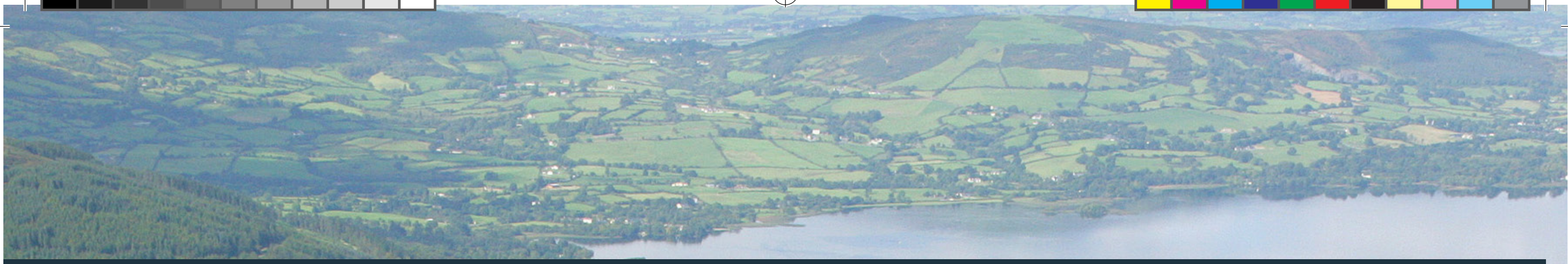

Clare County Council

KILLALOE BYPASS, SHANNON BRIDGE CROSSING AND R494 IMPROVEMENT

ENVIRONMENTAL IMPACT STATEMENT

VOLUME 2 - MAIN TEