impact on the Calcareous fens surrounding the lough. This impact is dealt with and accounted for within the Hydrogeology assessment **Section 6.5.3**.

Green1 Route Option

The Green1 Route Option passes in close proximity to internationally important Blanket bog, Wet heath and Transition mire and Quaking bog habitats east of the River Corrib associated with the Moycullen Bog NHA at Tonabrocky Ecological Site EC22 and at Ballagh Ecological Site EC25. The potential indirect impacts of the road construction and operation could result in dewatering and drainage impacts to these habitats having a high impact magnitude.

Similar to a number of the other route options this corridor crosses through section of Wet and Dry heath associated with Ecological Sites EC19 and EC20 which have attribute values of low to high. The Wet heath complex is sensitive to hydrological regime change through drainage and potential dewatering and the potential impact of the route option on this receptor is classified as moderate to high and through appropriate drainage design this impact can be reduced to slight to moderate.

At the River Corrib crossing the route option comes in close proximity to Alkaline fens on both sides of the River Corrib. The route option also takes it across Wet grassland area associated with the Ballindooley Lough riparian zone ecological site EC39 with the potential for a moderate magnitude impact during construction and operational stages.

Hydro Ecology Summary

Overall the least preferred route option of the six route options is the Green1 Route Option due to its close proximity to Blanket bog habitats west of the River Corrib (Moycullen Bog NHA at Tonabrocky ecological site EC22 and at Ballagh ecological site EC25) and its close proximity to Alkaline fens at the River Corrib crossing located on both sides of the river. The Green1 Route Option also takes it across Wet grassland area associated with the Ballindooley Lough riparian zone ecological site EC39.

The preferred route option is the Orange1 Route Option as it has the least potential for impact to Wetland habitats east of the River Corrib, avoids the River Corrib and floodplain area through tunnelling and the habitat mapping indicates it avoiding impact to important aquatic habitats east of the River Corrib.

The Red1 Route Option represents the second ranked route option as it is similar in terms of potential impact but will require in-stream works in River Corrib for its bridge support piers (two piers likely to be proposed).

The Blue1, Pink1 and Yellow1 Route Options and associated link road with the N59 pass to the east of the Blanket bog and Wet heath/Wet grassland habitats

associated with the Moycullen Bog NHA at Ballagh. These routes also encounter at a number of locations, Wet grassland habitat of local importance. At the tie location with Section 1 all corridors encounter a small section of Wet and Dry heath of international importance and locally important Wet grassland (at ecological sites EC19 and 20).

Crossing of the River Corrib and its floodplain will be by long bridge which limits the potential impact to Wetland habitats associated with the River Corrib and its floodplain, similar to the Green1 Route Option. These route options pass upstream of the Coolagh Lakes and its associated Alkaline Fens and Calcareous springs with the Yellow1 Route Options passing within the floodplain area of this lough system with the potential for impact to the water flow towards these fens. The Blue1 and Pink1 Route Options are ranked third and the Yellow1 Route Option is ranked fifth in terms of hydro-ecology impact.

Water Quality

The River Corrib is classified as Salmonid Waters which is a qualifying interest of the Lough Corrib cSAC. The Bearna Stream and the Knocknacarra Stream outflow into the Galway Bay Complex cSAC and are considered sensitive to both operational and constructional pollution. The River Corrib and the Terryland River also discharge into the Galway Bay Complex cSAC and therefore area also considered sensitive to potential water quality impacts. Water quality impacts to these watercourses represents a moderate to significant impact and requires mitigation to avoid contaminated discharges both during construction and the operational phases of the road.

A major public water supply abstraction is present at Terryland with the abstraction point from the Jordan Island channel on the River Corrib. Such a large and important water supply which is rated as very high attribute value is highly sensitive to water quality impacts both during construction and operational phases of the scheme (i.e. in the event of routine road runoff discharges and accidental spillages).There are plans by Irish Water to relocate the abstraction point out into the River Corrib main channel downstream of Jordan’s Island. All of the route options fall within the source protection area of the supply. The closest options to the intake in the upstream direction are considered to have the greatest potential for impact both during construction and operation given the distance, speed and mixing volume available. This potentially represents a significant impact on a very high importance attribute both during construction and potentially during the operational phase of the scheme.

Lough Atalia is part of the Galway Bay Complex cSAC and is a coastal lagoon priority habitat. The route options are unlikely to result in any significant impact to water quality, salinity or to the hydrological regime within the coastal lagoon. The overall impact, provided appropriate mitigation is carried out, is likely to have an imperceptible impact on the Galway Bay Complex cSAC.

The Bearna Stream and all watercourses eastwards from this, eventually discharge into the Galway Bay Complex cSAC which is a sensitive waterbody in respect to water quality. The Terryland River by virtue of it disappearing underground and representing a point source to the regionally important karst bedrock aquifer makes it highly sensitive watercourse in respect to pollution.

Red1 Route Option

The Red1 Route Option is located downstream of the Terryland city water supply intake and consequently both operational and constructional works are unlikely to result in an upstream impact to the water abstraction. The potential for migration of disturbed sediment during construction and potential surface plumes from road spillage cannot be ruled out during gate closure at the salmon weirs and prevailing southerly to south-easterly winds. However the risk of this is considered low and the potential impact on such an abstraction is rated as slight to moderate impact. The River Corrib is a Salmonid River and road runoff discharges on the water quality of the River Corrib is rated as high as is potential constructional water quality impacts associated with the bridge crossing. The impact for the smaller watercourses have been assessed under watercourse assessment. This route option does involve works and drainage discharges to the Terryland River which disappears underground and thus represents a source of groundwater pollution to a regionally important karst aquifer and potential source of pollution to the Galway Bay Complex cSAC. This potential impact is rated as high in respect to groundwater and slight in respect to the Galway Bay Complex cSAC.

Orange1 Route Option

The Orange1 Route Option with its long tunnel avoids the River Corrib during construction and its road runoff are unlikely to discharge directly to the River Corrib. The impact for the smaller watercourses have been assessed under watercourse assessment. This route option involves works and drainage discharges to the Terryland River which disappears underground and thus represents a point source of groundwater pollution to a regionally important karst limestone bedrock aquifer and potential source of pollution to the Galway Bay Complex cSAC. This potential impact is rated as high in respect to groundwater and slight in respect to the Galway Bay Complex cSAC.

Yellow1 Route Option

The Yellow1 Route Option crosses the River Corrib upstream of the Terryland city water supply intake and consequently represents a significant risk to a very high attribute water supply receptor being within 1.4km of the intake which at a modest flow velocity of 0.5m/s could see a plume reaching the intake within *c.*50 minutes. The proposed crossing of the River Corrib will be full spanning structure and therefore avoids any in-stream works associated with construction of the piers. Construction impacts of constructing the bridge deck and floodplain piers remain which could potentially cause sedimentation and construction spillages (concretes, hydrocarbons) released into the River Corrib. During the operation stage the road drainage presents a significant risk to the intake and as a Salmonid water in respect to accidental spillages. Mitigation will be required to minimise or eliminate this risk by preventing direct discharge of road drainage to the River Corrib. Routine road runoff is unlikely to cause a significant impact given the high dilution available within the River Corrib.

The impact for the smaller watercourses have been assessed under watercourse assessment.

The Yellow1 Route Option will involve works adjacent to the Coolagh Lakes which are connected directly to the River Corrib 900m upstream of the intake. This combined with the River Corrib crossing increases the works area and road distance that could give rise to serious impact on Lough Corrib cSAC and on the Terryland Water Works supply intake. The potential water quality impact on the Lough Corrib cSAC is assessed as moderate and the potential impact on the Terryland city water supply intake is assessed as high both for construction and operational phases. Operation phase impact can be mitigated to a slight and moderate impact through preventing direct discharge of road drainage to the river and the Coolagh Lake area and providing spillage containment and treatment.

The Yellow1 Route Option involves works and drainage discharges to the Terryland River which disappears underground and thus represents a point source of groundwater pollution to a regionally important karst limestone bedrock aquifer and potential source of pollution to the Galway Bay Complex cSAC. This potential impact is rated as high in respect to groundwater and slight in respect to the Galway Bay Complex cSAC.

Blue1 Route Option

The Blue1 Route Option crosses the River Corrib upstream of the Terryland city water supply intake and consequently represents a significant risk to a very high attribute water supply receptor being within 1.4km of the intake which at a modest flow velocity of 0.5m/s could see a plume reaching the intake within *c.*50 minutes. The proposed crossing of the River Corrib will be full spanning structure and therefore avoids any in-stream works associated with construction of the piers. Construction impacts of constructing the bridge deck (will involve some in stream works from a barrage) and floodplain piers remain which could potentially cause sedimentation, disturbance of the river bed and construction spillages (concretes, hydrocarbons) released into the River Corrib. During the operation stage the road drainage presents a significant risk to the intake and to the Salmonid waters in respect to accidental spillages. Mitigation will be required to minimise or eliminate this risk by preventing direct untreated discharge of road drainage to the River Corrib. Routine road runoff is unlikely to cause a significant impact to the water quality given the high dilution available within the River Corrib relative to road drainage discharges and pollutant loads.

The Blue1 Route Option will involve works adjacent to the Coolagh Lakes which are connected directly to the River Corrib 900m upstream of the intake. This combined with the River Corrib crossing increases the works area and road distance that could give rise to serious impact on Lough Corrib cSAC and on the Terryland Water Works supply intake. The potential water quality impact on the River Corrib is assessed as moderate and the potential impact on the Terryland city water supply intake is assessed as high both for construction and operational phases. Operation phase impact can be mitigated to a slight and moderate impact through preventing direct discharge of road drainage to the River Corrib and the Coolagh lake area and providing spillage containment and treatment.

The impact on the smaller watercourses has been assessed and included for earlier under the assessment of watercourses. The Blue1 Route Option avoids the Terryland River Basin but does pass south of Ballindooley Lough with the potential

for road drainage discharge to the lough and construction impacts caused by the proximity of the route to the flood area of the lough. This is a high attribute receptor and the water quality potential impact is rated as moderate but can be reduced to slight with mitigation in respect to treatment of the road drainage.

Pink1 Route Option

The Pink1 Route Option crosses the River Corrib upstream of the Terryland city water supply intake and consequently represents a significant risk to a very high attribute water supply receptor being within 1.4km of the intake which at a modest flow velocity of 0.5m/s could see a plume reaching the intake within *c.*50minutes. The proposed crossing of the River Corrib will be full spanning structure and therefore avoids any in-stream works associated with construction of the piers. Construction impacts of constructing the bridge deck (will involve some in stream works from a barrage) and floodplain piers remain which could potentially cause sedimentation, disturbance of the river bed and construction spillages (concretes, hydrocarbons) released into the River Corrib. During the operation stage the road drainage presents a significant risk to the intake and to the Salmonid waters in respect to accidental spillages. Mitigation will be required to minimise or eliminate this risk by preventing direct untreated discharge of road drainage to the River Corrib. Routine road runoff is unlikely to cause a significant impact to the water quality given the high dilution available within the River Corrib relative to road drainage discharges and pollutant loads.

The Pink1 Route Option will involve works adjacent to the Coolagh Lakes floodplain area which are connected directly to the River Corrib 900m upstream of the intake. This combined with the River Corrib crossing increases the works area and road distance that could give rise to serious impact on Lough Corrib cSAC and on the Terryland city water supply intake. The potential water quality impact on the Lough Corrib is assessed as moderate and the potential impact on the Terryland Water Works supply intake is assessed as high both for construction and operational phases. Operation phase impact can be mitigated to a slight and moderate impact through preventing direct discharge of road drainage to the River Corrib and the Coolagh Lake area and providing spillage containment and treatment.

The impact on the smaller watercourses has been assessed and included for earlier under the assessment of watercourses. The Pink1 Route Option avoids the Terryland River Basin but does pass south of Ballindooley Lough with the potential for road drainage discharge to the lough and construction impacts caused by the proximity of the route option to the flood area of the lough. This is a high attribute receptor and the water quality potential impact is rated as moderate but can be reduced to slight with mitigation in respect to treatment of the road drainage.

Green1 Route Option

The Green1 Route Option crosses the River Corrib upstream of the Terryland city water supply intake and consequently represents a significant risk to a very high attribute water supply receptor being within 2.2km of the intake which at a modest flow velocity of 0.5m/s could see a plume reaching the intake within *c.*90minutes. The proposed crossing of the River Corrib will be a full spanning structure and therefore avoids any in-stream works associated with construction of the piers. Construction impacts of constructing the bridge deck (will involve some in-stream

works from a barrage) and floodplain piers remain which could potentially cause sedimentation, disturbance of the river bed and construction spillages (concretes, hydrocarbons) released into the River Corrib. During the operation stage the road drainage presents a significant risk to the intake and to the Salmonid waters in respect to accidental spillages. Mitigation will be required to minimise or eliminate this risk by preventing direct untreated discharge of road drainage to the River Corrib. Routine road runoff is unlikely to cause a significant impact to the water quality given the high dilution available within the River Corrib relative to road drainage discharges and pollutant loads.

The impact on the smaller watercourses has been assessed and included for earlier under the assessment of watercourses. The Green1 Route Option avoids the Terryland River Basin but does pass north of Ballindooley Lough with the potential for road drainage discharge to the lough and construction impacts caused by the proximity of the road to the flood area of the Lough. This is a high attribute receptor and the water quality potential impact is rated as moderate but can be reduced to slight with mitigation in respect to treatment of the road drainage.

Water Quality Summary

The Orange1 Route Option is considered to be the most preferred route option as it avoids the River Corrib during construction and its road runoff discharges are unlikely to discharge to the River Corrib. This route option does involve works and drainage discharges to the Terryland River.

The Red1 Route Option is ranked second as it is located downstream of the Terryland Water supply intake notwithstanding the in-stream works associated with its bridge piers and the degree of encroachment within the Terryland River Basin and potential outfalls to the Terryland River.

The Green1 Route Option is ranked third having the furthest upstream river crossing from Terryland intake, followed in fourth by the Blue1 and Pink1 Route Options and in fifth by the Yellow1 Route Options which involve works and drainage discharges to the Terryland River.

Summary of Section 2 Assessment

Table 6.5.4.3 below outlines the order of preference for the hydrological aspects with respect to each of the route options. The routes have been ranked from 1 to 6 with 1 being the most favourable and 6 being the least favourable in terms of hydrological impacts along each of the route options. Assessment rankings have been assigned under the following headings: River Corrib crossing, hydro-ecology, flood risk and watercourses and water quality. The sum of the rankings for each route was calculated and the order of preference for the routes was assigned.

Table 6.5.4.3 Section 2 Hydrology Assessment

Route Option	River Corrib crossing	Hydro-ecology	Flood Risk and Watercourses	Water Quality	Total Score	Rank	Preference
Red1	6	2	4	2	14	4	I
Orange1	1	1	3	1	6	1	P
Yellow1	2	5	6	6	19	6	I/ LP
Blue1	2	3	1	5	11	3	I
Pink1	2	3	1	4	10	2	I
Green1	5	6	5	3	19	5	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.4.4 Summary

In terms of impact to hydrology all of the route options are considered to be feasible with engineering solutions available to mitigate all significant impacts both during construction and during operation.

Table 6.5.4.4 Hydrology Assessment Ranking Summary

Route Option	Section 1	Section 2
Red1	P	I
Orange1	P	P
Yellow1	I/LP	LP
Blue1	I	I
Pink1	I	I
Green1	I/LP	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

For Section 1, all route options are considered acceptable in terms of not causing significant hydrological impact with the least preferred being the Green1 and Yellow1 Route Option. The other route options all scored the same with the Red1 and Orange1 Route Option being identified as preferred.

For Section 2, all corridors are considered acceptable in terms of not causing significant hydrological impact. The Yellow1 Route Option is considered to be the least preferable scoring the lowest rank on two of the four assessment categories. The Orange1 Route Option is the preferred option. The Blue1, Pink1, Red1, Green1 Route Options all scored similarly.

6.5.4.5 References

The Office of Public Works (1987) *Hydraulic and Hydrologic Investigation of Lough Corrib Flow Regime and of Gate Manipulation Policy at Galway Sluice Barrage.*

The Office of Public Works CFRAM. *Western Basin Corrib Catchment – Inception Report.*

The Office of Public Works. *Preliminary Flood Risk Assessment (pFRA) Mapping for County Galway.*

The Office of Public Works CFRAM. *Flood Extent and Flood Zone Mapping – Corrib Catchment Galway City.*

Tobin Consulting Engineers (1999) *Terryland River Valley Drainage Scheme for Galway Corporation.*

Hydro Environmental Ltd. *Strategic Flood Risk Assessment Study of NUI Galway Campus (Oct 2011)*

Galway Harbour Extension EIS. (2014) *Chapter 8 Water*

The Office of Public Works. Flood Studies update web Portal http://opw.hydronet.com/

The Office of Public Works. *Network of live gauged water level data* http://waterlevel.ie/

The Office of Public Works Floodmaps. i.e. Historical archived flood events web site http://floodmaps.ie/

Environmental Protection Agency. Hydrotool web site for estimating low flow and flow duration in gauged and ungauged Irish rivers and streams http://watermaps.wfdireland.ie/HydroTool/

N6 Galway Outer Bypass – *Constraints Study 2006*

N6 Galway Outer Bypass – *Route Selection Study 2006*

N6 Galway Outer Bypass – *EIS Reports 2008*

Environmental Protection Agency. (2015) *Water Quality in Ireland 2010-2012*

Western River Basin Management Plan 2009-2015

Water Maps Mapping Information System to support River Basin Management Plans http://www.wfdireland.ie/maps.html

National Roads Authority. (2008) *Guidelines on Procedures for Assessment and Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes*

6.5.5 Landscape and Visual

6.5.5.1 Introduction

This section details the Stage 1 assessment of the route options with respect to the constraints associated with landscape and visual identified in **Section 4.7 Landscape and Visual** of this report. The route options as described in **Section 6.1** while the landscape and visual constraints are presented in **Figures 6.5.5.1** to **6.5.5.12**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.5.2 outlines the methodology that was used to carry out the study and **Section 6.5.5.3** details the options assessment. A summary is presented in **Section 6.5.5.4** and references are listed in **Section 6.5.5.5.**

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 is from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.5.5.2 Methodology

The Landscape and Visual assessment focuses on the potential impacts on both the physical landscape/townscape and visual environments.

The landscape/townscape and visual assessment is based on the methodology provided by the Advice Notes and Guidelines for Environmental Impact Assessment as prepared by the Environmental Protection Agency (EPA), supplemented by the Guidelines for Landscape and Visual Impact Assessment (3rd Ed.) produced by the Landscape Institute (UK) and Institute of Environmental Assessment, as well as the Environmental Assessment and Construction Guidelines produced by the NRA.

For the purposes of the assessment, drawings of horizontal and vertical alignment of each route option were analysed as was information on associated link roads, bridges and junction strategies.

The nature of the existing environment is varied ranging from established city suburbs comprising the typical mix and interaction of residential estates, community/social uses, commercial and business uses as well as amenity and recreational assets – to rural (city edge) landscapes comprising a diverse mix of agricultural landscapes, trees, hedgerows, scrub and small woodlands, river, lake and wetland corridors, areas of peat bog and rock outcrop, shallow valleys and low hills – some with deep rock quarries, as well as significant residential development along local roads and in village clusters.

The development of any route option within such an environment will result in significant landscape/townscape and visual impacts. The nature, extent and duration of such impacts will depend on the intensity of the development; the proximity of residential and related amenity uses; the magnitude of direct impact – and/or

removal; the degree and duration of disruption; the sensitivity of the resource and the rarity and/or uniqueness of the landscape. Impacts on landscape/townscape and visual environment are also influenced by interaction with other effects such as community/human beings, noise, air quality, heritage, etc.

The significance of impacts on the landscape/townscape and visual environment is considered as per the EPA Guidelines on EIS, as follows:

Profound Impact: Is an impact that obliterates sensitive characteristics.

Significant Impact: Is an impact, which by its character, magnitude, duration or intensity, alters a sensitive aspect of the environment.

Moderate: An impact that alters the character of the environment in a manner that is consistent with existing and emerging trends.

Slight: An impact, which causes noticeable changes in the character of the environment without affecting its sensitivities.

Imperceptible: An impact capable of measurement but without noticeable consequences.

However, for the purposes of the route options study the assessment has focused on identifying potentially significant and profound impacts on the landscape/townscape and visual environment.

The likely profound and significant impacts on the physical landscape/townscape and visual environments are presented in the following sections on a route-by-route basis. Thereafter a ranking of preference – based on significant and profound landscape/townscape and visual impacts – is provided for the route options.

Figures 6.5.5.1 to **6.5.5.12** indicate likely profound and significant impacts on the landscape/townscape and visual environment for each route option.

6.5.5.3 Option Assessment

A detailed description for each of the route options is described in **Section 6.1** and shown on **Figures 6.1.1** and **6.1.2**.

For the purposes of the landscape and visual option assessment both the construction and operational considered.

Development of any of the route options presents a significant challenge in terms of the landscape/townscape and visual environments. It is clear that each and every route option will result in very significant negative landscape and visual impacts both during construction and in operation. This is a result of the constrained nature of the physical landscape – shoehorned as it is between the city to the south and Lough Corrib to the north; the attractiveness and quality of the local landscape – and especially of the river/lake corridor; the developed and established extent of the city suburbs, with its diverse mix of residential, commercial, community, open space, recreational, and social land uses; the presence of architectural and cultural features; and the noted prominence and density of primarily – but not exclusively –

residential development radiating out along and between local, regional and national roads throughout the scheme study area.

An outline assessment of each option is provided in the following sections.

Red1 Route Option

The alignment of the Red1 Route Option closely follows the line of the existing Seamus Quirke Road through the existing established city suburbs. The principal aspects of the route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Red1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly in the vicinity of Browne Roundabout and through Rahoon;
- Direct take/removal of existing (retained) residential amenities, including footpaths, gardens, roads, and associated open space – most especially from River Corrib west along Seamus Quirke Road through Rahoon to the Western Distributor Road;
- Direct and indirect impacts – including demolition – on other community, social and recreational-related buildings and land uses, including at NUIG grounds west of the River Corrib and from Browne Roundabout through Rahoon;
- Direct take/removal of existing open space, amenity, parkland, plantings along the road corridor – particularly through Terryland Forest/River Park to River Corrib;
- Disturbance, excavation, earthworks, construction activity and traffic, lighting and related noise, dust effects etc.;
- Significant level of interim traffic management/re-allocation/diversion/temporary works over many phases of construction programme;
- Long-term, intense nature of construction works directly adjacent to residential, community, social, amenity and recreation areas/uses as well as alongside schools and the university, churches, hospital, shops and workplaces, etc.;
- The construction of significant underground and overground structures – including an elevated viaduct and section of tunnel – through an existing developed environment; and
- Impact on Protected Views on existing Quin Bridge over the River Corrib, as well as along R338 east to Kirwan Roundabout and north south along the east bank of the River Corrib (Views V.1, V.2, V.14 and V.16).

* Total demolitions on the Red1 Route Option are outlined in **Section 6.5.8 Material Assets – Non- Agricultural**.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of all of these aspects will give rise to locally pervasive and profoundly negative impacts on the townscape and visual character of the existing urban/developed environment – most particularly from Terryland Forest Park, through NUIG grounds and from Browne Roundabout to Rahoon and through to the Western Distributor Road.

Operation Stage

The following are the principal aspects of the Red1 Route Option that would give rise to the significant and profound landscape/townscape and visual impacts during operation:

- Provision of an elevation section of viaduct through an existing developed area – with consequently elevated traffic, noise issues/barriers, illumination, road lighting etc.;
- The provision of a second bridge over the River Corrib in close proximity to the existing bridge – which includes protected views - and through existing developed areas of NUIG;
- The provision – at various levels – of a wide corridor of multi-lane road development through an existing sensitive community of mixed residential, community, social, hospital and amenity land uses in the vicinity of Browne Roundabout. Impacts would be compounded by noise/noise barriers, lighting and additional traffic impacts; and
- The direct and indirect effect of the loss of a significant number of existing residences from the communities at Rahoon – albeit with a reinstated landscape corridor over the proposed tunnel post construction.

Again whilst individual impacting aspects are outlined above it is considered that the collective effect of the scale of major infrastructure required to be provided will give rise to unacceptable, overbearing and residual negative impacts on the townscape and visual character of the corridor – most particularly from Terryland Forest Park, through NUIG grounds and from Browne Roundabout to Rahoon and through to the Western Distributor Road.

Overall Landscape/Townscape Effects ***– Profound Adverse.***

Overall Visual Effects – ***Profound to Significant Adverse.***

Orange1 Route Option

The alignment of the Orange1 Route Option alignment runs north from east of Bearna past Ballyburke to a proposed tunnel that extends from Letteragh northwest of the city, underneath Newcastle, the River Corrib at Jordan's Island, and Terryland to emerge at Glenanail on the northeast side of the city. From Glenanail the Orange1 Route follows the existing N6 past Ballybrit to the east of the city.

The principal aspects of the route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Orange1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly in the vicinity of the two tunnel portals at Letteragh and Terryland and at Knockaunnacarragh (Bearna), Ballard West, Glenanail and at Coolagh-Briarhill;
- Direct take/removal of existing (retained) residential amenities, including footpaths, gardens, roads, and associated open space – most especially at Bearna, Ballard West (north of Bearna); at Ballyburke-Keeraun, at Mincloon, at Letteragh, at Terryland andat Bushypark (realigned N59);
- Direct take/removal of existing open space, amenity, parkland, plantings along the route option – particularly north of Bearna and at Terryland Forest Park;
- Disturbance, excavation, earthworks, construction activity and traffic, lighting and related noise, dust effects *etc*. - most especially at the location of the two tunnel portal sites in Letteragh and Terryalnd/Glenanail;
- Significant level of interim traffic management/re-allocation/diversion/temporary works over many phases of construction programme;
- Long-term, intense nature of construction works directly adjacent to residential, community, social, amenity and recreation areas/uses as well as alongside other community and social uses, most especially at the location of the two tunnel portal sites in Letteragh and Terryland;
- The construction of significant underground and overground structures – including a long tunnel – through an existing developed urban environment;
- Impact on Protected View Number 72 north of Bearna Village; and
- Potential impact on Greenway proposals - most especially along stream north of Bearna and at Terryland Forest Park.

* Total demolitions on the Orange1 Route Option are outlined in **Section 6.5.8** Material Assets – Non- Agricultural.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of all of these aspects will give rise to locally pervasive and profoundly negative construction impacts on very significant impacts on landscape/townscape and visual character – most particularly at the two tunnel portal sites at Letteragh and Terryland/Glenanail.

Operation Stage

The following are the principal aspects of the Orange1 Route Option that would give rise to the significant and profound landscape/townscape and visual impacts during operation:

- The direct and indirect effect of the loss of a significant number of existing residences from with the communities at Ballard West, Terryland/Glenanail and elsewhere along the route option;
- Provision of major road infrastructure through established residential communities;
- Impact of major road infrastructure on existing established amenity at Terryland Forest Park;
- General impact - visual disturbance of road infrastructure, noise issues/barriers, illumination, road lighting *etc*., on residential property at disperse locations along the route;
- Impact on Protected View Number 72 north of Bearna Village; and
- The provision of two tunnel portal sites within existing established residential areas.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of the scale of major infrastructure required to be provided will give rise to significant and residual negative impacts on residential development and on the character of the corridor along the route option – most particularly at the portal sites at Letteragh and Terryland/Glenanail.

Overall Landscape/Townscape Effects - ***Significant - Moderate Adverse.***

Overall Visual Effects - *Significant* - ***Moderate Adverse.***

Yellow1 Route Option

The Yellow1 Route Option alignment passes outside of, and in parts through, the outer central suburbs of the northern city. The Yellow1 Route Option is in-part similar to the Blue1 and Pink1 Route Options but in contrast, has a more westerly tie-in to the R336 west of Bearna and utilises a greater length of the existing N6 at Ballybrit to the east of the city. The principal aspects of the route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Yellow1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly in the crossing local roads at Na Forraí Maola Thiar (Bearna), at Ballard West, between The Heath and Aughnacurra to either side of the N59 at Upper Dangan, at Carraig Bán, at Sceilg Ard (near the crossing of the N84 at Ballinfoyle), at Glenburren Park/Glenanail and at Coolagh-Briarhill and at Bushypark (along realigned N59);
- Direct take/removal of existing (retained) residential amenities, including property boundaries, portions of gardens, *etc.* – most particularly to either side of the N59 at Upper Dangan; as well as at dispersed locations along the length

of the route option, including at, Na Foraí Maola, Trusky West, Ballard West, Ballyburke-Keeraun, Carraig Bán, and at Sceilg Ard, (Ballinfoyle), at Glenanail, and at Coolagh-Briarhill;

- Profound impact on the existing amenity, NUIG Recreational Facilities at Dangan Upper and at St James's National School, Bushypark;
- Significant new bridging of the River Corrib at naturally attractive setting in foreground of view/setting of Menlo Castle;
- Direct take/removal/impact on existing/proposed open space, natural amenity, landscape character, plantings – particularly in crossing the natural setting of the River Corrib and in passing Coolagh-Menlough, but also in running along stream/proposed greenway north of Bearna, in crossing open space/stream west of Ballyburke at the sports facility at Carraig Bán/Ballinfolyle and at Terryland Forest Park;
- General disturbance, excavation, earthworks, construction activity, lighting and related noise, dust effects *etc*., including removal of existing boundaries and vegetation, soil stripping and storage, raising of embankments, cutting of slopes, and construction traffic;
- Significant level of interim local traffic management/re-allocation/diversion/temporary works over phases of construction programme. Works will require construction of new bridging structures and local road re-alignments;
- Impact on Protected County View Numbers 72 & 74 north of Bearna Village; and
- Potential impact on Greenway proposals - most especially along stream north of Bearna, along River Corrib and at Terryland Forest Park.

* Total demolitions on the Yellow1 Route Option are outlined in **Section 6.5.8 Material Assets – Non- Agricultural**.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of all of these aspects will give rise to locally pervasive and profoundly negative impacts on the residential, amenity, recreational and visual character of the existing established environments - residential uses and NUIG Recreational Facilities – in crossing N59 at Upper Dangan and in crossing the River Corrib, as well as passing the residential areas at Na Forraí Maola Thiar, of Carraig Bán and at Sceilg Ard, Ballinfoyle.

Operation Stage

The following are the principal aspects of the Yellow1 Route Option that would give rise to the significant and profound landscape/townscape and visual impacts during operation:

- The direct and indirect effect of the loss of a significant number of existing residences from with the communities at Forramoyle West (Bearna), Ballard West, Upper Dangan, Carraig Bán/Sceilg Ard,/Ballinfoyle - and elsewhere along the route option;

- Provision of major road infrastructure through established residential communities at Upper Dangan, Coolagh-Menlough, Carraig Bán, Sceilg Ard, Ballinfoyle, and Coolagh-Briarhill;
- Impact of major road infrastructure on existing established NUIG sporting facility/amenity at Upper Dangan, St. James's National School, Bushypark, sports facility at Ballinfoyle and Terryland Forest Park;
- General impact - visual disturbance of road infrastructure, noise issues/barriers, illumination, road lighting *etc*., on residential property at disperse locations along the route option
- Impact on Protected County View Numbers 72 & 74 north of Bearna Village; and
- The provision of a bridge over the River Corrib in an existing high quality natural landscape setting close to riverside setting of Menlo Castle.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of the scale of major infrastructure required to be provided will give rise to very significant and residual negative impacts on residential development and on the character of the corridor – most particularly from Upper Dangan across the River Corrib, through Coolagh-Menlough to Sceilg Ard, Ballinfoyle to the existing N6 west of Ballybrit.

Overall Landscape/Townscape Effects - ***Profound Adverse.***

Overall Visual Effects - ***Profound Adverse.***

Blue1 Route Option

The alignment of the Blue1 Route Option passes outside of, and in parts through, the outer suburbs of the city. The Blue1 Route Option is broadly similar to the Pink1 Route Option - but in contrast, passes through Galway Racecourse at Ballybrit. The principal aspects of this route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Blue1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly in crossing the N59 (from The Heath through Aughnacurra) at Dangan, in crossing the N84 Headford Road and in passing through Castlegar but also at dispersed locations along the length of the route option, including Ballindooley and Castlegar;
- Direct take/removal of existing (retained) residential amenities, including property boundaries, portions of gardens, *etc.* – most particularly to either side of the N59 at Dangan; as well as at dispersed locations along the length of the

route option, including at Bearna, Ballyburke, Letteragh, Coolagh-Menlough and in crossing R339 at Ballybrit;

- N84 Link has a significant impact on established residential areas at Ballagh/Bushypark;
- Profound impact on the existing amenity, NUIG Recreational Facilities at Dangan Upper and St. James's National School, Bushypark;
- Significant new bridging of the River Corrib at naturally attractive setting in foreground of view/setting of Menlo Castle;
- Very significant/profound impact on setting of Galway Racecourse;
- Direct take/removal/impact on existing/proposed open space, natural amenity, landscape character, plantings – particularly in crossing the natural setting of the River Corrib and in passing Castlegar, but also in running along stream/proposed greenway north of Bearna, in crossing open space/stream west of Ballyburke, in crossing Ballybrit and Coolagh;
- General disturbance, excavation, earthworks, construction activity, lighting and related noise, dust effects *etc*., including removal of existing boundaries and vegetation, soil stripping and storage, raising of embankments, cutting of slopes, and construction traffic;
- Significant level of interim local traffic management/re-allocation/diversion/temporary works over phases of construction programme. Works will require construction of new bridging structures and local road re-alignments;
- Impact on Protected County View Number 72 north of Bearna Village and Scenic City Views V.19 at N84 and V.6 both at Ballinfoyle; and
- Potential impact on Greenway proposals - most especially along stream north of Bearna and along River Corrib.

* Total demolitions on the Blue1 Route Option are outline in **Section 6.5.8 Material Assets – Non- Agricultural**.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of all of these aspects will give rise to locally pervasive and profoundly negative impacts on the residential, amenity, recreational and visual character of the existing established environments - residential uses and NUIG Recreational Facilities – in crossing N59 at Upper Dangan and west thereof and in crossing the River Corrib.

Operation Stage

The following are the principal aspects of the Blue1 Route Option that would give rise to the significant and profound landscape/townscape and visual impacts during operation:

- The direct and indirect effect of the loss of a significant number of existing residences from within the communities at Upper Dangan, Ballindooley, Castlegar - and elsewhere along the route option;

- Provision of major road infrastructure through established residential communities at Upper Dangan, Ballindooley, Castlegar and Coolagh-Briarhill;
- Impact of major road infrastructure on existing established NUIG Recreational Facility/amenity at Upper Dangan, on St. James's National School, Bushypark and on Galway Racecourse;
- General impact - visual disturbance of road infrastructure, noise issues/barriers, illumination, road lighting *etc*., on residential property at disperse locations along the route option;
- Impact on Protected County View Number 72 north of Bearna Village and Scenic City Views V.19 at N84 and V.6 both at Ballinfoyle, and
- The provision of a bridge over the River Corrib in an existing high quality natural landscape setting close to riverside setting of Menlo Castle.

Again whilst individual impacting aspects are outlined above it is considered that the collective effect of the scale of major infrastructure required to be provided will give rise to very significant and residual negative impacts on residential property and on the character of the corridor – most particularly to either side of the N59 through Upper Dangan, at Castlegar and in crossing the River Corrib.

Overall Landscape/Townscape Effects - ***Profound to Significant Adverse.***

Overall Visual Effects - ***Profound to Significant Adverse.***

Pink1 Route Option

The alignment of the Pink1 Route Option passes outside of, and in parts through, the outer suburbs of the city. The Pink1 Route Option is broadly similar to the Blue1 Route Option - but in contrast, passes largely to the east of Galway Racecourse at Ballybrit and has an alternative alignment along a short section from the N59 to bridging the River Corrib. The principal aspects of the route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Pink1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly at Ballard West, and from The Heath to Aughnacurra (in crossing the N59 at Dangan and west thereof) but also at dispersed locations along the length of the route option, including at Menlough, Ballindooley and Castlegar;
- Direct take/removal of existing (retained) residential amenities, including property boundaries, portions of gardens, *etc.* – most particularly to either side of the N59 at Dangan and west thereof; as well as at dispersed locations along the length of the route, including Bearna, Castlegar and Coolagh-Briarhill.
- Profound impact on the existing amenity, NUIG Recreational Facilities at Dangan Upper and at St James's National School, Bushypark;

- Significant new bridging of the River Corrib at naturally attractive setting in foreground of view/setting of Menlo Castle;
- Direct take/removal/impact on existing/proposed open space, natural amenity, landscape character, plantings – particularly in crossing the natural setting of the River Corrib and in passing Castlegar, but also in running along stream/proposed greenway north of Bearna, in crossing open space/stream west of Ballyburke and Coolagh-Briarhill;
- General disturbance, excavation, earthworks, construction activity, lighting and related noise, dust effects *etc*., including removal of existing boundaries and vegetation, soil stripping and storage, raising of embankments, cutting of slopes, and construction traffic;
- Significant level of interim local traffic management/re-allocation/diversion/temporary works over phases of construction programme. Works will require construction of new bridging structures and local road re-alignments;
- Impact on Protected County View Number 72 north of Bearna Village and Scenic City View V.19 at N84 and V.6 both at Ballinfoyle; and
- Potential impact on Greenway proposals - most especially along stream north of Bearna and along River Corrib.

* Total demolitions on the Pink1 Route are outlined in **Section 6.5.8 Material Assets – Non- Agricultural**.

Whilst individual impacting aspects are outlined above it is considered that the collective effect of all of these aspects will give rise to locally pervasive and profoundly negative impacts on the residential, amenity, recreational and visual character of the existing established environments - residential uses and NUIG Recreational Facilities – in crossing N59 at Upper Dangan, west thereof, in crossing the River Corrib, at Castlegar and at Coolagh-Briarhill.

Operation Stage

The following are the principal aspects of the Pink1 Route Option that would give rise to the significant and profound landscape/townscape and visual impacts during operation:

- The direct and indirect effect of the loss of a significant number of existing residences from with the communities at Upper Dangan and west thereof - and elsewhere along the route option;
- Provision of major road infrastructure through established residential communities at Ballard West, The Heath, Upper Dangan, Menlough, Ballinfoyle Castlegar and Coolagh-Briarhill;
- Impact of major road infrastructure on existing established NUIG Recreational Facilities/amenity at Upper Dangan and St. James's National School, Bushypark;

- General impact - visual disturbance of road infrastructure, noise issues/barriers, illumination, road lighting *etc*., on residential property at disperse locations along the route option;
- Impact on Protected County View Number 72 north of Bearna Village and Scenic City View V.19 at N84 and V.6 both at Ballinfoyle, and
- The provision of a bridge over the River Corrib in an existing high quality natural landscape setting close to riverside setting of Menlo Castle;

Again whilst individual impacting aspects are outlined above it is considered that the collective effect of the scale of major infrastructure required to be provided will give rise to very significant and residual negative impacts on residential development and on the character of the corridor – most particularly from Upper Dangan, in crossing the River Corrib.

Overall Landscape/Townscape Effects - ***Profound to Significant Adverse.***

Overall Visual Effects - ***Profound to Significant Adverse.***

Green1 Route Option

The alignment of the Green1 Route Option passes through the more rural or edge of city landscape north of Galway City. Nevertheless, the alignment still interacts with significant areas of established development – primarily residential and amenity/recreation related. The principal aspects of this route option most likely to give rise to the greatest level of significant and profound negative impacts are set out in the following.

Construction Stage

The following are the principal aspects of the Green1 Route Option that would give rise to the significant and profound impacts on the landscape/townscape and visual environments during construction:

- Demolition of significant numbers of existing residential properties* – particularly at Na Forraí Maola Thiar (Bearna) in crossing the N59 at Ballagh/Bushypark/Dangan Lower, in passing through the village settlement of Menlough, in passing through Ballindooley and in crossing Ballybrit Crescent and the R339 at Coolagh-Briarhill;
- Demolition of other residential properties* at specific locations – mainly in crossing local roads and at dispersed rural locations along the length of the route option (*e.g*. north of Bearna, at Ballyburke and Keeraun, in crossing Letteragh Road, at Monument Road Menlough-Kiloughter, and along the realigned N84 at Ballindooley Cross);
- Direct take/removal of existing (retained) residential amenities, including property boundaries, portions of gardens, *etc*. – most particularly at Na Forraí Maola (Bearna) to either side of the N59 at Bushypark; in passing through the village settlement of Menlough and east thereof, at Coolagh-Briarhill, as well as at dispersed locations along the length of the route option;

- Significant new bridging of the River Corrib at remote, naturally attractive setting close to mouth from Lough Corrib. Bridge crossing also in background of view/setting of Menlo Castle;
- Direct take/removal/impact on existing/proposed open space, natural amenity, landscape character, plantings – particularly in crossing the natural setting of the River Corrib and passing Ballindooley Lough, but also in crossing natural stream corridors north of Bearna, and west of Ballyburke;
- Impact on existing amenity/recreation facilities (e.g. Equestrian facility at Bushypark, Glenlo Abbey Golf Course, and general amenity along the River Corrib);
- General disturbance, excavation, earthworks, construction activity, lighting and related noise, dust effects *etc*., including removal of existing boundaries and vegetation, soil stripping and storage, raising of embankments, cutting of slopes, and construction traffic;
- Significant level of interim local traffic management/re-allocation/diversion/temporary works over phases of construction programme. Works will require construction of new bridging structures and local road re-alignments;
- Impact on Protected County Views Numbers 72 & 74 north of Bearna Village and No. 70 between the N59 and River Corrib, as well as Scenic City Views V.10 at N59 Bushypark, V.7 at Monument Road (Menlough-Kiloughter) and to a lesser extent V.19 at N84 and V.6 both at Ballinfoyle; and
- Potential impact on Greenway proposals - most especially along River Corrib towards Lough Corrib.

* Total demolitions on the Green1 Route Option are outlined in **Section 6.5.8 Material Assets – Non- Agricultural**.

It is considered that the individual impacting aspects outlined above will in combination give rise to locally pervasive and profound negative impacts from intense construction activity on the village, community and visual character of Menlough and Coolagh-Briarhill; and on established residential communities located to either side of the N59 at Bushypark, and at Ballindooley Lough; as well as on the natural landscape character of the corridor of the River Corrib.

Operation Stage

The following are the principal aspects of the Green1 Route Option that would give rise to the significant and profound landscape / townscape and visual impacts during operation:

- The direct and indirect effect of the loss of a significant number of existing residences from within the Bushypark, Menlough, Ballindooley and Coolagh-Briarhill communities;
- Provision of major road infrastructure through established residential communities at Na Forraí Maola (Bearna), Bushypark, Menlough, Ballindooley and Coolagh-Briarhill;

- General impact - visual disturbance of road infrastructure, noise issues/barriers, illumination, road lighting *etc*., on residential property at disperse locations along the route option;
- Impact on Protected County Views Numbers 72 and 74 north of Bearna Village, and No. 70, between the N59 and River Corrib, as well as Scenic City Views V.7 at Monument Road, and V19 and V.6 at Ballinfoyle; and
- The provision of a bridge over the River Corrib in an existing high quality natural landscape setting close to riverside setting of Menlo Castle.

It is considered that the collective effect of impacts related to the scale of major infrastructure required to be provided - often within established residential community - will give rise to particularly significant and residual adverse impacts on the landscape/townscape and visual environment of the road corridor between Bushypark/N59 and east of Menlough.

Overall Landscape/Townscape Effects - ***Profound to Significant Adverse.***

Overall Visual Effects - ***Profound Adverse.***

6.5.5.4 Summary

The difference between the various route options is less distinct within Section 1. Nevertheless, the Blue1 and Pink1 Route Options are preferred, followed by the Orange1 and Red1 Route Options with the Green1 and Yellow1 least preferred.

By contrast impacts tend to be more expansive, intense and of greater duration and scale – with notable differences within Section 2. That said in overall terms, it is clear that each and every route option presents significant impacts in terms of landscape/townscape and visual impacts. The intensity of proposed route options in combination with the nature, scale and duration of impact means that the Green1 and Red1 Route Options are least preferable in landscape/townscape and visual terms. Whilst still having some very significant landscape/townscape and visual impacts, the Blue1, Yellow1 and Pink1 Route Options are of varying intermediate preference, with the Pink1 Route Option being best of the three because of lesser impact at Galway Racecourse. As a result of the long section of tunnel - and notwithstanding very significant construction impacts at portal sites - the Orange1 Route Option is considered to be most preferable in terms of landscape/townscape and visual effects.

The Orange1, Yellow1, Blue1 and Pink1 Route Options all require provision of a new link to the N59. Of the two options proposed – Blue1/Yellow1/Pink1 and Orange1 - the Orange1 Option is preferable as a result of appreciably lesser visual impact and impact on residential amenity at Bushypark in general.

Table 6.5.5.1 Summary of Landscape and Visual Aspects ranking of Route Options

Route Option	Section 1	Section 2
Red1	LP	LP
Orange1	LP	P
Yellow1	P	LP

Route Option	Section 1	Section 2
Blue1	I	LP
Pink1	I	I
Green1	LP	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.5.5 References

Enviornomental Protection Agency. (2003) *Advice Notes on Information Advice Notes on Current Practice (in the preparation of Environmental Impact Statements).*

Enviornmental Protection Agency. (2002) *Guidelines on Information to be contained in Environmental Impact Statements.*

Galway City Council. (2011) *Galway County Development Plan 2011-2017*.

Galway County Council. (2007) *Bearna Local Area Plan 2007-2017*.

Galway County Council. (2015) *Galway County Development Plan 2015-2021*.

Landscape Institute & IEMA (2014) *Guidelines for Landscape and Visual Impact Assessment*, 3rd Ed.

National Roads Authority. (2008) *Environmental Impact Assessment of National Road Schemes – A Practical Guide.*

6.5.6 Archaeological, Architectural and Cultural Heritage

6.5.6.1 Introduction

This section details the stage 1 assessment of the route options with respect to the constraints associated with archaeological, architectural and cultural heritage identified in **Section 4.11** Archaeological, Architectural and Cultural Heritage of this report. The route options as described in **Section 6.1** with the archaeological, architectural and cultural heritage constraints are presented in **Figures 6.5.6.1** and **6.5.6.6**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.6.2 outlines the methodology that was used to carry out the study and **Section 6.5.6.3** details the options assessment. A summary is presented in **Section 6.5.6.4** and references are listed in **Section 6.5.6.5**.

The route options are assessed in two sections as shown on Figure 6.1.1 and 6.1.2. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options. Constraints identified during the initial constraints study consist of the following:

- Recorded Monuments & Places (RMP);
- Sites and Monuments Record (SMR);
- National Monuments;
- Monuments protected with a Preservation Order;
- Protected Structures;
- National Inventory of Architectural Heritage;
- Architectural Conservation Areas;
- Designed Landscapes;
- Previous Archaeological Excavations; and
- Previously unrecorded cultural heritage sites.

6.5.6.2 Methodology

The following impact types and definitions were used in order to assess the potential impacts of the proposed route options. The result of this assessment leads to an order of preference for the route options regarding the cultural heritage resource.

Impact Definitions

The quality and type of an impact can vary to include the following (as per NRA's Guidelines for the Assessment of Archaeological/Architectural Heritage Impacts of National Road Schemes (NRA, 2005, 25/54):

Negative Impact: A change that will detract from or permanently remove an archaeological/architectural monument/structure from the landscape.

Neutral Impact: A change that does not affect the archaeological/architectural heritage.

Positive Impact: A change that improves or enhances the setting of an archaeological/architectural monument/structure.

Direct Impact: Where an archaeological/architectural feature or site is physically located within the footprint of a potential route and entails the removal of part, or all of the monument or feature.

Indirect Impact: Where a feature or site of archaeological/architectural heritage merit or its setting is located in close proximity to the footprint of a potential route alignment.

No Predicted Impact: Where the potential route does not adversely or positively affect an archaeological/architectural heritage site.

It should be noted that whilst impact levels and definitions are applied consistently to the cultural heritage resource, direct impacts on sites that are subject to statutory protection are considered to be more significant during the route selection process.

Impact Definitions (as outlined in the NRA's Guidelines for the Assessment of Archaeological/Architectural Heritage Impacts of National Road Schemes (NRA, 2005, 54/21).

Table 6.5.6.1 Impact Definitions: Archaeology

Type of Impact	Definitions relating to sites of an archaeological nature
Profound	Applies where mitigation would be unlikely to remove adverse effects. Reserved for adverse, negative effects only. These effects arise when an archaeological site is completely and irreversibly destroyed by a proposed development.
Significant	An impact which, by its magnitude, duration or intensity, alters an important aspect of the environment. An impact like this would be where part of a site would be permanently impacted upon, leading to a loss of character, integrity and data about the archaeological feature/site.
Moderate	A moderate impact arises where a change to the site is proposed, which although noticeable, is not such that the archaeological integrity of the site is compromised and which is reversible. This arises where an archaeological feature can be incorporated into modern day development without damage and that all procedures used to facilitate this are reversible.
Slight	An impact which causes changes to the character of the environment which are not significant or profound and do not directly impact or affect an archaeological feature or monument.
Imperceptible	An impact capable of measurement but without noticeable consequences.

Table 6.5.6.2 Impact Definitions: Architecture

Type of Impact	Definitions relating to sites of an archaeological nature
Profound	An impact that obliterates the architectural heritage of a structure or feature of national or international importance. These effects arise where an architectural structure or feature is completely and irreversibly destroyed by the proposed development. Mitigation is unlikely to remove adverse effects.
Significant	An impact that, by its, magnitude, duration or intensity alters the character and/or setting of the architectural heritage. These effects arise where an aspect or aspects of the architectural heritage is/are permanently impacted upon leading to a loss of character and integrity in the architectural structure or feature. Appropriate mitigation is likely to reduce the impact.
Moderate	An impact that results in a change to the architectural heritage which, although noticeable, is not such that alters the integrity of the heritage. The change is likely to be consistent with existing and emerging trends. Impacts are probably reversible and may be of relatively short duration. Appropriate mitigation is very likely to reduce the impact.
Slight	An impact that causes some minor change in the character of architectural heritage of local or regional importance without affecting its integrity or sensitivities. Although noticeable, the effects do not directly impact on the architectural structure or feature. Impacts are reversible and of relatively short duration. Appropriate mitigation will reduce the impact.
Imperceptible	An impact on architectural heritage of local importance that is capable of measurement but without noticeable consequences.

6.5.6.3 Option Assessment

The impacts along each of the route options are summarised in the following section in **Tables 6.5.6.3** to **6.5.6.14**.

Section 1

Red1 Route Option

Table 6.5.6.3 Potential Impacts on the Red1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
DL 1	Eagle Lodge and demesne	No	0m	Direct	Moderate negative

Orange1 Route Option

Table 6.5.6.4 Potential Impacts on the Orange1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
DL 1	Eagle Lodge and demesne	No	0m	Direct	Moderate negative

Yellow1 Route Option

Table 6.5.6.5 Potential Impacts on the Yellow1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 1	Redundant record	No	40m east	N/a	N/a
CH 1	Enclosure (2006 EIS)	No	40m east	Indirect	Moderate negative

Blue1 Route Option

Table 6.5.6.6 Potential Impacts on the Blue1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 66	Ringfort - cashel	No	42m NNW	Indirect	Slight negative
AH 68	Church	**Yes**	136m south-west	Indirect	Slight negative
AH 69	Settlement cluster	No	142m NNW	Indirect	Slight positive
AH 67	Field system	No	43m NNW	Neutral	N/a

Pink1 Route Option

Table 6.5.6.7 Potential Impacts on the Pink1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 66	Ringfort - cashel	No	42m NNW	Indirect	Slight negative
AH 68	Church	**Yes**	136m south-west	Indirect	Slight negative
AH 69	Settlement cluster	No	142m NNW	Indirect	Slight positive
AH 67	Field system	No	43m NNW	Neutral	N/a

Green1 Route Option

Table 6.5.6.8 Potential Impacts on the Green1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 1	Redundant record	No	40m east	N/a	N/a
CH 1	Enclosure (2006 EIS)	No	40m east	Indirect	Moderate negative

Section 2

Red1 Route Option

Table 6.5.6.9 Potential Impacts on the Red1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 35	*Fulacht fiadh*	**Yes**	131m north	Neutral	N/a
AH 59	Church, Graveyard, Ecclesiastical enclosure	**Yes**	0m	Direct	Profound negative
AH 58	Enclosure	**Yes**	0m	Direct	Significant negative
BH 16	Rahoon House	**Yes**	44m north	Indirect	Moderate negative
AH 56	House - indeterminate date	**Yes**	44m north	Indirect	Moderate negative
AH 57	Ritual site - holy well	**Yes**	73m north	Indirect	Moderate negative
AH 64	Designed landscape feature	**Yes**	19m north	Indirect	Moderate negative
DL 15	Rahoon House demesne	No	0m	Neutral	N/a
BH 17	Entrance to Rahoon House	**Yes**	132m north	Indirect	Slight negative
BH 18	Summerdale House	**Yes**	117m south	Indirect	Slight negative
AH 55	Ringfort - unclassified	**Yes**	150m south	Neutral	N/a
BH 33	No. 49 (house)	**Yes**	37m west	Neutral	N/a
BH 35	College (former nunnery)	No	To immediate east	Indirect	Moderate negative
DL 26	Newcastle house demesne	No	0m	Indirect	Imperceptible negative
BH 19	Mill race	No	0m	Direct	Moderate negative
AH 60	Church	**Yes**	82m SSE	Indirect	Moderate negative
AH 61	18th/19th century house	**Yes**	0m	Direct	Profound negative
AH 62	Castle – unclassified, House - 17th century	**Yes**	27m north	Neutral	N/a
BH 20	Castle – unclassified, House - 17th century	**Yes**	27m north	Neutral	N/a
BH 21	Waterworks	**Yes**	40m north	Neutral	N/a

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 37	NUIG Campus	**Yes**	111m north	Indirect	Imperceptible negative
CH 14	Railway (site of)	No	0m	Neutral	N/a
AH 48	Quarry	No	0m	Direct	Moderate negative
AH 49	Redundant record	No	0m	N/a	N/a
AH 50	Quarry	No	22m north-west	Indirect	Slight negative
AH 51	Quarry	No	50m north-west	Neutral	N/a
AH 30	Quarry	No	42m north	Neutral	N/a
AH 31	Redundant record	No	109m NNE	N/a	N/a
DL 21	Merview House demesne	No	55m south-west	Neutral	N/a
DL 25	Ballybrit House demesne	No	0m	Neutral	N/a
AH 32	Earthwork	No	51m SSE	Neutral	N/a
AH 33	Designed landscape feature	No	0m	Neutral	N/a
AH 24	Settlement deserted - medieval	**Yes**	153m NNW	Neutral	N/a
AH 26	Enclosure	**Yes**	81m NNW	Neutral	N/a
AH 27	Ringfort – rath House - indeterminate date	**Yes**	72m NNW	Neutral	N/a

Orange1 Route Option

Table 6.5.6.10 Potential Impacts on the Orange1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 48	Quarry	No	0m	Direct	Profound negative
DL 6	Bushypark House demesne	**House is in the RPS**[6]	0m	Direct	Slight negative
AH 36	Bullaun stone	**Yes**	148m NNW	Indirect	Imperceptible negative
BH 11	Thatched Cottage	**Yes**	80m NNW	Indirect	Moderate negative
BH 4	Church	**Yes**	66m east	Indirect	Moderate negative

[6] Record of Protected Structures (RPS) (Galway City Development Plan 2011-2017/ Galway County Development Plan 2015-2021)

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 12	Thatched Cottage	**Yes**	145m south-east	Indirect	Imperceptible negative
DL 7	Lake View House demesne	No	138m east	Indirect	Imperceptible negative
AH 49	Redundant record	No	0m	N/a	N/a
AH 50	Quarry	No	0m	Direct	Profound negative
AH 51	Quarry	No	50m north-west	Neutral	N/a
BH 69	Farmyard	**Yes**	15m north-west (link)	Indirect	Moderate negative
AH 30	Quarry	No	42m north	Neutral	N/a
AH 31	Redundant record	No	109m NNE	Neutral	N/a
DL 21	Merview House demesne	No	55m south-west	Neutral	N/a
DL 25	Ballybrit House demesne	No	0m	Neutral	N/a
AH 32	Earthwork	No	51m SSE	Neutral	N/a
AH 33	Designed landscape feature	No	0m	Neutral	N/a
AH 24	Settlement deserted - medieval	**Yes**	153m NNW	Neutral	N/a
AH 26	Enclosure	**Yes**	81m NNW	Neutral	N/a
AH 27	Ringfort – rath House - indeterminate date	**Yes**	72m NNW	Neutral	N/a

Yellow1 Route Option

Table 6.5.6.11 Potential Impacts on the Yellow1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 11	Thatched Cottage	**Yes**	64m NNW	Indirect	Moderate negative
AH 36	Bullaun stone	**Yes**	0m	Direct	Significant negative
AH 37	Redundant record	No	64m south-east	N/a	N/a
DL 8	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes	**No**	0m	Direct	Moderate negative
CH 42	Mary Ville	No	73m SSE	Indirect	Slight negative

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
DL 9	Ashley Park demesne	No	22m south-east	No impact	N/a
AH 42	Barrow - unclassified	**Yes**	148m	No impact	N/a
CH 41	Site of Dangan Cottage	**No**	0m	Direct	Significant negative
AH 39	Designed landscape feature	**Yes**	46m SSE	Indirect	Slight negative
CH 40	Dangan House	No	23m SSE	Indirect	Moderate negative
AH 40	Designed landscape feature	**Yes**	0m	Direct	Profound negative
AH 41	Summer house (Also BH 13)	**Yes**	35m north-west	Indirect	Moderate negative
BH 13	Summer house (Also AH 41)	**Yes**	35m north-west	Indirect	Moderate negative
CH 14	Railway track (disused)	No	0m	Direct	Moderate negative
DL 10	Menlo Castle demesne	**House is in the RSP**[6]	0m	Direct	Significant negative
CH 21	Vernacular animal shelter (2006 EIS)	No	106m north-west	Indirect	Slight negative
CH 22	Possible prehistoric tomb (2006 EIS)	No	0m	Direct	Profound negative
CH 23	Circular feature? (2006 EIS)	No	0m	Direct	Profound negative
CH 24	Small boulder (2006 EIS)	No	124m north	Indirect	Slight negative
AH 29	Redundant record	No	0m	N/a	N/a
AH 30	Quarry	No	0m	Direct	Significant negative
AH 31	Redundant record	No	115m NNW	N/a	N/a
DL 25	Ballybrit House demesne	No	0m	Neutral	N/a
AH 32	Earthwork	No	51m SSE	Neutral	N/a
AH 33	Designed landscape feature	No	0m	Neutral	N/a
AH 24	Settlement deserted - medieval	**Yes**	153m NNW	Neutral	N/a
AH 26	Enclosure	**Yes**	81m NNW	Neutral	N/a
AH 27	Ringfort – rath House - indeterminate date	**Yes**	72m NNW	Neutral	N/a

Blue1 Route Option

Table 6.5.6.12 Potential of Impacts on the Blue1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 11	Thatched Cottage	**Yes**	64m NNW	Indirect	Moderate negative
AH 36	Bullaun stone	**Yes**	0m	Direct	Significant negative
BH 30	Heffernans cottage	**Yes**	43m ENE	Indirect	Moderate negative
DL 5	Glenloe Abbey demesne	No	0m	Direct	Slight negative
AH 37	Redundant record	No	64m south-east	N/a	N/a
DL 8	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes	No	0m	Direct	Moderate negative
CH 42	Mary Ville	No	73m SSE	Indirect	Slight negative
DL 9	Ashley Park demesne	No	22m south-east	No impact	N/a
AH 42	Barrow - unclassified	**Yes**	148m	No impact	N/a
CH 41	Site of Dangan Cottage	No	0m	Direct	Significant negative
AH 39	Designed landscape feature	**Yes**	46m SSE	Indirect	Slight negative
CH 40	Dangan House	No	23m SSE	Indirect	Moderate negative
AH 40	Designed landscape feature	**Yes**	0m	Direct	Profound negative
AH 41	Summer house	**Yes**	35m north-west	Indirect	Moderate negative
BH 13	Summer house	**Yes**	35m north-west	Indirect	Moderate negative
CH 14	Railway track (disused)	No	0m	Direct	Moderate negative
DL 10	Menlo Castle demesne	**House is in the RSP**[6]	0m	Direct	Significant negative

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 27	Ringfort – rath House - indeterminate date	**Yes**	0m	Direct	Significant negative
AH 24	Settlement deserted - medieval	**Yes**	22m south-west	Indirect	Moderate negative
AH 25	Tower House	**Yes**	75m south-west	Indirect	Moderate negative
AH 26	Enclosure	**Yes**	102m south-west	Indirect	Slight negative
AH 18	Enclosure	No	67m south-east	No impact	N/a
AH 19	Ringfort - unclassified	No	10m SSE	No impact	N/a
AH 147	Quarry	No	150m SSW	No impact	N/a
AH 148	Redundant record	No	45m north	N/a	N/a
BH 73	House	**Yes**	10m north	Indirect	Significant negative
BH 6	Tower House	**Yes**	75m south-west	Indirect	Moderate negative
CH 22	Possible prehistoric tomb (2006 EIS)	No	16m south-east	Indirect	Moderate negative
CH 23	Circular feature? (2006 EIS)	No	23m south-east	Indirect	Moderate negative
CH 24	Small boulder (2006 EIS)	No	17m NNW	Indirect	Moderate negative
CH 25	Possible cairn (2006 EIS)	No	67m NNW	Indirect	Slight negative
CH 21	Vernacular animal shelter (2006 EIS)	No	98m WNW	Indirect	Slight negative

Pink1 Route Option

Table 6.5.6.13 Potential Impacts on the Pink1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 11	Thatched Cottage	**Yes**	64m NNW	Indirect	Moderate negative
AH 36	Bullaun stone	**Yes**	0m	Direct	Significant negative
AH 37	Redundant record	No	64m south-east	N/a	N/a
DL 8	Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes	**No**	0m	Direct	Moderate negative
CH 42	Mary Ville	No	73m SSE	Indirect	Slight negative
DL 9	Ashley Park demesne	No	22m south-east	No impact	N/a
AH 42	Barrow - unclassified	**Yes**	148m	No impact	N/a
CH 41	Site of Dangan Cottage	**No**	0m	Direct	Significant negative
AH 39	Designed landscape feature	**Yes**	46m SSE	Indirect	Slight negative
CH 40	Dangan House	No	23m SSE	Indirect	Moderate negative
AH 40	Designed landscape feature	**Yes**	0m	Direct	Profound negative
AH 41	Summer house (Also BH 13)	**Yes**	35m north-west	Indirect	Moderate negative
BH 13	Summer house (Also AH 41)	**Yes**	35m north-west	Indirect	Moderate negative
CH 14	Railway track (disused)	No	0m	Direct	Moderate negative
DL 10	Menlo Castle demesne	**House is in the RSP**[6]	0m	Direct	Significant negative
AH 18	Enclosure	No	67m south-east	No impact	N/a
AH 19	Ringfort - unclassified	No	10m SSE	No impact	N/a
AH 148	Redundant record	No	45m north	N/a	N/a
BH 73	House	**Yes**	10m north	Indirect	Significant negative

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
CH 22	Possible prehistoric tomb (2006 EIS)	No	16m south-east	Indirect	Moderate negative
CH 23	Circular feature? (2006 EIS)	No	23m south-east	Indirect	Moderate negative
CH 24	Small boulder (2006 EIS)	No	17m NNW	Indirect	Moderate negative
CH 25	Possible cairn (2006 EIS)	No	67m NNW	Indirect	Slight negative
CH 21	Vernacular animal shelter (2006 EIS)	No	98m WNW	Indirect	Slight negative
AH 151	Anomalous stone group	**Yes**	113m south-west	Indirect	Slight negative
AH 152	Ringfort – cashel, souterrain, children's burial ground	**Yes**	138m south-west	Indirect	Slight negative
BH 74	Ringfort – cashel, souterrain, children's burial ground	**Yes**	138m south-west	Indirect	Slight negative

Green1 Route Option

Table 6.5.6.14 Potential Impacts on the Green1 Route Option

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
AH 7	Designed landscape feature	No	0m	Direct	Profound negative
BH 11	Thatched Cottage	**Yes**	111m NW	Indirect	Slight negative
AH 8	Designed landscape feature	No	0m	Direct	Significant negative
BH 9	Thatched cottage	**Yes**	0m	Direct	Profound negative
DL 10	Menlo Castle demesne	**House is in the RSP**[6]	0m	Direct	Significant negative
DL 6	Bushypark House demesne	**House is in the RSP**[6]	0m	Direct	Moderate negative
DL 5	Glenlo Abbey demesne	No	0m	Direct	Slight negative
BH 100	Thatched cottage	**Yes**	129m NW	Indirect	Imperceptible negative

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
BH 99	Remains of stone fort	**Yes**	98m north	Indirect	Slight negative
CH 14	Railway track (disused)	No	0m	Direct	Moderate negative
CH 17	Medieval field system? (2006 EIS)	No	0m	Direct	Moderate negative
AH 9	Gate house	**Yes**	37m south-east	Indirect	Moderate negative
AH 6	Burial ground	**Yes**	40m north-west	Indirect	Moderate negative
AH 161	Ringfort	**Yes**	88m north-east	Indirect	Moderate negative
AH 117	Settlement cluster & Redundant record	No	68m north-west	Indirect	Moderate negative
AH 116	Pillar stone	**Yes**	30m north-west	Indirect	Moderate negative
AH 159	Enclosure	**Yes**	145m south-east	Indirect	Slight negative
AH 160	Hut site	**Yes**	130m south-east	Indirect	Slight negative
AH 162	Redundant record	No	75m north-east	N/a	N/a
AH 17	Redundant record	No	25m south	N/a	N/a
BH 3	Gate house	**Yes**	37m south-east	Indirect	Moderate negative
BH 5	Bushypark House	**Yes**	176m south	Indirect	Moderate negative
BH 31	x3 houses at Menlough	**Yes**	70m north-west	Indirect	Moderate negative
BH 10	Thatched cottage	**Yes**	140m ESE	Indirect	Slight negative
CH 31	Vernacular buildings, in ruins (2006 EIS)	No	27m NNW	Indirect	Moderate negative

ID No.:	Classification:	Statutory Protection:	Dist. from route:	Impact type:	Impact level:
CH 27	Possible corn/turf drying stand, possible ringfort, possible cairn, possible consumption wall, three possible structures (2006 EIS)	No	65m south-west	Indirect	Slight negative
CH 28	Possible *fulacht fiadh* (2006 EIS)	No	83m north-east	Indirect	Slight negative
CH 29	Possible ringfort (2006 EIS)	No	56m NNE	Indirect	Slight negative
CH 30	Rectangular feature (2006 EIS)	No	140m north	Indirect	Slight negative
AH 163	Castle, 17th C House, Inscribed stone	**Yes**	55m WNW	Indirect	Moderate negative
CH 31	Vernacular buildings, in ruins (2006 EIS)	No	27m NNW	Indirect	Moderate negative
CH 49	Burnt mound and ditches? (Geophysical survey 2005)	No	0m	Direct	Significant negative
AH 12	Castle - tower house	**Yes**	75m SSW	Indirect	Moderate negative
BH 36	Castle - tower house	**Yes**	75m SSW	Indirect	Moderate negative
AH 151	Anomalous stone group	**Yes**	122m south-west	Indirect	Slight negative
AH 152	Ringfort – cashel, souterrain, children's burial ground	**Yes**	138m south-west	Indirect	Slight negative
BH 74	Ringfort – cashel, souterrain, children's burial ground	**Yes**	138m south-west	Indirect	Slight negative
CH 46	Burnt mound? (Geophysical survey 2005)	No	69m north	Neutral	N/a
CH 47	Two Burnt mounds? (Geophysical survey 2005)	No	166m NNW	Neutral	N/a

6.5.6.4 Summary

Six route options have been subject to preliminary route assessment as part of the overall route selection phase of the N6 Galway City Transport Project. Sites of archaeological, architectural and cultural heritage significance within 150m of the

proposed route option were subject to impact assessment for each route option. These are summarised below from **Tables 6.5.6.15** to **6.5.6.20.** It should be noted that Section 1 of the route options are all very similar in terms of potential impacts and as such no potential impacts have been identified that separate them into an order of preference.

Please note that this preliminary route selection assessment was carried out based on the constraints identified in **Section 4.11**. A more detailed route selection assessment is included in **Section 7.6.5**, as per the requirements of the NRA's Guidelines for the Assessment of Archaeological/Architectural Heritage Impacts of National Road Schemes.

The Red1 Route Option represents an online option, reutilising the existing road infrastructure, for much of its length. However, despite this, it will have a high impact on the archaeological resource in particular and as such, is considered to be the joint least preferable route option with the Green1 Route Option. The impacts are summarised below:

Table 6.5.6.15 Summary of Impacts on the Red1 Route Option

Profound Negative	Significant negative	Moderate negative	Slight negative	Imperceptible negative
AH 59 (church, graveyard, ecclesiastical enclosure); **AH 61** (18^{th}/19^{th} century house);	**AH 58** (enclosure);	**DL 1** (Eagle Lodge demesne); **BH 16/ AH 36** (Rahoon House); **AH 57** (Holy well); **AH 64** (Designed landscape feature); **BH 19** (Millrace); **AH 60** (Church); **AH 48** (Quarry);	**BH 17** (Rahoon House entrance); **BH 18** (Summerdale House); **AH 50** (Quarry);	**DL 26** (Newcastle House demesne); **BH 37** (NUIG Campus);
Neutral: AH 35 (fulacht fiadh), DL 15 (Rahoon House demesne), AH 55 (Ringfort), BH 33 (College), AH 62/ BH 20 (Castle), BH 21 (Waterworks), CH 14 (Railway, site of), AH 51 (Quarry), AH 30 (Quarry), DL 21 (Merview House demesne), DL 25 (Ballybrit House demesne), AH 32 (Earthwork), AH 33 (Designed landscape feature), AH 24 (Deserted medieval settlement), AH 26 (Enclosure), AH 27 (Ringfort and house).				

The Orange1 Route Option is the most preferable route option from an archaeological, architectural and cultural heritage perspective. The impacts are summarised below:

Table 6.5.6.16 Summary of Impacts on the Orange1 Route Option

Profound Negative	Significant negative	Moderate negative	Slight negative	Imperceptible negative
AH 48 (Quarry); **AH 50** (Quarry)	**AH 58** (enclosure)	**DL 1** (Eagle Lodge demesne);	**Dl 6** (Bushypark demesne); **AH 50** (Quarry);	**AH 36** (Bullaun stone);

Profound Negative	Significant negative	Moderate negative	Slight negative	Imperceptible negative
		BH 11 (Thatched cottage); **BH 4** (Church); **BH 69** (Farmyard);		**BH 12** (Thatched cottage); **DL 7** (Lakeview House demesne);
Neutral: AH 51 (Quarry), AH 30 (Quarry), DL 21 (Merview House demesne), DL 25 (Ballybrit House demesne), AH 32 (Earthwork), AH 33 (Designed landscape feature), AH 24 (Deserted medieval settlement), AH 26 (Enclosure), AH 27 (Ringfort and house).				

The Yellow1 Route Option is very similar to the Blue1 Route Option in terms of impacts upon the cultural heritage resource. The Yellow1 Route Option is considered to be the third preference from an archaeological, architectural and cultural heritage perspective, as it is slightly more preferable than the Blue1 Route Option.

Table 6.5.6.17 Summary of Impacts on the Yellow1 Route Option

Profound negative	Significant negative	Moderate negative	Slight negative	Imperceptible negative
AH 40 (Designed landscape feature); **CH 22** (Possible prehistoric tomb); **CH 23** (Circular feature); **AH 30** (Quarry)	**CH 41** (Site of Dangan Cottage); **DL 10** (Menlo Castle demesne)	**CH 1** (enclosure); **BH 11** (Thatched cottage); **DL 8** (Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes); **CH 40** (Dangan House); **AH 41/ BH 13** (Summerhouse) **CH 14** (Railway track)	**CH 42** (Mary Ville); **AH 39** (Designed landscape feature); **CH 21** (Vernacular animal shelter); **CH 24** (small boulder)	**AH 36** (Bullaun stone); **BH 12** (Thatched cottage); **DL 7** (Lakeview House demesne);
Neutral: DL 25 (Ballybrit House demesne), AH 32 (Earthwork), AH 33 (Designed landscape feature), AH 24 (Deserted medieval settlement), AH 26 (Enclosure), AH 27 (Ringfort and house). **No Impact:** DL 9 (Ashley Park demesne), AH 42 (Barrow)				

The Blue1 Route Option will impact considerably upon the cultural heritage resource. The Blue1 Route Option is considered to be the fourth preference from an archaeological, architectural and cultural heritage perspective. Impacts are summarised below:

Table 6.5.6.18 Summary of Impacts on the Blue1 Route Option

Profound negative	Significant negative	Moderate negative	Slight negative	Imperceptible negative
AH 40 (Designed landscape feature)	**CH 41** (Site of Dangan Cottage); **DL 10** (Menlo Castle demesne);	**BH 11** (Thatched cottage); **BH 30** (Heffernans Cottage); **DL 8** (Dangan Cottage, Dangan House, Dangan	**AH 66 (Cashel);** **AH 68 (Church);** **DL 5** (Glenlo Abbey demesne); **CH 42** (Mary Ville);	**AH 36** (Bullaun stone)

Profound negative	**Significant negative**	**Moderate negative**	**Slight negative**	**Imperceptible negative**
	AH 27 (Ringfort); **BH 73** (House)	Nunnery, Mary Ville demesnes); **CH 40** (Dangan House); **AH 41/ BH 13** (Summerhouse) **CH 14** (Railway track); **AH 24** (Deserted medieval settlement); **AH 25/ BH 6** Tower House; **CH 22** (Possible prehistoric tomb); **CH 23** (Circular feature); **CH 24** (small boulder)	**AH 39** (Designed landscape feature); **AH 26** (Enclosure) **CH 25** (Possible cairn); **CH 21** (Vernacular animal shelter)	
Positive: AH 69 (Settlement cluster, slight positive) **Neutral:** AH 67 (Field system) **No Impact:** DL 9 (Ashley Park demesne), AH 42 (Barrow), AH 18 (Enclosure), AH 19 (Ringfort), AH 147 (Quarry)				

The Pink1 Route Option follows a similar route to the Blue1 Route Option, but has less of an impact upon the cultural heritage resource. The Pink1 Route Option is considered to be the second preference from an archaeological, architectural and cultural heritage perspective. Impacts are summarised below:

Table 6.5.6.19 Summary of Impacts on the Pink1 Route Option

Profound N**egative**	Significant negative	Moderate negative	Slight negative	Imperceptible negative
AH 40 (Designed landscape feature)	CH 41 (Site of Dangan Cottage); DL 10 (Menlo Castle demesne); BH 73 (House)	BH 11 (Thatched cottage); DL 8 (Dangan Cottage, Dangan House, Dangan Nunnery, Mary Ville demesnes); CH 40 (Dangan House); AH 41/ BH 13 (Summerhouse) CH 14 (Railway track); CH 22 (Possible prehistoric tomb); CH 23 (Circular feature); CH 24 (small boulder)	CH 42 (Mary Ville); AH 39 (Designed landscape feature); AH 26 (Enclosure) CH 25 (Possible cairn); CH 21 (Vernacular animal shelter) AH 151 (Anomalous stone group); AH 152/ BH 74 (Cashel, souterrain, children's burial ground)	AH 36 (Bullaun stone)
Positive: AH 69 (Settlement cluster, slight positive) Neutral: AH 67 (Field system)				

Profound N**egative**	Significant negative	Moderate negative	Slight negative	Imperceptible negative
No Impact: DL 9 (Ashley Park demesne), AH 42 (Barrow), AH 18 (Enclosure), AH 19 (Ringfort),				

The Green1 Route Option possesses the greatest overall length and will impact considerably upon the cultural heritage resource. The Green1 Route Option is considered to be the joint least preferable (with the Red1) from an archaeological, architectural and cultural heritage perspective. Impacts are summarised below:

Table 6.5.6.20 Summary of Impacts on the Green1 Route Option

Profound Negative	**Significant negative**	**Moderate negative**	**Slight negative**	**Imperceptible negative**
AH 7 (Designed landscape feature); **AH 8** (Designed landscape feature); **BH 9** (Thatched cottage)	**DL 10** (Menlo Castle Demesne); **CH 49** (Burnt mound and ditches)	**CH 1** (Enclosure); **DL 6** (Bushy Park House demesne); **CH 14** (Railway track); **CH 17** (Medieval field system); **AH 9/ BH 3** (Gate house); **AH 6** (Burial ground); **AH 161** (Ringfort); **AH 117** (Settlement cluster); **AH 116** (Pillar stone); **BH 5** (Bushy Park House); **BH 31** (x3 houses at Menlough); **AH 163** (Castle, 17th C house, inscribed stone) **CH 31** (Vernacular buildings); **CH 31** (Vernacular buildings); **AH 12/ BH 36** (Tower house)	**DL 5** (Glenlo Abbey demesne); **BH 99** (Stone fort remains) **AH 159** (Enclosure); **AH 160** (Hut site); **BH 10** (Thatched cottage); **CH 27** (Multiple potential features); **CH 28** (Possible fulacht fiadh); **CH 29** (Possible ringfort); **CH 30** (Rectangular feature); **AH 151** (Anomalous stone group); **AH 152** (Cashel, souterrain, children's burial ground)	**BH 100** (Thatched cottage)
Neutral: CH 46 (Burnt mound), CH 47 (Two burnt mounds)				

Table 6.5.6.21 below provides a summary of the route options rankings in terms of Archaeology, Architectural and Cultural Heritage.

Table 6.5.6.21 Summary of Archaeology, Architectural and Cultural Heritage rankings of Route Option

Route Option	Section 1	Section 2
Red1 Route Option	I	LP
Orange1 Route Option	I	P
Yellow1 Route Option	I	I
Blue1 Route Option	I	I
Pink1 Route Option	I	I
Green1 Route Option	I	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.6.5 References

Bennett, I. (ed.) (1987–2010) Excavations: *Summary Accounts of Archaeological Excavations in Ireland. Bray. Wordwell.*

Bonsall, J & Gimson, H. (2005) *Geophysical Survey of the proposed N6 Galway City Outer Bypass.* Unpublished report for Galway CC.

Galway City Council. (2011–2017) *Galway City Development Plan.*

Galway County Council. (2009–2015) *Galway County Development Plan*

Galway County Council. (2015–2021) *Galway County Development Plan*

National Roads Authority. (2005) *Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes.*

National Roads Authority. (2005) *Guidelines for the Assessment of Architectural Heritage Impacts of National Road Schemes.*

National Monument Service, Department of Arts, Heritage and the Gaeltacht. *Sites and Monuments Record*, County Galway

N6 Galway City Outer Bypass EIS. (2006) *Vol.2 chp.13. Vol.4 Appendices 13.1-4*

Ordnance Survey 6” & 25” maps of County Galway (1838/39, 1915-20)

www.excavations.ie - Summary publication of every archaeological excavation that has taken place in Ireland (1970–2010), edited by Isabel Bennett. (accessed on 2-19/03/15)

www.archaeology.ie - DoAHG website listing all SMR sites, National Monuments and sites with Preservation Orders. Database of archaeological sites known to the National Monuments Service. (Accessed on 2-19/03/15)

www.osi.ie – Ordnance Survey website containing aerial photographs and historic mapping (accessed on 2-19/03/15)

www.buildingsofireland.ie – Website listing the results of the NIAH building and garden survey for Galway (accessed on 2-19/03/15)

www.googleearth.com – Website containing aerial photographic datasets and street view (accessed on 2-19/03/15)

6.5.7 Material Assets – Agriculture

6.5.7.1 Introduction

This section details the stage 1 assessment of the route options with respect to the agricultural constraints identified in **Section 4.12 Material Assets - Agriculture** of this report. The route options as described in **Section 6.1** with the agricultural constraints are presented in **Figure 6.5.7.1** and **6.5.7.2**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.7.2 outlines the methodology that was used to carry out the study and **Section 6.5.7.3** details the options assessment. A summary is presented in **Section 6.5.7.4** and references are listed in **Section 6.5.7.5.**

The constraints study identified three main agricultural constraints:

- Good quality agricultural land;
- Farm yards[7]; and
- Equine Enterprises.

Each of the route options was assessed for potential impacts on agricultural land (including good agricultural land) farm yards and equine enterprises. The route options are assessed in two sections. Section 1 is from the R336 to Na hAille and Section 2 is from Na hAille to the N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide Corridor for these route options.

6.5.7.2 Methodology

The impact on agricultural land is assessed by:

- Measuring the area of agricultural land within the footprint of the route option. The agricultural land includes grass land, rough grazing and cut over bog. This land is mapped using aerial photography;
- Measuring the area of good agricultural land within the footprint of the route option. Good agricultural land is good quality grass land. It is mapped using aerial photography, visual assessment from road side surveys and referring to EPA mapping data;
- Measuring area of land registry land parcels which consist of mainly agricultural land. The land registry land parcels are land ownership boundary parcels provided from the Property Registration Authority of Ireland database. This information only provides an indication of land ownership and farming practices, for example, several land parcels may be part of the same farm;

[7]Included in the "Farm yards" category are yards without sheds e.g. silage pits, single sheds, cattle holding pens and accommodation roads.

- Counting the number of farm yards and agricultural structures within the footprint of each route option and counting the number of high sensitive farm yards (i.e. equine farms). These are mapped using aerial photography and visual assessment from roadside surveys.

6.5.7.3 Option Assessment

Section 1

Table 6.5.7.1 below identifies the potential agricultural impacts for Section 1 of the Route Selection Stage 1 assessment.

Table 6.5.7.1 Potential Agricultural Impacts in Section 1

Route Option	Agricultural land (HA)	Good quality agricultural land (HA)	Area of land parcels (HA)	No of farm yards / farm structures	No of Equine enterprises	Order of Preference
Red1	6	0	43	0	0	P
Orange1	6	0	43	0	0	P
Yellow1	19	0	120	4	0	I
Blue1	13	0	95	1	0	I
Pink1	13	0	95	1	0	I
Green1	20	0	120	4	0	I

- Red1 and Orange1 Route Options have the lowest area of agricultural land and potentially affect the lowest number and area of agricultural land parcels. These two route options affect the lowest number of farm yards/farm structures (i.e. none);
- The Blue1 and Pink1 Route Options have the third lowest areas of agricultural land and potentially affect the third lowest area of agricultural land parcels. They both affect one farm yard/farm structure; and
- The Green1 and Yellow1 Route Options have the highest areas of agricultural land and potentially affect the highest area of agricultural land parcels. They both affect four farm yards/farm structures.

Section 2

Table 6.5.7.2 below identifies the potential agricultural impacts for Section 2 of the Route Selection Stage 1 assessment.

Table 6.5.7.2 Potential Agricultural Impacts in Section 2

Route Option	Agricultural land (HA)	Good quality agricultural land (HA)	Area of land parcels (HA)	No of farm yards/farm structures	No of Equine enterprises	Order of Preference
Red1	28	14	145	2	0	P
Orange1	74	18	337	13	0	I
Yellow1	80	19	423	11	0	I
Blue1	95	44	595	12	0	I
Pink1	90	41	478	12	0	I
Green1	118	72	676	11	0	LP

- The Red1 Route Option has the lowest area of agricultural land and potentially affects the lowest area of agricultural land parcels. It affects the lowest number of farm yards/farm structures;
- The Orange1 Route Option has the second lowest area of agricultural land and potentially affects the second lowest area of agricultural land parcels. It affects a similar number of farm yards/farm structures to the other routes – except for the Red1 Route Option;
- The Yellow1 Route Option has the third lowest area of agricultural land, and potentially affects the third lowest area of agricultural land parcels. It affects a similar number of farm yards/farm structures to the other routes – except for the Red1 Route Option;
- The Blue1 and Pink1 Route Options have the fourth lowest areas of agricultural land and potentially affect the fourth lowest area of agricultural land parcels. They affect a similar number of farm yards farm structures to the other route options – except for the Red1 Route Option. The Pink1 Route Option has a slightly lower impact than the Blue1 Route Option but overall they are grouped together as fourth preference; and
- The Green1 Route Option has the highest area of agricultural land and potentially affect the highest area of agricultural land parcels. It affects a similar number of farm yards/farm structures to the other route options (except for the Red1 Route Option), however it affects two equine farm yards.

6.5.7.4 Summary

The ranking preferences for the routes in Section 1 and 2 are shown in **Table 6.5.7.3**.

Table 6.5.7.3 Summary of Material Assets – Agricultural ranking of Route Options

Route Option	Section 1	Section 2
Red1	P	P
Orange1	P	I
Yellow1	I	I
Blue1	I	I
Pink1	I	I
Green1	I	LP

Note: Preferred (P), intermediate (I) or least preferred (LP)

From a material asset agricultural perspective the Red1 and Orange1 Route Options are the preferred route option for Section 1 and for Section 2.

6.5.7.5 References

None

6.5.8 Material Assets – Non-Agriculture

6.5.8.1 Introduction

This section details the Stage 1 assessment of the route options with respect to the material assets non-agriculture constraints identified in **Section 4.13 Material Assets –Non-Agriculture** of this report. The route options as described in **Section 6.1** with the material assets non-agriculture constraints are presented in **Figure 6.5.8.1** to **6.5.8.14**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.8.2 outlines the methodology that was used to carry out the study and **Section 6.5.8.3** details the options assessment. A summary is presented in **Section 6.5.8.4** and references are listed in **Section 6.5.8.5**.

6.5.8.2 Methodology

The assessment Material assets - Non-agricultural is based on the constraints identified in **Section 4.12.**

For Stage 1 assessment, the route options are assessed in two sections. Section 1 extends from the R336 to Barr Aille Road and Section 2 extends from here to the existing N6 in the east of the city. The assessment is carried out on the mainline of each route option.

For this assessment two types of properties were examined:

- Residential properties; and
- Commercial and industrial properties.

The impact on the infrastructure of public and private utilities/service providers is also assessed.

Material assets non-agriculture excluding utilities and services assessment methodology

For the purposes of assessing direct impacts on properties the footprint for each of the route options was considered to include all lands required to construct the proposed road. This included the design and a buffer of 10m from the edge of the earthworks associated with the design apart from the following exception:

- Along the Western Distributor Road from Cappagh Road to Bothar Stiofáin on the Red1 Route Option, there is an existing retaining wall, set back from the edge of the existing carriageway, in place. This existing wall was taken as the extents of the footprint of the Red1 Route Option at this location;
- On the Red1 Route Option from where the design crosses the Rahoon Road to the River Corrib a 2m buffer from the back of verge for the proposed road was used for the extents of the footprint at this location;
- For the proposed viaduct at Terryland associated with the Red1 Route Option a 2m buffer from the back of verge for the proposed road was used for the extents

of the footprint at this location, however the footprint for the new junction and link roads at Terryland includes a 10m buffer; and

- On the Red1 Route Option where the cutting begins to the eastern end of the Terryland viaduct along the route of the existing N6 to the Briarhill Junction a 2m buffer from the back of verge for the proposed road was used for the extents of the footprint at this location. This same 2m buffer was used for the sections of the Orange1 and Yellow1 Route Option which also re-use with existing N6 in this area.

Level of Impact

The impact of the route options on non-agricultural properties is assessed according to the significance criteria detailed below in **Table 6.5.8.1**. These criteria were based on the National Roads Authority (NRA) - Environmental Impact Assessment of National Road Schemes – A Practical Guide (2008).

Table 6.5.8.1 Criteria for Assessing the Significance of Impact on Material Assets

Significance Level/ Degree of Impact	Definition
Profound	Occurs where a non-agricultural property or other material asset of national or regional importance is acquired and/or demolished/removed.
Significant	Occurs where part, or all, of a non-agricultural property or other material asset is acquired, which may result in demolition of the property or removal of the asset.
Moderate	Occurs where part, or all, of a non-agricultural property or other material asset is acquired, resulting in a significant change to the environment of the property or material asset.
Slight	Occurs where part of a non-agricultural property or other material asset is acquired, resulting in little change to the environment
Imperceptible	Occurs where part of a non-agricultural property or other material asset is acquired, resulting in minimal changes to the environment of the property or material asset. This includes impacts on properties which are currently occupied by a public right-of-way. These lands are in the ownership of the adjacent property, however are occupied by existing roads.

The level of impacts for residential, commercial and industrial properties have been considered under three categories:

- All properties fully within the footprint are considered as full acquisitions and are significant impacts;
- Any property holding partially within the footprint are considered to require partial landtake. Depending on the extent of the landtake these impacts vary from moderate to imperceptible; and
- All properties that lie within 150m corridor but outside the footprint were also included in this assessment as the route may need be realigned within the corridor and could potentially have a direct impact on these properties also.

This assessment has been carried out and the number of affected properties and a synopsis of the impacts are presented in **Section 6.5.8.3** below.

Utilities and services assessment methodology

Existing Utility records were obtained from the relevant utility service providers. At this stage of the assessment of route options, it is difficult to consider all utilities that are impacted by all of the options.

There are considerable numbers of low voltage ESB lines, servicing every home and business in the scheme study area, these services were not assessed as part of this assessment, as they are required for each of the route options and are considered to be a minor constraint and will be readily diverted where necessary for the final design. The ESB services that have been assessed, see bullet list below, are considered to be the major utilities for this service provider and pose more significant constraints for the scheme.

Similarly, there are numerous small diameter foul, combined and surface water sewers and watermains throughout the city that have not been assessed as part of this assessment, as they are required for each of the route options and are considered to be a minor constraint and will be readily diverted where necessary for the final design. The assessment has been carried out based on the larger diameter, more critical services, as detailed in the bulleted list below, as these pose more significant constraints for the scheme.

As a preliminary assessment of the various route options, impacts on larger utilities and services were assessed. The following utilities and services were considered for the assessment:

- SSE 110kV lines;
- ESB High Voltage Overhead Lines (HV OH);
- ESB High Voltage Underground Lines (HV UG);
- ESB Medium Voltage Overhead Lines (MV OH);
- ESB Medium/Low Voltage Underground Lines (MV/LV UG);
- Galway City Council, Water mains with pipe diameter greater than 300mm;
- Irish Water, Foul and Combined Sewers pipe diameters greater than 300mm;
- Galway City Council, Foul and combined sewers with pipe diameters greater than 300mm;
- Galway City Council, Surface water and trunk sewers with pipe diameters greater than 600mm;
- Gas Networks Ireland (also referred to as Bord Gáis) underground services;
- Eircom underground services;
- E-Net services; and
- UPC.

At the time of writing, there was no available Gas Networks Ireland utility records for the areas west of Western Distributor Road to the R336 at Bearna.

The existing waste facilities within the scheme study area boundary have been identified in **Section 4.13 Material Assets – Non Agricultural**. The footprint described above for Material assets non-agriculture excluding utilities and services assessment was also used for the waste assessment. The footprint of each route option was examined against the waste constraints identified, any waste facility within this footprint was assessed as an impact.

This assessment has been carried out and the assessment of the number of conflicts for utilities and services, for each route option is presented in S**ection 6.5.8.3** below.

6.5.8.3 Option Assessment

Section 1 - Material assets non-agriculture excluding utilities and services

The assessment for the number of properties impacted for each route option in Section 1 is presented below in **Table 6.5.8.2**.

Table 6.5.8.2 Property Assessment - Section 1

Route Option	Residential Acquisitions	Residential Partial Landtake	Residential Properties within the corridor *	Order of Preference
Red1	11	2	14	P
Orange1	14	3	10	I
Yellow1	19	2	11	LP
Blue1	6	36	26	I
Pink1	6	36	26	I
Green1	19	2	11	LP

**These are properties outside of the footprint of the route option but within close proximity and within the route option corridor.*

There are no impacts on commercial properties in Section 1. The high number of one off rural housing within the Green1 and Yellow1 Route Options means that these route options have the greatest number of impacts on residential properties with the full acquisition of 19 properties and are the least preferred route option. The Blue1 and Pink1 Route Options have a high number of residential properties with partial landtake, however they have the least number of residential property acquisitions, which are moderate impacts. There is a large number of residential properties within the 150m corridor of the Pink1 and Blue1 Route Options and this must be taken into consideration when considering the material impacts as a whole. For these reasons the Blue1 and Pink1 Route Options are considered to be intermediate with the Red1 Route Option has fewer properties acquisition compared to the Orange1 Route Option and is considered to be the preferred route options for Section 1 in terms of material assets non-agriculture excluding utilities and services.

Section 1- Utilities and Services

The assessment for the number of crossing points for utilities and services for each route option within Section 1 is presented in **Table 6.5.8.3** below. These impacts range from crossing of the road footprint to diversions of kilometres of service ducts and pipelines. There are no conflicts with E-Net, Gas Networks Ireland, ESB HV underground, UPC, Galway City and County Council watermains, surface drainage, foul sewer or trunk sewers or SSE Airtricity and as such they are excluded from **Table 6.5.8.3** below. There are also no waste facility impacts in Section 1 for any of the route options.

Table 6.5.8.3 No. of Utilities and Services Conflicts - Section 1

Utility	Red1 Option	Orange1 Option	Yellow1 Option	Blue1 Option	Pink1 Option	Green1 Option
ESB HV OH	1	1	1	1	1	1
ESB MV OH	2	2	6	5	5	6
ESB MV/LV UG	1	1	0	3	3	0
Eircom	4	4	6	7	7	6
Section 1 Total	8	8	13	16	16	13
Order of Preference	P	P	I	LP	LP	1

The total number of utility impacts are quantified in the table above. These impact range from crossing of the road footprint to diversions of kilometres of service ducts and pipelines. As all of the route options in Section 1 are in a rural setting the number of conflicts is low. The Red1 and Orange1 Route Options are the shortest and consequently have the least number of conflicts. The Blue1 and Pink1 Route Option come closest to Bearna Village and as such have the highest number of conflicts, therefore they are the least preferred in terms of conflicts with utilities and services. .

Section 1 - Overview

In the overall ranking of the route options for Section 1 in terms of material assets non-agriculture the number of property acquisitions are taken more into consideration than conflicts with utilities as these utilities can be diverted as part of the works. **Table 6.5.8.4** below summarises the order of ranking for the route options in Section 1.

Table 6.5.8.4 Ranking of Route Options – Section 1

Route Option	Order of Preference
Red1	P
Orange1	I
Yellow1	LP
Blue1	I

Route Option	Order of Preference
Pink1	I
Green1	LP

Section 2 - Material assets non-agriculture excluding utilities and services

The assessment for the number of properties impacted for each route option in Section 2 is presented below in **Table 6.5.8.5.**

Table 6.5.8.5 Section 2 - Property Assessment

Route Option	Residential Acquisitions	Residential Partial Landtake	Residential Properties within the corridor*	Commercial Acquisitions	Commercial Partial Landtake	Commercial Properties within the corridor*	Planning Permissions	Order of Preference
Red1 Option	104	22	4	15	12	-	2	LP
Orange1 Option	51	12	24	6	10	-	1	I
Yellow1 Option	106 **	11	70	7	12	3	1	LP
Blue1 Option	49	17	35	6	5	4	1	P
Pink1 Option	45	19	35	9	8	6	1	P
Green1 Option	88	39	53	7	12	5	1	LP

*These are properties outside of the footprint of the route option but within close proximity and within the route option corridor.

**An apartment block accounts for 37 residential acquisitions

AS

The Red1 Route Option has the largest number of commercial and residential acquisitions. A combined total of 119 properties would be acquired, 15 of which are commercial properties. This route option traverses the more urbanised area of Galway City and as a result has the largest direct impact on properties. There are a further 34 properties from which partial landtake would be required, which are moderate impacts.

The Yellow1 Route Option has the second highest number of acquisitions and will impact on combined total of 113 commercial and residential properties, all of which are significant impacts. 106 of these are residential properties, including an apartment block of 37 units. Partial landtake will be required from 23 properties, which are moderate impacts.

The Green1 Route Option will acquire 7 commercial and 88 residential properties, a combined total of 95 significant impacts. There are a further 51 properties from which partial landtake would be required, which are moderate impacts. Additionally, there are a high number of potentially affected properties lying within the 150m wide corridor on the Green1 Route Option.

Although the Orange1 Route Option travels through a densely residential area, the large tunnel section on this route option means that it would have a total property acquisition of 57 properties, 51 of which are residential properties, all of which are significant impacts. Partial landtake will be required from 22 properties, which are moderate impacts.

The number of acquisitions on the Blue1 and Pink1 Route Options are very similar to each other, however, there are 9 commercial acquisitions on the Pink1 Route Option compared with 6 commercial properties on the Blue1 Route Option. The total number of commercial and residential acquisitions on the Blue1 Route Option is 55, 49 of which are residential properties. These are significant impacts. There are a further 22 properties from which partial landtake would be required, which are moderate impacts. The total number of commercial and residential acquisitions on the Pink1 Route Option is 54, 45 of which are residential properties. These are significant impacts. Partial landtake will be required from 27 properties, which are moderate impacts. Whilst the Pink1 Route Option has one less significant impact compared to the Blue1 Route Option it has more moderate impacts. For these reasons the Pink1 and Blue1 Route Options are the preferred in terms of material assets non-agriculture excluding utilities and services.

Section 2- Utilities and Services

The assessment for the number of conflicts with utilities and services for each Route Option within Section 2 is presented in **Table 6.5.8.6** below. These impacts range from crossing of the road footprint to diversions of kilometres of service ducts and pipelines.

Table 6.5.8.6 No. of Utilities and Services Conflicts - Section 2

Utility	Red1 Option	Orange1 Option	Yellow1 Option	Blue1 Option	Pink1 Option	Green1 Option
E-Net	13	5	6	3	4	4
ESB HV OH	7	9	16	13	12	6
ESB HV UG	7	6	5	3	1	1
ESB MV OH	2	6	14	15	15	18
ESB MV/LV UG	27	10	13	7	6	6
Eircom	39	16	28	18	21	20
Gas	14	3	3	1	1	2
UPC	31	6	11	3	3	2
Water - 300mm	4	3	4	2	2	2
Water - 450mm	4	1	0	0	0	0
Water - 500mm	1	1	1	1	1	1
Foul Pipes	1	1	2	2	2	1
Surface Drainage	4	1	2	2	2	1
Trunk Sewer	25	11	7	2	5	2
SSE	1	3	5	4	4	1
Waste Facilities	1	0	0	0	0	0
Section 2 Total	181	82	117	76	79	67
Order of Preference	LP	I	I	I	I	P

The Red1 Route Option is closest to the city centre and consequently has the most conflicts with utilities and services. The sections of cut following the alignment of the existing roads, along the Red1 Route Option at Rahoon and Terryland will have a high impact on utilities with large scale diversions required. Some utility services run parallel to the Red1 Route Option. Along Seamus Quirke Road, Gas Networks Ireland, ESB and UPC services run within the footprint and parallel to the existing road. Similarly at the Western Distributor Road, Eircom, ESB and Gas Networks Ireland services run parallel to the road. Eircom, E-Net, ESB and Gas Networks Ireland all run along the existing N6. There is also a large number of trunk sewer crossings on the Red1 Route Option, this is considered to be a major constraint. The Red1 Route Option impacts on a single waste facility in Section 2, the bring bank facility which is located along Western Distributor Road and is within the footprint of the Red1Route Option.

The Yellow1 option has 117 utility conflicts; the major impacts on the Yellow1 Route Option will be the five crossings of the new 110kV SSE Airtricity line from Moycullen.

The tunnel section on the Orange1 Route Option would not have significant impact on utilities, at full depth, however there remains a high number crossing points when this route option merges with the existing N6 at Terryland.

The Blue1 and Pink1 Route Options have a similar number of conflicts with utilities.

The Green1 Route Option has the least number of conflicts with utilities as it is the most northern route option and the services are more dispersed.

Section 2 - Overview

In the overall ranking of the route options for Section 2 in terms of material assets non-agriculture the number of property acquisitions are taken more into consideration than conflicts with utilities as these utilities can be diverted as part of the works. **Table 6.5.8.7** below summarises the order of ranking for the route options in Section 2.

Table 6.5.8.7 Ranking of Route Options – Section 2

Route Option	Order of Preference
Red1	LP
Orange1	I
Yellow1	LP
Blue1	P
Pink1	P
Green1	LP

6.5.8.4 Summary

The overall ranking preferences for the route options in Section 1 and 2, in terms of material assets non-agriculture are shown in **Table 6.5.8.8** below, where P = Preferred, I = Intermediate, LP = Least Preferred.

Table 6.5.8.8 Summary of rankings for Material Assets Non-agriculture

Route Option	Section 1	Section 2
Red1	P	LP
Orange1	I	I
Yellow1	LP	LP
Blue1	I	P
Pink1	I	P
Green1	LP	I

6.5.8.5 References

None

6.5.9 Air Quality and Climate

6.5.9.1 Introduction

This section details the stage 1 assessment of the route options with respect to the air quality and climate constraints identified in **Section 4.14 Air Quality and Climate** of this report. The route options as described in **Section 6.1** with the air quality and climate constraints are presented in **Figure 6.5.9.1** and **6.5.9.2**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.9.2 outlines the methodology that was used to carry out the study and **Section 6.5.9.3** details the options assessment. A summary is presented in **Section 6.5.9.4** and references are listed in **Section 6.5.9.5**.

The Route Options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

6.5.9.2 Methodology

The air quality and climate assessment has been prepared in accordance with the National Roads Authority (NRA) document *'Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes'*, 2011. This section relates to the Route Selection Process Stage 1 Preliminary Options Assessment, which requires the following:

- Describe existing local air quality conditions within the scheme study area in relation to nitrogen dioxide (NO_2) and particulate matter (PM_{10}). This takes full account of any existing monitoring data from networks established by the Environmental Protection Agency (EPA). It also identifies any areas where the standards are exceeded;
- Describe any non-road sources that may significantly affect air quality within the scheme study area, for example, industry, ports, areas of domestic solid fuel combustion, or power stations; and
- Identify and record all sensitive receptor locations within the scheme study area and all sensitive receptors within 50m of the carriageway of each feasible route option that are, or have the potential to be significantly affected by a proposed scheme.

Sensitive receptor locations are defined in the guidelines as residential housing, schools, hospitals, places of worship, sports centres and shopping areas, i.e. locations where members of the public are likely to be regularly present. Designated habitats are also potentially sensitive receptors. Such sites include, Natural Heritage Areas (NHA), Special Areas of Conservation (SAC), Special Protection Areas (SPA), National Parks, Nature Reserves, Refuges for Fauna, Refuges for Flora,

Wildfowl Sanctuaries, Ramsar Sites, Biogenetic Reserves and UNESCO Biosphere Reserves.

The length of the route options is also considered in the assessment; with a shorter route being preferable from an air quality and climate perspective. However, the proximity and number of sensitive receptors within 200m of the centreline of each route option is the dominating factor in determining the preferences. The 200m band is included in the assessment as the route options may still vary within the route corridor, refer to **Figure 6.5.9.1** and **6.5.9.2** for sensitive receptor locations.

6.5.9.3 Option Assessment

The NRA guidelines state that the existing baseline should be considered during this stage of the options assessment. The air quality concentrations recorded in Zone C (defined by the EPA as 21 large towns in Ireland with a population greater than 15,000 and includes Galway City and its environs) is shown to be well within air quality standards and the assimilative capacity of the air within the scheme study area is considered good, refer to **Section 4.14.2**. As the baseline air quality includes the full scheme study area, no variation on the existing air quality for the route options is envisaged.

A number of air emission sources in the scheme study area are identified in **Section 4.14.2**. However, these are not likely to significantly affect air quality within the vicinity of each route option.

Table 6.5.9.1 below describes the route option preferences from an air quality and climate perspective. For Section 1, the preferred route option is the Red1/Orange1 Route Option as it is the shortest route with the fewest sensitive receptors within 200m of the centreline. This is followed by the Green1/Yellow1/Pink1 Option as it has fewer receptors within 200m of the centreline than the Blue1 Option.

For Section 2, the preferred option is the Pink1 Route Option as it is has the fewest sensitive receptors within 200m of the centreline. This is followed by the Blue1 Route Option. The least preferred route option is the Red1 Route Option due to the significant number of sensitive receptors within 200m of the centreline.

Table 6.5.9.1 Summary of Air quality and climate ranking of Route Options

Route option	Section 1	Section 2
Red1	P	LP
Orange1	P	I
Yellow1	LP	I
Blue1	LP	I
Pink1	I	P
Green1	I	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.5.9.4 Summary

The air quality concentrations in the scheme study area are shown to be well within air quality standards and the assimilative capacity of the air within the scheme study area is considered good. The preferred option from an air quality and climate perspective is the Pink1 Route Option, as it is estimated to have the fewest sensitive receptors within 200m of its centreline.

6.5.9.5 References

National Road Authority. (2011) *Guidelines for the Treatment of Air Quality during the Planning and Construction of National Road Schemes.*

6.5.10 Noise and Vibration

6.5.10.1 Introduction

This section details the stage 1 assessment of the Route Options with respect to the noise and vibration constraints identified in **Section 4.15 Noise and Vibration** of this report. The Route Options as described in **Section 6.1** with the noise and vibration constraints are presented in **Figure 6.5.10.1** and **6.5.10.2**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options.

Section 6.5.10.2 outlines the methodology that was used to carry out the study and **Section 6.5.10.3** details the options assessment. A summary is presented in **Section 6.5.10.4** and references are listed in **Section 6.5.10.5**.

The route options are assessed in two sections. Section 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. The assessment is mindful that these route options could be realigned within their corridors and therefore the overall impact of the route corridor is also assessed to identify possible impacts within the 150m wide corridor for these route options.

The preliminary options assessment for Stage 1 has been undertaken to determine the most preferential routes in terms of noise and vibration to feed into the overall environmental ranking matrix.

6.5.10.2 Methodology

In order to establish a ranking methodology for the stage 1 Preliminary Options Assessment, the following approach was undertaken in line with the guidelines set out in Chapter 5 of the National Roads Authority (NRA) document “Guidelines for the Treatment of Noise and Vibration in National Road Schemes (2004)” and Chapter 2 of the NRA document, “Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes (2014)”.

In terms of operational noise, the Authority considers it appropriate to set the design goal for Ireland as follows:

- day-evening-night 60dB L_{den} (free field)

Both documents acknowledge that it may not always be sustainable to achieve this design goal. In such circumstances, nevertheless, a structured approach should be taken in order to ameliorate as far as practicable road traffic noise through the consideration of measures such as alignment changes, barrier type (e.g. earth mounds) or low noise road surfaces.

In general, the assessment of noise potential and noise and vibration impacts is based primarily upon property counts, likely changes in traffic flow and a review of the likely requirement for mitigation measures.

The following has been conducted to assess the impact rating of each of the six route options under consideration:

- Property counts have been conducted within four bands either side of the centreline of each route option, i.e. 0 to 50m, 50 to 100m, 100 to 200m and 200 to 300m. Using this information the Potential Impact Rating (PIR) for each route was established;
- The potential noise footprint of each route option was then established taking into account the vertical alignments for varying sections of each route corridor, traffic flows and traffic speed for the route options; and
- An assessment of the potential number of properties likely to be exposed to traffic noise levels at or above 60dB $L_{den,}$ and hence require noise mitigation was determined using a noise 'footprint' assessment.

Potential Impact Rating (PIR)

The NRA Guidelines advise that the initial stage of a route selection assessment on noise should focus on the PIR for each route. This involves counting the number of noise sensitive properties within 300m from the centre line of each corridor, subdivided into four distance bands of 0 – 50m, 50 – 100m, 100 – 200m, and 200 – 300m. The total number of receptors within each band is multiplied by an arbitrary rating factor suggested as follows within the guidelines:

- Band 1 (0 – 50m) 4
- Band 2 (50 – 100m) 3
- Band 3 (100 – 200m) 2
- Band 4 (200 - 300m) 1

The resultant values are summed to give a single rating number for each route option, the larger the PIR, the higher impact is potentially associated with the route option.

Noise Footprint of Route Corridors

To analyse the potential noise and or vibration impacts associated with the route corridors, the noise 'footprint' of each route alignment was determined using the following methodology.

- Each route alignment was overlaid on OS and aerial mapping. The proposed vertical alignment of each route was then reviewed to determine areas of grade, cuttings and embankments along each route corridor;
- Using guidance from the NRA's *'Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes'* (March 2014), the approximate distance to a 60dB L_{den} contour was established using the noise footprint graphs set out in Chapter 5 of the Guidance document;
- The noise contour lines were determined for individual sections of each route option, taking account the vertical alignment of the route option corridor, traffic flows, traffic speed and the road surface;
- An operational speed of 100km/hr was assumed along all route options and traffic flows of 8,000 AADT was used for route options within Section 1 (west of Na hAille including the Bearna Link Road) and 30,000 AADT for Section 2

(east of na hAille). A standard hot rolled asphalt road surface was used for all route options;

- In order to account for horizontal divergence of the route option corridor (150m in width), it was considered prudent to assess the 60dB contour band 75m beyond each side of the centreline and junctions to include for properties which could potentially fall within the 60dB L_{den} contour line. The exception to this was along on-line upgrades to the existing N6 where the road corridor is already defined;
- The number of noise sensitive properties within the 60dB L_{den} contour for each section of route option was counted and a total number between each section was established, and;
- For the Blue1, Pink1, Yellow1 and Orange1 Route Options, a link road to the N59 associated with each of these route options, was included in the property count also.

It should be noted, that the approach used for this stage is a high level screening assessment and is not used to calculate specific noise levels at individual properties or groups of properties or used to determine the extent of noise mitigation. The procedure used at this stage of the preliminary options assessment is to provide an objective methodology for ranking the potential noise impacts associated with each route option on a comparative basis.

Route Options with the highest number of noise sensitive properties within the 60dB L_{den} contour were ranked least favourably whilst those with the least were ranked highest.

Whilst some sections of routes have similar numbers of noise sensitive properties within their 300m wide corridor, those route options which extend into a deep cut have a narrower 60dB L_{den} contour band (i.e. fewer properties would exceed this criterion closer to the road development) and hence were ranked more favourably compared to those at-grade or on embankment.

For route options passing through tunnels, no noise sensitive locations were counted above the route options due to the road traffic noise being shielded at these locations.

On consideration of the various route options, once operational, ground vibrations produced by road traffic are typically low enough that they do not cause perciptable levels of vibration within properties, particularly from well maintained road surfaces. Vibration within tunnelled sections of road are also expected to be lower again than that caused by traffic on the surfaces of the existing roads due to the separation distances and the low level of vibration generated by road traffic through ground surfaces.

Vibration considerations are typically associated with the construction phase of the routes. Route options requiring extensive cut and cover, tunnel boring and surface and/or rock breaking works have the highest potential vibration impacts during their construction phase.

6.5.10.3 Option Assessment

The assessment has been divided into two Sections, as follows:

- Section 1: R335 to the assessment breakline at Na hAille; and
- Section 2: From Na hAille to the end of the scheme.

Tables 6.5.10.1 and **6.5.10.2** present the PIR assessment summaries for Sections 1 and 2 respectively of the for the six route options. The property counts associated with the PIR counts are included in **Appendix A.6.3**

Table 6.5.10.1 PIR Values for Section 1 of Route Options

Route Option	Potential Impact Rating Calculated for Each Distance Band				Total Rating Value
	PIR Band 1	PIR Band 2	PIR Band 3	PIR Band 4	
Red1	76	60	52	25	213
Orange1	76	60	52	25	213
Yellow1	64	69	104	42	279
Blue1	232	270	310	106	918
Pink1	232	270	310	106	918
Green1	64	69	104	42	279

The highest PIR value is associated with the Blue1 and Pink1 Route Options within Section 1. This is due to the number of properties along the Bearna Link Road coupled within those along the mainline. The alignment followed by the Red1 and Orange1 Route Options have the lowest PIR for this section.

Table 6.5.10.2 PIR Values for Section 2 of Route Options

Route Option	Potential Impact Rating Calculated for Each Distance Band				Total Rating Value
	PIR Band 1	PIR Band 2	PIR Band 3	PIR Band 4	
Red1	1256	1869	1932	1164	6221
Orange1	704	798	1112	863	3477
Yellow1	792	609	1404	1051	3856
Blue1	232	249	670	690	1841
Pink1	220	255	676	659	1810
Green1	232	318	418	293	1810

For Section 2, the Red1 Route Option has the highest calculated PIR rating followed by the Yellow1 and Orange1 Route Options. All three options are located towards the central part of the scheme study area where the highest density of properties are

located. In this instance, the properties count out to 300m captures the highest number of properties for these route options.

The lowest impact rating for Section 2 is calculated along the Green1 and Pink1 Route Options followed by the Blue1 Route Options.

Whilst the PIR assessment above provides information on the number of noise properties in the vicinity of each route option, the Guidelines acknowledge that the PIR process is used only to provide an initial high level screening for route ranking. This approach does not take into account other key factors affecting the potential noise impact from a route option, most notably its vertical alignment (cuttings, embankments, at-grade, tunnels etc.), road traffic flows and potential for noise mitigation.

For Section 1 of the route assessment scheme study area, the 60dB L_{den} contour line was determined based on the traffic flows and vertical alignments. Sections of the route options in deep cut were determined to have the smallest footprint (40m from the off-set line) while large embankments having the widest footprint (out to 90m from the off-set line).

Table 6.5.10.3 summaries the number of counted properties falling within the 60dB L_{den} noise contour line or 'footprint' for Section 1 of the six route options.

Table 6.5.10.3 Number of Properties within 60dB L_{den} Contour Line for Section 1 of Route Options

Route Option	No. of Properties Within 60dB L_{den} Contour Line		Total
	Mainline	Bearna Link Road	
Red1	46	0	46
Orange1	46	0	46
Yellow1	62	0	62
Blue1	26	47	73
Pink1	26	47	73
Green1	62	0	62

For Section 1, the highest number of properties within the 60dB L_{den} were counted along the Blue1 and Pink1 Route Options. The majority of these properties are located along the Bearna Link Road at the end of the scheme and hence increases the overall count for these two route options. The lowest number of properties falling within the 60dB L_{den} contour line were counted along the Red1 and Orange1 Route Options. In this instance, the Red1 and Orange1 Routes within Section 1 would be ranked the most favourably.

The assessment has concluded therefore that the Blue1 and Pink1 Route Corridors are those likely to require the greatest extent of noise mitigation measures to reduce noise levels to within the NRA traffic design goal of 60dB L_{den}.

For Section 2, the 60dB L_{den} contour line was extended out between 60 to 220m beyond the offset line depending on the traffic flow information and vertical alignment of sections of the route options. The wider footprint being as a result of higher traffic flows within this Section of the scheme study area.

Table 6.5.10.4 summaries the number of counted properties falling within the 60dB L_{den} noise contour line or 'footprint' for Section 2 of the six route options.

Table 6.5.10.4 Number of Properties within 60dB L_{den} Contour Line for Section 2 of Route Options

Route Option	No. of Properties Within 60dB L_{den} Contour Line		Total
	Mainline	N59 Link Road	
Red1	891	0	891
Orange1	348	23	371
Yellow1	912	51	963
Blue1	419	51	470
Pink1	401	51	452
Green1	561	0	561

Within Section 2, the highest number of properties within the 60dB L_{den} were counted along the Yellow1 Route Option, closely followed by the Red1 Route Option.

In this instance, noise mitigation measures would potentially be required for a significant number of properties along these route options in order to adequately reduce operational noise levels to within the NRA's design goal. For properties in close proximity to these route options, it may not be possible to suitably reduce noise levels within the traffic noise design goal.

The lowest number of properties falling within the 60dB L_{den} contour line were counted along Orange1 Route Option making it the most preferred route option in the scheme study area. This is noted to be due to the extent of the tunnel proposed as part of this route option which would shield road traffic noise from the high density of noise sensitive properties above this section of the Orange1 Route Option.

Both the Pink1 and Blue1 Route Options are calculated as having a high number of properties falling with the 60dB Ld_{en} noise contour but are nominally half those associated with the Red1 and Yellow1 Route Options and hence are ranked as mid preference options.

Red1 Route Option

The Red1 Route Option commences at the eastern end of Bearna Village and proceeds north along a new road alignment to join the existing Western Distributor Road. The route followed by this route option within this section of the route option is semi-rural with ribbon style development located along local roads across which the route transverses. Prior to joining the Western Distributor Road, the number of properties in the vicinity of this route option is comparable against the other options and is the preferred route up to the assessment breakline.

The remainder of the Red1 Route Option follows a combination of an on-line alignment and sections of tunnels/cut and cover alignments to cross high density areas. The number of noise sensitive properties within the 300m distance bands

from this corridor is the highest of all the route options with a calculated PIR of >6000. The noise footprint assessment for this route option also resulted in a significantly high number of properties potentially requiring noise mitigation compared to the other routes. Whilst the existing noise environment along the Western Distributor Road and existing N6 which the Red1 Route Option will follow is already exposed to road traffic noise, the traffic volumes along these routes are expected to increase by at least 25% during the operation of this route. Given the existing traffic noise levels along parts of these route options already exceed both the NRA's 60dB L_{den} design goal for new roads and the Galway City Council's threshold values for noise management of 70dB L_{den} (Source Galway City Council Noise Action Plan Maps, 2013-2018), the Red1 Route Option is likely to add to existing traffic noise levels along a large portion of its route and hence a significant number of properties would be affected by its operation.

In addition to the operational phase impacts, the construction of the Red1 Route Option will involve extensive surface works, tunnelling works and cut and cover works in close proximity to a significant number of noise sensitive properties along its route. The duration of the works coupled with the potentially high construction noise levels and potential vibration generation activities during this phase is considered to pose significant impacts to noise and vibration sensitive properties in the vicinity. It is considered that exensive mitigation measures would be required in order to reduce construction impacts to within acceptable levels at adjacent sensitive properties. These coupled with restrictive allowable noise and vibration limits and hours of work are likely to make constructability of this route option the least preferred of all the route options available.

Orange1 Route Option

The Orange1 Route Option commences at the eastern end of Bearna Village and proceeds north as per the Red1 Route Option to a point west of the Western Distributor Road where it veers northeast. Section 1 of this route is the most preferred route option compared to the other options in line with the Red1 Route Option. This is due to the lowest potential number of noise sensitive properties affected by road traffic noise during its operation.

The Orange1 Route Option continues in a north eastern direction passing to the north of number of residential estates as far as a proposed N59 Link road. The Orange1 Option continues east and enters a tunnel crossing under the River Corrib travelling towards the Terryland area where it exits immediately adjacent to the existing N6 at Terryland. The Orange1 Route Option will then follow the Red1 Route Option utilising the exiting N6 in a similar manner as the Red1 Route Option to tie to the existing N6 at Ardaun.

In terms of potential noise impacts, the total PIR value along Section 2 of this route option is the mid ranking compared to the other route options taking account of the number of noise sensitive properties extending out to 300m from the centreline. The number of noise sensitive properties likely to exceed 60dB L_{den} and hence require noise mitigation in the vicinity of this route from Section 1 as far as the N84 Road is low by comparison, taking into account the extent of the proposed tunnel and the alignment corridor set back from high density residential estates to the west of the River Corrib. Within Section 2, the highest number of noise sensitive locations in

proximity to the route corridor is along the exiting N6 where it follows the same alignment of the Red1 Route Option. Overall, in line with the assessment undertaken, this route option has, marginally, the lowest potential operational noise impact.

During the construction phase, standard road construction methods would be used along the majority of this route. Tunnel works associated with this route have the potential for noise and vibration impacts at noise sensitive properties in the vicinity of work compounds, TMB launch sites and above the tunnel corridor depending on the depth of construction, methodologies used and time periods of construction. It is possible, however to design and site over ground work areas (TBM launch sites etc) away from noise sensitive locations for these works and the tunnelling methodology can be designed to ensure impacts to noise and vibration during tunnelling are controlled to within acceptable levels. Notwithstanding the available mitigation measures, there is the potential for residual construction noise and vibration impacts to be experienced at sensitive buidlings along the route, depending on the methodogies chosen and other site constraints.

Yellow1 Route Option

The Yellow1 Route Option commences approximately 2km to the west of Bearna Village and follows a north eastern alignment towards Na hAille to the breakline for Section 1. The route option in this section transverses a number of local roads with ribbon style developments along them and property clusters at junctions and crossroads. The PIR for this section is a mid-ranking value compared to the other route options alongside the Green1 Route Option. The number of noise sensitive properties falling within the 60dB L_{den} noise contour along this section of the Yellow1 Route Option is also the mid ranking compared to the other options for Section 1 with a total of 62 properties potentially being exposed to noise levels at or above 60dB L_{den}.

The Yellow1 Route Option continues northwest with a new link road accessing the N59 in the vicinity of Knocknabrona. The route follows an alignment immediately north of a number of residential estates between the R336 and Rahoon Road and passes through the residential areas in the vicinity of Upper Dangan, Bushypark and the NUIG Recreational Facilities to the west of the River Corrib crossing. The route corridor crosses the River Corrib to the south of Menlo Castle and proceeds to the south of Menlough Village. From this point the Yellow1 Route Option proceeds south east passing through and in close proximity to a number of residential areas at Coolough, Carraig Bán and Sceilg Ard proceeding south to connect back to the existing N6 at Terryland where it follows the Red1 and Orange1 Route Options to the end of the scheme. The PIR for Section 2 of this route option corridor is the second highest of the route options, the highest number of properties being located within the corridor between the point of deviation between the Blue1 and Orange1 route options. The Yellow1 Route Option has the highest number of properties potentially falling into the 60dB L_{den} corridor for Section 2 compared to the other route options. This is primarily due to the overland option for this route (i.e. it does not pass through any tunnel alignments) compared to the Orange1 and Red1 Route Options and its close proximity to a number of noise sensitive properties where the vertical alignment results in a wider noise footprint.

In terms of construction, standard road construction methods would be used for this route. Whilst the road construction would occur in close proximity to a number of noise sensitive properties, the nature of the works are likely to be mitigated to within the appropriate construction noise and vibration limits and the duration of the works in the vicinity of any one area would be relatively short-term compared to other route construction options.

Blue1 Route Option

The Blue1 Option commences at the western end of Bearna Village and proceeds along an existing relief road parallel to and north of the R336. There are a number of noise sensitive properties located immediately along the edge of the Bearna Relief Road which forms part of this Route Option. The route corridor proceeds north east, similarly traversing a number of local roads with ribbon style development along them to the Break Point of Section 1 at Na hAille. The PIR along this section of the Blue1 Route Option is the highest alongside the Pink1 Route Option due to the number of properties in proximity to the Bearna Relief Road and the mainline itself. The mainline section of the route alignment between the Bearna Relief Road and the Section 1 breakline has the lowest PIR count however. The same applies to the number of properties counted within the 60dB L_{den} line along this section with the highest number being in proximity to the edge of the Bearna Relief Road.

Moving northeast into Section 2, the route option follows the same alignment as the Yellow1 Route Option as far as Menlough. The route therefore follows an alignment immediately north of a number of residential estates between the R336 and Rahoon Road and passes through the residential areas in the vicinity of Upper Dangan, Bushypark and the NUIG Recreational Facilities. The Blue1 Route veers north of the Yellow1 Route Option to the east of Menlough and passes through a tunnel at Lackagh Quarry and continues south east towards Ballybrit passing to the north of residential estates at Castlegar and passing in close proximity to a number of individual properties along the N84 and adjoining local road with a number of properties being acquired in this area. The route option crosses Galway Racecourse within a cut and cover tunnel and re-emerges to the south of Briarhill Business Park and ties back into the existing N6 Road. The section of the route is largely set back from or screened from noise sensitive properties by tunnel/cut and cover sections.

The PIR for Section 2 of the Blue1 Route Option is the second lowest compared to the other options. This Route Option has the third lowest number of properties counted within its 60dB L_{den} noise contour line, the highest number of properties counted being in the vicinity of Upper Dangan/Bushypark.

During the construction phase, standard road construction methods would be used along the majority of this route. Tunnel works in the vicinity of Lackagh Quarry are well set back from noise sensitive properties and similarly the proposed cut and cover works across Galway Racecourse are well set back from noise sensitive properties. This assumes activities within the racecourse would not be operational during the construction works. Whilst the standard road construction would occur in close proximity to a number of noise sensitive properties, the nature of the works are likely to be mitigated to within the appropriate construction noise and vibration

limits and the duration of the works in the vicinity of any one area would be relatively short-term compared to other route construction options.

Pink1 Route Option

The Pink1 Route Option follows the same alignment as the Blue1 Route Option up to the Tuam Road. The Pink1 Route Option diverts north east to avoid the Galway Racecourse and follows an alignment between Ballybrit Business Park and the Galway Racecourse. The alignment veers south east from this point to meet the existing N6 to the south of Coolagh Village. The PIR and noise contour counts for Section 1 of this route option is the same as the Blue1 Route Option making it the least preferred option.

Section 2 of the Pink1 Route Option has a marginally lower PIR and noise footprint count than the Blue1 Route Option, this relates to the different alignment options beyond Ballybrit as far as the N6 tie in where a marginally fewer number of noise sensitive properties are located within the distance bands beyond the centreline.

Similar construction noise and vibration impacts would be experienced for the Pink1 Route Option to that of the Blue1 Route Option.

Green1 Route Option

The Green1 Route Option is the furthest off-line option in the scheme study scheme which extends to the northern section of the scheme study area. The route option commences approximately 2km to the west of Bearna Village. The route continues northeast crossing the highest number of local roads as far as the assessment breakline at Na hAille. The calculated PIR for this section of the Green1 Route Option is the second highest of the three corridor options in this section of the scheme study area in line with the Yellow1 Route Option. In terms of the noise footprint for this section, the number of properties which have the potential to fall into the 60dB L_{den} contour were also counted and found to also be the second highest of the corridor options available.

Moving beyond Na hAille the Green1 Route Option continues northeast following the same alignment to the Yellow1 Route Option to the north of residential estates between the R336 and the Rahoon Road. The Green1 Route Option veers north at this point to cross the N59 Road and passing through and in close proximity to properties at Bushypark and Menlough village further east of the River Corrib. The route proceeds further northwards from this point passing a number of individual properties dispersed along small local roads. The route proceeds south through a large quarry at Pollkeen and past Parkmore West Business Park which it continues south east to the tie in point with the existing N6. The PIR calculated for Section 2 of this route is the lowest of all the route options. This is primarily due to the fact that this route passes furthest away from large clusters of noise sensitive properties in residential estates which are more densely located towards the city centre and immediate boundaries.

By comparison to the other routes, the number of noise sensitive properties extending out to 300m is therefore lowest for this route, the highest density of properties being located within the closest distance band. The potential noise footprint assessment for this route option indicates that the number of properties

which have the potential to fall into the 60dB L_{den} noise contour line is, however, the third highest compared to the other routes however. In this instance, whilst the PIR rating for this route is the lowest by comparison to the other routes, taking account of the vertical alignment and the number of properties within the closest distance bands, the number of properties likely to require noise mitigation is higher than the Blue1, Pink1 and Orange1 Options.

In terms of construction, standard road construction methods would be used for this route. Whilst the road construction would occur in close proximity to a high number of noise sensitive properties, the nature of the works are likely to be mitigated to within the appropriate construction noise and vibration limits and the duration of the works in the vicinity of any one area would be relatively short-term compared to other route construction options.

Ranking of Options

Taking account of the above assessments, the following ranking has been applied for Section 1 and Section 2 for the six route options.

Table 6.5.10.5 Summary of Noise and Vibration rankings of Route Options

Route Option	Section 1	Section 2
Red1	P	LP
Orange1	P	P
Yellow1	I	LP
Blue1	LP	I
Pink1	LP	I
Green1	I	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

For Section 1, the preferred route option is the Red1 and Orange1 Route Options due to the lowest PIR and overall number of properties likely to exceed the 60dB L_{den} design goal. The least preferred route option is that followed by the Blue1 and Pink1 Route Options.

For Section 2, the preferred route option is the Orange1 Route Option which was found to have the least potential operational noise impact on its surrounding environment taking account of its vertical alignment and the number of properties likely to require noise mitigation.

The Pink1 and Blue1 Route Options are of comparable ranking taking account of the number of properties likely to fall within the 60dB L_{den} contour and their PIR's. The Pink1 Route Option has been ranked just above the Blue1 Route Option taking account of the various factors noted above. Both these options have been ranked as intermediate (I). The Green Route Option has also been ranked as Intermediate taking account of the lower PIR value along this section compared to the other route options and the number of properties likely to require noise mitigation.

The least preferred route options are the Yellow1 and Red1 Route Options. Whislt the Red1 Route Option has a lower number of properties potentially impacted by its operation compared to the Yellow1 Route Option, the potential long term

significant noise and vibration impacts associated with the construction phase of the route option places this route in a similar ranking of least preferred.

The least preferred route option is the Yellow1 Route Option which has been determined to have the highest potential operational noise impact to its surrounding environment. The Red1 Route Option has a lower overall noise footprint count for its operational phase, however, the potential long term construction noise and vibration impacts rank this route option of least acceptable similar to the Yellow1 Route Option.

6.5.10.4 Summary

The six route options have been ranked in order of preference for noise and vibration, taking account of the potential number of properties within the route corridor 300m distance bands and the likely number of properties likely to fall within the 60dB L_{den} design goal during its operational phase.

For Section 1, the most preferred options are the Red1 and Orange1 Route Options with the Blue1 and Pink1 Options the least preferred.

For Section 2, the most preferred option is the Orange1 Route Option with the least preferred being the Yellow1 and Red1 Route Options.

6.5.10.5 References

National Roads Authority. (March 2014) *Good Practice Guidance for the Treatment of Noise during the Planning of National Road Schemes*.

National Roads Authority. (October 2004) *Guidelines for the Treatment of Noise and Vibration in National Road Schemes*.

Galway City Council. *Noise Action Plan 2013 to 2018*

County Galway Local Authorities City Council. *Noise Action Plan 2013 to 2018*

6.5.11 Human Beings

6.5.11.1 Introduction

This section details the Stage 1 assessment of the route options with respect to the constraints associated with human beings as identified in **Section 4.17 Human Beings** of this report. The route options, as described in **Section 6.1,** with the human being constraints are presented in **Figure 6.5.11.1**. These six route options are referenced as Red1 Route Option, Orange1 Route Option etc. to differentiate that these are Stage 1 route options. The section can be read in conjunction with **Material Assets Non-Agriculture Section 6.5.8** which contains a Stage 1 assessment of the route options on residential properties and, by association, assessment in terms of individual dwellings. The **Air Quality and Climate Section 6.5.9** and **Noise and Vibration Section 6.5.10** also assess the route options in terms of human beings. **Landscape and Visual Section 6.5.5** also includes an assessment of the route options relative to amenities enjoyed by individuals.
Section 6.5.11.2 outlines the methodology that was used to carry out the study and **Section 6.5.11.3** details the options assessment. A summary is presented in **Section 6.5.11.4** and references are listed in **Section 6.5.11.5**.

Information on the existing environment, including the location of community facilities and demographic data, can be found in **Section 4.3.9**.

6.5.11.2 Methodology

The assessment identifies locations along the proposed route options where impacts on local people and communities could potentially occur and has been prepared in accordance with the following guidelines:

- EPA Advice Notes on Current Practice in the Preparation of Environmental Impact Statements (2003);
- EPA Guidelines on the Information to be contained in Environmental Impact Statements (2002); and
- NRA Environmental Impact Assessment of National Road Schemes – A Practical Guide (2006).

Impacts of human beings that are typically associated with a road development fall into four principal categories, namely:

- Journey characteristics, accessibility and connectivity, i.e. potential impacts on journey time, journey time reliability and travel patterns including accessibility and connectivity;
- Community severance with regard to the use of community facilities, particularly those used by older people, children or other vulnerable groups. The category includes both new severance and relief from severance;

- Amenity, i.e. impacts on individual and community well-being due, for example, to people's exposure to the environmental impacts of traffic (e.g. safety, noise, dirt, visual intrusion and air quality); and
- Impacts that could affect economic growth prospects and employment.

Impacts can be positive or negative. Their significance is assigned as Imperceptible, Slight, Moderate, Major or Profound, and depends, amongst other considerations, on the nature of the environment affected, the duration of an impact and the probability of its occurrence. It often follows that impacts on human beings are a function of:

- The scale of the impact itself;
- The numbers of people likely to be affected; and
- The impact on vulnerable or sensitive groups.

The assessment generally addresses impacts at a community level rather than for individuals or identifiable properties, although impacts for individual businesses are discussed where these are located beside a route option or are very dependent on road traffic or accessibility. The assessment addresses impacts in both the construction and operation phases. Property impacts are specifically addressed in **Section 6.5.8 Material Assets Non-Agriculture**, but the number of properties impacted is relevant to the assessment of impacts on human beings where this number is such as to impact on the integrity of a distinct community. The significance of impacts as they would affect the worst hit subset of the population are summarised in **Tables 6.5.11.1** to **6.5.11.4**. The 'magnitude' of impacts represents the number of people (or businesses) likely to be affected and is labelled as very high, high, medium or low.

Journey Characteristics

Assessment of journey times and patterns is inevitably dependent on precisely where an individual journey originates and ends, when it is undertaken (e.g. within or outside peak hours) and by whom it is undertaken, i.e. by drivers, cyclists, users of public transport or pedestrians including individuals whose transport options may be restricted. The impact varies for each journey, but typical journeys to particular destinations can usually be identified. Impacts have been assessed in accordance with the significance criteria outlined in **Table 6.5.11.1** with positive impacts resulting from a decrease in journey length or time and negative impacts resulting from an increase in journey length or time.

Table 6.5.11.1 Journey Length, Journey Time or Time Reliability criteria

Impact level	Significance criteria
Imperceptible	No appreciable change to present journeys
Slight	Some reduction in journeys time where positive, or inconvenience where impact is negative, but present journey patterns likely to be maintained.
Moderate	Journeys become shorted where impact is positive. Journeys become longer where impact is negative such that some groups may be dissuaded from making trips.

Impact level	Significance criteria
Major	Considerable improvement in convenience where impact is positive. Where negative, the loss of convenience is considerable and many people will be deterred from making trips.
Profound	Very considerable increase or decrease in journey length or duration sufficient to cause marked change in behaviour of a sizeable proportion of population.

In this report, journey characteristics are primarily addressed as far as the route options are judged to impact on accessibility or connectivity to key destinations for local journeys and through traffic.

Community severance

Severance is a typical impact of a road development. New severance can discourage community interaction and occurs where access to community facilities, or between neighbourhoods, is impeded by the physical barrier of a road. Social severance can occur from the restriction of people's accessibility, but also where communities become identified by their containment within certain road boundaries. This can include the psychological effect of traffic or safety concerns as barriers to social interaction. On the other hand, relief from existing severance may be provided by a new road if traffic volumes or speed are moderated, by the inclusion of crossing facilities in the design or through the presence of overbridges or underpasses.

The definition of severance is not precise. It depends on the location of community facilities, the level of use of facilities, the time of day or duration when traffic conditions are experienced, the sensitivity of the population affected and the geographical spread of the community. Children, the elderly, people with disabilities and people without access to a private car would be amongst those most affected by community severance and any corresponding loss of neighbourhood interaction.

Table 6.5.11.2 New or Increased Severance criteria

Impact level	Significance criteria
Imperceptible	Journey patterns maintained
Slight	Present journey patterns likely to be maintained, albeit with some hindrance to movement.
Moderate	Some residents, particularly children and elderly people, could be dissuaded from making journeys. For others, journeys are longer or less attractive.
Major	Most residents are likely to encounter severance which, in some cases, will be sufficient to induce a reorganisation of their activities or cause them to make less frequent trips to nearby neighbourhoods or less use of particular community facilities.
Profound	People are likely to be deterred from making trips to an extent that includes permanent loss of access or a change in the location of centres of activity.

Table 6.5.11.3 Relief from Severance criteria

Impact level	Significance criteria
Imperceptible	Very slight reduction in daily traffic levels or current journey patterns maintained
Slight	Small reduction in traffic levels or some reduction in severance
Moderate	Moderate reduction in traffic levels or a reduction in severance sufficient to encourage some residents to make more frequent journeys to community facilities.
Major	Considerable reduction in traffic levels or a reduction in severance such as to allow most residents to make more frequent journeys to community facilities or to switch from car to pedestrian or cycle journeys
Profound	Very considerable reduction in traffic levels or reductions in severance such as to provide new access to community facilities or to cause a very significant increase in pedestrian or cycle journeys

For the purposes of the Stage 1 Route Option assessment detailed option design such as pedestrian or cyclist crossings are not yet available. Consequently, in this assessment, severance is addressed mainly in terms of potential physical severance and social severance.

Amenity

The assessment of journey amenity uses the same significance categories as before and is supported by cross-references where necessary with the **Chapter 3 Traffic Assessment and Route Cross-section, Section 6.5.10 Noise and Vibration** and **Section 6.5.5 Landscape and Visual** and **Section 6.5.9 Air Quality and Climate** for traffic, noise, visual impacts or air quality. The level of traffic on a road, the proximity and separation of footpaths and cycle-paths, the nature of any crossings/junctions to be negotiated, the legibility of a journey (including signage), visual intrusions (including sightlines) and perceived safety are amongst the factors relevant to the assessment of amenity. Detailed option design factors such as pedestrian or cyclists crossings are not yet available. Consequently, in this assessment, severance is addressed mainly in terms of potential physical severance and social severance.

More informed observations can be made at this stage with regard to the likely general amenity of people living in the vicinity of the route options. The same is true of direct or indirect impacts on particular community facilities and recreational sites. Typically, these impacts are specifically addressed under the headings of Noise and Vibration (**Section 6.5.10**), or Landscape and Visual (**Section 6.5.5**), but they have a community dimension too in that human well-being is affected. Significant impacts can be expected where community facilities are directly impacted by the alignment of a route option. These impacts are described in the text and individually identified in **Table 6.5.11.4**.

Economic

Economic and employment impacts occur at both the regional and local scale and can be either positive or negative. Much road development is proposed with the intention of improving national competitiveness and economic/social linkages, for

instance in relation to reducing journey time and improving journey time reliability for commercial goods or for travel and commuting by employees. However, there can also be some negative impacts in relation due to any direct impact of businesses, their proximity to a road or loss of passing trade.

Table 6.5.11.4 Economic Impact criteria

Impact level	Significance criteria
Imperceptible	No significant economic impacts are apparent
Slight	A small impact on the business environment can be attributed to the proposed development
Moderate	A moderate impact on the business environment can be identified.
Major	An impact that has the potential to substantially affect business performance or to influence the location decisions of new business.
Profound	Impacts of a scale to significantly affect the performance of a major business or several businesses. Where these businesses are important local employers there is the possibility of significant impacts for the general prosperity of the local area or region.

Economic impacts may affect an identifiable local business and such businesses could be important local employers. In this case, impacts on individual companies may be discussed in the text. Other economic impacts could affect the wider community, for example where a number of businesses are affected or where the retail or business environment of a town is impacted. As with the other categories above, detailed road design information is not available at this stage, excepting the location of major junctions and proposed links to existing roads.

6.5.11.3 Options Assessment

Section 1

The principal constraints in Section 1 relate to the village of Bearna, the risk of adverse impacts on environmental amenity in the centre of the community and of physical or social community severance.

Red1 Route Option

By commencing on the R336 to the east of Bearna at Node C, the Red1 Route Option will attract local Bearna traffic and West Galway traffic through the centre of Bearna with the risk of physical or social severance respectively. The route option will provide relief form severance for community facilities such as the Church of Mary Immaculate on the Bearna Road into Galway City by substantially reducing traffic based on the traffic projections (**see Chapter 3**).

A considerable amount of scattered development along the route of the Red1 Route Option does mean that there are significant construction impacts due to the demolition of properties in Trusky East and Ballard West. The amount of demolitions could impact on community identity and introduce social severance. There may be potential within the band to avoid construction impacts on individual properties at Knockaunnacarragh. Some demolitions are likely at Ballard West.

The development is linear in character and so would include at-grade crossings of existing roads. Overall, while there are construction impacts, the operational community impacts such as neighbourhood severance, could be mitigated or are likely to be *imperceptible to slight.*

Orange1 Route Option

As with Red1, the Orange1 Route Option commences on the R336 at Node C to the east of Bearna. Consequently, the option will attract local Bearna traffic and West Galway traffic through the centre of Bearna or along the proposed relief road with the risk of physical or social severance respectively. The route option will provide relief form severance for community facilities such as the Church of Mary Immaculate on the Bearna Road into Galway City by substantially reducing traffic based on the traffic projections (**see Chapter 3**).

A considerable amount of scattered development along the route of the Orange1 Option does mean that there are significant construction impacts due to the demolition of properties in Trusky West and Ballard West. The amount of demolitions could impact on community identity and introduce social severance. Some of these construction impacts could possibly be avoided by aligning the road to the edge of the corridor (this possibility is allowed for in the assessment). The development is linear in character and so would include at-grade crossings of existing roads. Overall, while there are construction impacts, operational community impacts such as neighbourhood severance could be mitigated or are likely to be *imperceptible to slight.*

Yellow1 Route Option

The Yellow1 Route Option connects to the R338 west of Bearna at Node A so that traffic from the scheme would not impact on the village. There could be some negative economic impacts on passing trade for services in Bearna, although the community itself provides the principal catchment for these services. The Bearna LAP proposes that the village centre would, in due course, be provided with a relief road such that much of this impact could be expected to occur in the future in any event. As with the Green1 Option, Yellow1 has the disadvantage that it will be less successful at collecting local traffic from Bearna with a lesser beneficial impact in terms of journey amenity.

A considerable amount of scattered development along the Yellow1 Option means that there are significant construction impacts due to the demolition of properties in Na Foraí Maola and Trusky West. The amount of demolitions could impact on community identity and introduce social severance. Some of these construction impacts could possibly be avoided by some changes in alignment. The development is linear in character and so would include crossings over existing roads. Therefore, the operational community impacts such as neighbourhood severance are likely to be *slight*. Overall, while there are construction impacts, operational community impacts such as neighbourhood severance, could be mitigated or are likely to be *imperceptible to slight.*

Blue1 Route Option

The Blue1 Route Option commences at Node B on the R336. The option introduces a social severance impact within the built-up area of Bearna, but the impact is moderated by the separation of estates of either side that has been allowed for within the design of the existing road.

There are likely construction impacts on properties at Scath Na Mara estate and in Ballard West. The amount of demolitions could impact on community identity and introduce social severance. Some of these impacts could be avoided by movements within the corridor. Overall, while there are construction impacts, operational community impacts such as neighbourhood severance, could be mitigated or are likely to be *slight.*

Pink1 Route Option

The Pink1 Route Option also makes use of a route that has been proposed forthe Bearna relief road. Like the Blue1 Option, it introduces a severance impact within Bearna Village, but the impact is moderated by the physical separation of estates using high walls of either side of the existing section of roadway. Overall, while there are construction impacts, operational community impacts such as neighbourhood severance, could be mitigated or are likely to be *imperceptible to slight.*

There are likely construction impacts on properties at Scath Na Mara estate and in Ballard West. The amount of demolitions could impact on community identity and introduce social severance. Some of these impacts could be avoided by movements within the corridor.

Green1 Route Option

The Green1 Route Option has the virtue of connecting to the R338 west of Bearna so that traffic from the scheme would not impact on the village. There could be some negative economic impacts on passing trade for services in Bearna, but for the most part, the community itself provides the catchment for these services. Furthermore, the village centre would, in due course, have been provided with a relief road as proposed within the Bearna LAP so that much of this impact could be expected to occur in the future in any event. The Green1 Option does, however, have the disadvantage that it will be less successful at collecting local traffic from Bearna with a lesser beneficial impact in terms of journey amenity.

A considerable amount of scattered development along this route does mean that there are significant construction impacts due to the demolition of properties in Na Foraí Maola, Trusky West, An Chloch Scoilte and Ballard West. The amount of demolitions could impact on community identity and introduce social severance. Some of these construction impacts could possibly be avoided by aligning the road to the edge of the corridor. The development is linear in character and so would includescrossings of existing roads using either, underbridges or overbridges. Therefore, the operational community impacts such as neighbourhood severance are likely to be slight.

Section 2

Red1 Route Option

The principal constraints for the Red1 Route Option in this section relate to construction impacts on community amenity and physical and social severance during both construction and operation, albeit with some opportunities to provide relief from severance on completion.

The Red1 Option follows the Western Distributor Road introducing new severance particularly during the construction phase. There would be very significant construction impacts in Rahoon, especially on the estate of Cruachan Park, a neighbourhood green space and on the old graveyard at Rahoon. This impact would be exacerbated if members of the community do not return to the neighbourhood on completion. Along Seamus Quirke Road and between Browne Roundabout and the River Corrib, impacts would be in the form of physical and social severance and loss of environmental amenity (see sections on Noise and Landscape & Visual). Significant severance is likely in the vicinity of important community and retail facilities combined with poor journey amenity. In addition, there would be a significant direct amenity impact on the NUIG Kingfisher Sports Centre due to the need for a second river crossing to the south of the existing Quincentenary Bridge. Overall, the construction community impacts are likely to be *major or profound.*

In the operational phase, the use of cut-and-cover tunnel would mean that there would be no lasting significant impact on a residential estate at Gort Na Bró or on the adjacent playing fields. The traffic model projects an increase in traffic flow compared with current levels, although in principle, the use of cut-and-cover means that the impact on the remaining Seamus Quirke Road could be positive. There is the potential for significant improvements to local traffic flow at Thomas Hynes Road and Newcastle Road, and at the Bodkin Junction and Kirwan Roundabout to the east of the River Corrib. In principle, the option could provide for improved journey amenity for cyclists and pedestrians and for improved crossings at junctions with relief from severance. However, retaining through traffic in the city would mean that this corridor would remain quite trafficked where the road runs above ground with significant impacts on physical and social severance particularly east of Browne Roundabout.

To the east of the river, a negative amenity impact on the Terryland River greenway is likely. There is potential for the option to relieve traffic pressure at the junction with the N17, therefore providing for improved local journey time and amenity, and to reduce community severance on the N6 beside the Ballybrit Business Park, although most pedestrian and cyclist movements here are employment related.

In conclusion, the operational community impacts are likely to positive on balance, but to include some negative impacts.

Orange1 Route Option

The principal feature of the Orange1 Route Option is the use of a tunnel under Newcastle and Terryland that would avoid the direct impact on community facilities or community severance presented by an overland option.

The Orange1 Option enters the tunnel at Circular Road so avoiding impacts on residential estates, playing fields and any direct impact on St. Joseph's National School, Galway Educate Together School, St. Francis Community Nursing Facility and NUIG facilities. The tunnel would continue under the river and the suburb of Terryland. There would be a loss of amenity value once the option emerges above ground at a green space where a junction is proposed in the vicinity of Sandyvale Lawn. However, there are no significant severance impacts relative to the current situation. In conclusion, the operational community impacts are likely to be positive.

Due to the use of a tunnel below all built development, the construction impacts would be modest and restricted to tunnel entrance points and the construction of ventilation shafts.

Yellow1 Route Option

The principal impacts for the Yellow1 Route Option are the very significant direct amenity impact on the NUIG Recreational Facilities and almost equally significant impact on amenity green spaces in Terryland. In addition, there is a very significant community impact on residential estates in Terryland.

The Yellow1 Option runs behind the playing fields of St. James' National School, Bushypark. It has a direct impact on amenity by cutting directly through the NUIG Recreational Facilities including key facilities such as the running track. It also crosses an important section of the greenway beside the River Corrib. Potentially the sports facilities can be moved, but only at much inconvenience given that the option takes a line through the centre of the facility. In addition, the connection with the N59 cuts through the community of Bushypark (see also **Section 6.5.5 Landscape and Visual**, and **Section 6.5.10 Noise and Vibration**) introducing a degree of neighbourhood severance (see also Blue1 Route Option below).

There is the prospect of demolitions of private properties on the Yellow1 Route Option near Menlough and at the Carraig Bán estate in Terryland, although these could be avoided with an alignment to the east of the corridor. Similarly, a significant impact on a community scale arises from the need for demolitions on the Sceilg Ard and Tornóg estates. These could potentially be avoided by a shift of the alignment to the north of the band. Without this, the significance of the construction impact would be raised. Similarly, there are likely to be significant construction impacts at the Glenanáil estate located between the N6 and the N17.

Overall, the construction community impacts are likely to be major unless it is feasible to make changes to the alignment.

On operation, the Yellow1 Route Option runs along the northern edge of a park to the north of Terryland which includes sports pitches. The option also crosses part of the Terryland Forest Park which, though underdeveloped and lightly used, has much potential to be an important amenity area in the future (see also **Section 6.5.5 Landscape and Visual**).

As with the Red1 and Orange1 Route Options, there would be improved traffic flow at the junction with the N17. Between Nodes R and T, there is the potential to

improve traffic flow at the junction with R339 and to improve access to Galway Racecourse and the Business Park.

In conclusion, the operational community impacts are likely to be positive on balance, but to include very significant negative impacts.

Blue1 Route Option

The principal impacts associated with the Blue1 Route Option are a very significant direct amenity impact on the NUIG Recreational Facilities. In addition, there is a potential impact on Galway Racecourse during construction. The proposed link road to the N59 would have a very significant construction and social severance impact on the communities of Ballagh and Bushypark.

During construction, the Blue1 Route Option presents a likelihood of impacts on a small number of properties in Castlegar and on properties at the N84. The option passes below Galway Racecourse in a cut-and-cover tunnel arrangement, but some impacts are likely. Adverse impacts on traffic movement are likely to be associated with the junction construction. Overall, the construction community impacts are likely to be major negative.

The Blue1 Route Option runs behind the playing fields of St. James' National School, Bushypark and presents a direct amenity impact by cutting directly through the NUIG Recreational Facilities including key facilities such as the running track. It also crosses an important section of the greenway beside the River Corrib. Potentially the sporting facilities can be moved, but only at much inconvenience given that the option takes a line through the centre of the facility. In addition, the link connection with the N59 cuts through the community of Bushypark introducing a degree of neighbourhood severance. The N59 link road impacts on several properties and also presents neighbourhood severance in Ballagh.

East of the River Corrib, there is a possibility of slight neighbourhood severance in vicinity of St. Colmcille's National School Castlegar. The use of cut-and-cover tunnel would avoid impacts on Galway Racecourse in the operational phase. At the proposed junction with the R339 and existing N6, there is the potential to improve traffic flow and access to the Racecourse and the Business Park. In conclusion, the operational community impacts are likely to be positive on balance, but to include significant negative impacts.

Pink1 Route Option

The principal impacts associated with the Pink1 Route Option are a very significant direct amenity impact on the NUIG Recreational Facilities. The proposed link road to the N59 would have a very significant construction, community and social severance impact on Ballagh and Bushypark.

During construction, the Pink1 Route Option presents a likelihood impacts on a small number of properties in Castlegar and on N84. The route option passes to the north of Galway Racecourse avoiding the some of the construction impacts to properties on the N17 that are associated with the Blue1 Route Option. The short length of cut-and-cover tunnel that is proposed for the unique section of the option in Ballybrit, means that there are no significant socio-economic impacts associated with this section except for adverse impacts on traffic movement that are likely to

be associated with junction construction. Overall, the construction community impacts are likely to be *major negative*.

On operation, the Pink1 Route Option runs behind the playing fields of St. James' National School, Bushypark and presents a direct amenity impact by cutting directly through the NUIG Recreational Facilities including key facilities such as the running track. It also cuts across an important section of the greenway beside the River Corrib. In addition, the link connection with the N59 cuts through the community of Bushypark introducing a degree of neighbourhood severance (compare with the Green1 Route Option). This link impacts on several properties and also presents neighbourhood severance in Ballagh.

In Castlegar, there is a possibility of slight neighbourhood severance caused by the Pink1 Route Option in vicinity of St Colmcille's National School Castlegar.

In conclusion, the operational community impacts are likely to be positive on balance, but to include significant negative impacts.

Green1 Route Option

The principal impacts associated with the Green1 Route Option relate to the construction and community severance impact on the communities of Ballagh and Bushypark. In addition, there would be a very significant construction impact and severance impact on the historic communities of Menlough and Ballindooley.

During the construction phase, there are demolition impacts on scattered linear development in the vicinity of Ballyburke and Keeraun, however, there is some potential for these to be avoided within the corridor band. A very significant impact would occur during the construction phase due to demolitions in Bushypark. There is also very significant construction impacts on individual properties in Menlough and on the Bóthar Coill Uachtair. Demolitions are likely in Ballindooley and on one business premises in the business park near Ballybrit. Overall, the construction community impacts are likely to be at least major negative.

In the west, there is a direct impact an equestrian centre at Tonabrocky, but however, mitigation may be possible in the form of re-location of this facility. Reference should also be made to **Section 6.5.7 Material Assets - Agriculture**. Significant construction impacts and neighbourhood severance is likely at Bushypark, especially with the junction connection to the N59. However, most impacts here are visual and noise related.

East of the River Corrib, the route option passes beside Menlo Graveyard which is of both heritage and amenity value (see also **Section 6.5.6 Archaeology**, **Architectural and Cultural Heritage**). It also passes close to jetty which includes amenity parking, see **Section 6.5.5 Landscape & Visual**. The Green1 Route Option passes through the centre of the community of Menlough. Although, careful alignment could minimise the impact on individual properties, this does present a very significant impact on social and potentially physical severance.

At Ballindooley there is the possibility of neighbourhood severance, although this is partly mitigated by the inclusion of a realignment of the N84 to the west of the existing N84. There is also a significant, but undefined economic and employment impact on the large Roadstone Quarry at Twomileditch.

The route passes to the north of Galway Racecourse and to the south of the Racecourse Business Park and the Galway Technology Park. Potentially improved access would be provided to these facilities. The option passes close to Briarhill National School on the R339, but it is possible to extend the distance to the western edge of the band (with a central alignment the operational impact would be raised by one point).

In conclusion, the operational community impacts are likely to be positive on balance, but to include very significant negative impacts.

6.5.11.4 Summary

The ranking tables are shown below for operational and construction impacts. The tables are based on scores that have been calculated for the operational and construction phases. For the route options, some of the construction impacts are quite significant in socio-economic terms. The construction rankings take into account the number of residential demolitions, but the significance of these is raised in locations where these properties form part of a more distinct community, be this a dispersed community such as Menlough or a more concentrated community such as Rahoon.

The rankings are dependent on the best alignment being selected within an option corridor. Where the choice of the central alignment would lead to a different outcome, this is described in the text. This consideration applies especially to the Orange1 Route Option.

All of the route options are quite different in terms of the impacts they present, but the final rankings are often quite similar due to the respective significance of the individual impacts of any one route option. Each of the route options must cross the River Corrib, but only the Orange1 Route Options is without significant socio-economic impacts. The Red1 Route Option might appear to present the most significant socio-economic impacts, but the assumption is that this route option would enable a design that provides for reduced severance and improved movement for pedestrians and cyclists throughout.

There are socio-economic impacts associated with changes in traffic flow in the city and with connecting national roads, including the success of the scheme in dealing with through traffic. However, for the most part, the analysis above does not include these considerations (excepting the N17) as this is dependent on the conclusions from the separate traffic modelling.

Table 6.5.11.5 Individual Assessment Matrix for Human Beings Assessment – Construction Phase

Route Option	Section 1	Section 2
Red1 Option	P	LP
Orange1 Option	P	P
Yellow1 Option	I	LP

Route Option	Section 1	Section 2
Blue1 Option	P	I
Pink1 Option	P	I
Green1 Option	I	LP

Table 6.5.11.6 Individual Assessment Matrix for Human Beings Assessment – Operational Phase

Route Option	Section 1	Section 2
Red1 Option	LP	I
Orange1 Option	LP	P
Yellow1 Option	P	LP
Blue1 Option	I	I
Pink1 Option	I	P
Green1 Option	P	LP

Table 6.5.11.6 Overall Summary Human Beings

Route Option	Section 1	Section 2
Red1 Option	LP	LP
Orange1 Option	LP	P
Yellow1 Option	I	LP
Blue1 Option	P	I
Pink1 Option	P	P
Green1 Option	I	LP

Note: Preferred (P), Intermediate (I) or least preferred (LP)

Socio-economic distinctions between options for Section 1 are not pronounced.

6.5.11.5 References

Environmental Protection Agency. (2003) *Advice Notes on Current Practice in the Preparation of Environmental Impact Statements.*

Environmental Protection Agency. (2002) *Guidelines on the Information to be contained in Environmental Impact Statements.*

National Roads Authority. (2006) *Environmental Impact Assessment of National Road Schemes – A Practical Guide.*

Galway County Council. *Galway County Development Plan 2015-2021*

Galway City Council. *Galway City Development Plan 2011-2017*

6.6 Option Comparison Cost Estimates

6.6.1 Introduction

This section outlines the methodology used when calculating the route selection Stage 1 Option Cost Estimates (OCEs). These Option Cost Estimates serve as the route selection stage one economic assessment and are for comparative purposes only.

Section 6.6.2 outlines the methodology used for this assessment; **Section 6.6.3** gives an Overview of Key Items. **Section 6.6.4** describes the Options Assessment. A summary is presented in **Section 6.6.5** with the references included in **Section 6.6.6**.

6.6.2 Methodology

The methodology followed in preparing the stage one Option Cost Estimates (OCEs) is as follows:

- Determination of all major quantities and grouping thereof in accordance with the NRA Method of Measurement for each corridor option;
- Quantification of land use and planning impacts;
- Assessment of land use and planning impacts;
- Identification and assessment of advance works and other contracts required for the delivery of each corridor option; and
- Comparative assessment of outturn and forecast costs from previous schemes in order to ascertain costs/ rates/units for the following items:
  - Archaeology;
  - Bridge/Civil Structures;
  - Main Contract Supervision;
  - Other Liabilities/Obligations of the Contractor;
  - Planning and Design;
  - Preliminaries;
  - Residual Network
  - Site Clearance;
  - Statutory Authorities and Utilities; and
  - Tunnelling.

Schemes included in the comparative assessment were the M7/N24 Ballysimon Junction Improvement in Limerick, the M20 Cork Limerick Motorway Scheme, N22 Macroom Ballyvourney Road Improvement Scheme in County Cork, N25 New Ross Bypass in County Wexford, N40 Bandon Sarsfield Upgrade Scheme in Cork and the R581 Doneraile Upgrade in County Cork.

- Compilation of Option Cost Estimates using the National Roads Authority's Roadworks Unit Rate Database (July 2013), information derived from the assessment of land use and planning impacts and information derived from the

comparative assessment of outturn and forecast costs from previous schemes. The rates used were comparable across the route options and therefore, adequate for comparative purposes of the route options.

- No Cost Benefit Analysis (CBA) was undertaken for the Stage 1 route selection economic assessment. The economic assessment is limited to construction and delivery costs and is for comparative purposes only.

6.6.3 Overview of Key Items

Archaeology:

Cost estimates for Archaeology were calculated on the basis of total area within the construction footprint, a per-hectare rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Bridge / Civil Structures:

The rates for new build bridges, bridge upgrade works, retaining walls and culverts are based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report and the NRA Roadworks Unit Rate Database.

Main Contract Supervision:

The cost estimate for Main Contract Supervision was calculated based on the total mainline length of each route option, a per-km rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Other Liabilities/Obligations of the Contractor:

The cost estimate for Other Liabilities/Obligations of the Contractor was calculated based on the total mainline length of each route option, a per-km rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Planning and Design:

The cost estimate for Planning and Design was calculated based on the total mainline length of each route option, a per-kilometre rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Preliminaries:

A preliminaries rate of 10% of total construction cost was used for predominantly off-line route options. A rate of 15% of total construction cost was adopted for predominantly on-line route options or route options which comprised a significant on-line construction element. These rates correspond with the rates adopted within the schemes noted within **Section 6.6.2** of this report.

Residual Network:

The rate to be used for Residual Network is to be determined in conjunction with the NRA. Notwithstanding this, the cost estimate for Residual Network for the route selection stage one economic assessment was based on a per-kilometre rate.

This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Site Clearance (general):

Cost estimates for (general) Site Clearance were calculated based on the total area within the construction footprint, a per-hectare rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report.

Statutory Authorities and Utilities:

The cost estimate for Statutory Authorities and Utilities was calculated based on the total mainline length of each route option, a per-kilometre rate was used. This rate was based on outturn and forecast costs from the schemes noted in **Section 6.6.2** of this report. It should be noted that significant utility works were identified and itemised separately within Advance Works and Other Contracts.

Tunnelling:

Per-kilometre rates which were used for the various tunnelling methods were based on a study completed as part of the development of the Dublin Eastern Bypass. This study examined the cost of tunnel delivery in Ireland and across Europe.

6.6.4 Option Assessment

The options assessed for the route selection stage one economic assessment via the preparation of Option Cost Estimates are as follows:

- Red1 Route Option;
- Orange1 Route Option;
- Yellow1 Route Option;
- Blue1 Route Option;
- Pink1 Route Option; and
- Green1 Route Option.

Detailed descriptions and an overview of features particular to each route option are provided in **Section 6.1** of this report.

The economic assessment of each route option was split into two distinct sections. This approach was adopted due to the proximity and interchangeability of options in the Knocknacarra area. S ection 1 is from the R336 to Barr Aille Road and Section 2 extends from Barr Aille Road to the existing N6. This approach allowed the options to be interchanged and assessed.

6.6.5 Summary

As noted, no Cost Benefit Analysis (CBA) was undertaken for the route selection stage one economic assessment. The economic assessment is limited to construction and delivery costs and is for comparative purposes only. The costs are inclusive of

value added tax but are exclusive of inflation, construction/interface risks and programme risk.

Table 6.6.5.1 summarises the route selection stage one Option Comparison Estimates.

Table 6.6.5.1 Route Selection Stage One Option Comparison Estimates

Route Option	Section 1 Construction (million)	Section 2 Construction (million)	Total Construction (million)	Total Estimated Cost (all items included) (million)	Rank (High – Low)
Red1	€27	€502	€529	€669	1
Orange1	€27	€486	€513	€631	2
Yellow1	€36	€305	€341	€424	6
Blue1	€28	€387	€415	€498	3
Pink1	€28	€360	€388	€473	4
Green1	€36	€349	€385	€472	5

Notes:

1. *Total estimated costs are inclusive of all items including Planning and Design, Archaeology, Advance Works and Other Contracts, Main Contract Supervision and Residual Network.*
2. *Costs are inclusive of value added tax but exclusive of inflation, construction/interface risks and programme risk.*

Table 6.6.5.2 Summary of Option Comparison Estimate rankings of Route Options

Route Option	Section 1	Section 2
Red1	P	LP
Orange1	P	LP
Yellow1	LP	P
Blue1	I	I
Pink1	I	I
Green1	LP	I

Note: Preferred (P), intermediate (I) or least preferred (LP)

6.6.6 References

National Roads Authority. (2011) *NRA MCDRW Documents, Volume 3 – Method of Measurement for Road Works and Notes for Guidance on the Method of Measurement for Road Works.* National Roads Authority, Ireland.

National Roads Authority. (2013) *Cost Management Manual, Road Works Unit Rate Database - Version 8.* National Roads Authority, Ireland.

6.7 Framework Matrix

A summary of the engineering, environment and option comparison estimate assessment outlined in previous sections are presented below in **Tables 6.7.1** to **6.7.4** with the overall ranking from each of these tables included in Framework Matrix Presented in **Table 6.7.5**.

Table 6.7.1 Summary Table of engineering matrix - Section 1

Route Option	Geometry	Length	Junctions	Structures	Constructability	Traffic	Overall
Red1	P	P	P	I	P	I	P
Orange1	P	P	P	I	P	I	P
Yellow1	I	LP	I	I	I	LP	LP
Blue1	I	I	LP	P	LP	P	I
Pink1	I	I	LP	P	LP	P	I
Green1	I	LP	I	I	I	LP	LP

Table 6.7.2 Summary Table of engineering matrix - Section 2

Route Option	Geometry	Length	Junctions	Structures	Constructability	Traffic	Overall
Red1	LP	P	P	LP	LP	P	LP
Orange1	I	P	I	LP	LP	I	I
Yellow1	I	I	LP	P	I	I	I
Blue1	I	I	I	I	I	I	P
Pink1	I	I	I	I	I	I	P
Green1	P	LP	LP	P	P	LP	I

Each of the route options were ranked, as shown in **Table 6.7.3** below, with respect to their impacts for each environmental discipline as follows: Preferred (P), Intermediate (I), and Least Preferred (LP). These terms are used to comparatively assess route options in either Section 1, Section 2 or Section 3 and should not be

interpreted to compare the significance of impacts between these sections. For example by virtue of the fact that route options in Section 2 cross a European site whereas in Section 1 they do not, the route option(s) assigned a ranking of LP in Section 2 for ecology are likely to have a much greater impact on the ecological environment than the route option(s) assigned a ranking of LP in Section 1.

The overall ranking for each route option in terms of the environment took into consideration the overall number of preferred, intermediate and least preferred rankings. During the course of the assessment process *Human Beings, Ecology, Landscape and Visual, and Material Assets – Non Agricultural* were identified as being significant disciplines and are italiced in the summary tables below. Therefore, these disciplines are shown in italics in the summary tables and are referred to as "key environmental disciplines" below. The overall ranking for each route option in terms of the environment took into consideration the overall number of preferred, intermediate and least preferred rankings.

Section 1

The Pink1 Route Option is the preferred for Section 1 along with the Blue1 Route Option. It has two preferred, eight intermediate and one least preferred rankings. Of the one least preferred ranking, this is not a key environmental discipline (noise). The Pink1 Route Option has the lowest number of least preferred rankings overall and has been assigned a Preferred ranking overall.

The Blue1 Route Option has also been assigned a Preferred ranking overall for Section 1. The Blue1 Route Option has two preferred, seven intermediate and two least preferred rankings. The Blue1 Route Option has no key environmental discipline which has a least preferred ranking and one key environmental discipline which has a preferred ranking, thereby giving it the overall Preferred ranking.

The Pink1 and Blue1 Route Options have been assigned a Preferred ranking overall for Section 1.

The Red1 and Orange1 Route Options have been assigned an Intermediate ranking overall for Section 1. The Red1 and Orange1 Route Options have seven and six preferred rankings respectively and both have three least preferred rankings for the same disciplines. Of the three least preferred rankings, two of these are for a key environmental discipline (landscape and visual and human beings).

The Red1 and Orange1 Route Options have been assigned an Intermediate ranking overall for Section 1.

The Green1 Route Option has one preferred, six intermediate and three least preferred rankings. Of the three least preferred rankings, three are key environmental disciplines. The Yellow1 Route Option has two preferred, four intermediate and four least preferred rankings. Of the four least preferred rankings, two are key environmental disciplines. The Green1 Route Option and Yellow1 Route Option have been assigned a Least Preferred ranking overall for Section 1.

In conclusion, the Pink1 and Blue1 Route Options are the preferred options for Section 1.

Section 2

The Orange1 is the preferred for Section 2. The Pink1 and Blue1 Route Option have been assigned an Intermediate ranking overall for Section 2. The Red1, Yellow1 and Green1 Route Options have all been assigned a Least Preferred ranking overall for Section 2. The overall rankings are discussed further below. In addition, given that the Lough Corrib cSAC is one of the major constraints in Section 2, ecology ranking is also discussed.

Orange1 Route Option

The Orange1 has been assigned a **preferred** ranking for Section 2. The Orange1 Route Option has the greatest number of preferred rankings (six), four intermediate and one least preferred. Of the one least preferred ranking, it is not a key environmental discipline. As much of this option is in a tunnel, many of the environmental constraints are not directly impacted, therefore it has been assigned a preferred ranking overall.

As detailed in Section **6.6.1 Ecology**, the Orange1 Route Option is the preferred route option for ecology as it avoids direct impacts on the Lough Corrib cSAC and as a significant length of this route option is either predominantly online or underground, its impact is reduced on many of the other ecological receptors identified within the scheme study area.

Pink1 Route Option

The Pink1 Route Option has been assigned an **intermediate** ranking for Section 2. The Pink1 Route Option has the second highest number of preferred rankings (three), seven intermediate rankings and one least preferred. Of the one least preferred ranking, it is not a key environmental discipline. The Pink1 Route Option has joint lowest number of least preferred rankings with Orange1 taking all environmental disciplines into consideration.

As detailed in Section **6.6.1 Ecology**, the Pink1 Route Option is ranked as Intermediate for ecology in Section 2. Both the Pink1 and Blue1 Route Options are similar as although they avoid any impacts to Annex I habitats within the boundary of the Lough Corrib cSAC, they will result in some degree of habitat loss within the designated site. Pink1 has a larger footprint than Blue1 within the Lough Corrib cSAC and a lesser impact on Annex I habitat overall in this section.

Blue1 Route Option

The Blue1 Route Option has been assigned an **intermediate** ranking overall for Section 2. It has one preferred ranking, eight intermediate, and two least preferred. Of the two least preferred rankings, one (landscape and visual) is a key environmental discipline.

As detailed in Section **6.6.1 Ecology**, the Blue1 Route Option is ranked as Intermediate for ecology in Section 2. Blue1 is more preferred than Pink1 due to its smaller footprint within the Lough Corrib cSAC and lesser impact on Annex I habitat overall in this section. However, other negative impacts were experienced by other environmental disciplines for Blue1.

Red1 Route Option

The Red1 Route Option has been assigned a **least preferred** ranking overall for Section 2. The Red1 Route Option has one preferred ranking, three intermediate and seven least preferred. Of the seven least preferred, three are key environmental disciplines.

It is acknowleged that the Red1 Route Option is ranked as intermediate for Ecology in Section 2 (refer to Section **6.6.1 Ecology**) because it is one of the route options with the lowest impact on the Lough Corrib cSAC, the lowest impact on Annex I habitats of all the route options and, by virtue of being predominantly online, is likely to have the least impact on most other ecological receptors.

However, significant/profound impacts have been identified on the Red1 Route Option for landscape and visual, archaeology and heritage, material assets-non agricutlure and human beings. Other negative impacts are also experienced for other environmental disciplines such as soils and geology, air and climate, planning and noise and vibration. Even though the Red1 Route Option is preferred for ecology, the cumulative impact of all of the other significant/profound negative impacts experienced by the other environmental disciplines means that this route option has been assigned a ranking as **least preferred** overall.

Yellow1 Route Option

The Yellow1 Route Option has been assigned a **least preferred** ranking overall for Section 2. The Yellow1 Route Option has zero preferred, five intermediate and five least preferred. Of the five least preferred rankings, four are key environmental disciplines.

As detailed in Section **6.6.1 Ecology**, the Yellow1 Route Option is ranked as least preferred for Ecology in Section 2 because it is the route option with the greatest potential for impacts to QI Annex I habitat within the Lough Corrib cSAC.

Green1 Route Option

The Green1 Route Option has been assigned a **least preferred** ranking overall for Section 2. The Green1 Route Option has two preferred, four intermediate and five least preferred. Of the five least preferred rankings, three are key environmental disciplines.

As detailed in Section **6.6.1 Ecology**, the Green1 Route Option is ranked as least preferred for Ecology in Section 2 as it is likely to result in indirect impacts to QI Annex I habitat within the Lough Corrib cSAC but less than that associated with the Yellow2 Route Option.

In conclusion, the Orange1 is **preferred** for Section 2.

Table 6.7.3 Summary of environmental matrix

	Route Option	*Ecology**	Soils & Geology	Hydrogeology	Hydrology	*Landscape & Visual**	Archaeology & Heritage	Material Assets - Agri	*Material Assets - Non Agri**	Air & Climate	Noise	*Human Beings**	Overall Ranking
Section 1	**Red1**	P	P	LP	P	LP	I	P	P	P	P	LP	I
	Orange1	P	P	LP	P	LP	I	P	I	P	P	LP	I
	Yellow1	LP	LP	P	I/LP	P	I	I	LP	LP	I	I	LP
	Blue1	I	P	I	I	I	I	I	I	LP	LP	P	P
	Pink1	I	P	I	I	I	I	I	I	I	LP	P	P
	Green1	LP	I	P	I/LP	LP	I	I	LP	I	I	I	LP
Section 2	**Red1**	I	LP	I	I	LP	LP	P	LP	LP	LP	LP	LP
	Orange1	P	LP	I	P	P	P	I	I	I	P	P	P
	Yellow1	LP	I	I	I/LP	LP	I	I	LP	I	LP	LP	LP
	Blue1	I	I	LP	I	LP	I	I	P	I	I	I	I
	Pink1	I	I	LP	I	I	I	I	P	P	I	P	I
	Green1	LP	P	P	I	LP	LP	LP	I	I	I	LP	LP

Note: Preferred = P, Intermediate, Least Preferred = LP

Table 6.7.4 Summary of Options Comparison Estimate

Route Option	Section 1	Section 2
Red1	P	LP
Orange1	P	LP
Yellow1	LP	P
Blue1	I	I
Pink1	I	I
Green1	LP	I

Table 6.7.5 Framework Matrix

	Route Option	Engineering	Environment	Option Comparative Estimate	Progress to Stage 2?
Section 1	Red1	P	I	P	YES
	Orange1	P	I	P	YES
	Yellow1	LP	LP	LP	YES
	Blue1	I	P	I	YES
	Pink1	I	P	I	YES
	Green1	LP	LP	LP	YES
Section 2	Red1	LP	LP	LP	YES
	Orange1	I	P	LP	YES
	Yellow1	I	LP	P	YES
	Blue1	P	I	I	YES
	Pink1	P	I	I	YES
	Green1	I	LP	I	YES

6.8 Recommendation

Following the Stage 1 Route Options assessment is it recommended that all six route options are progressed to the Stage 2 assessment for a more detailed analysis in the route selection process.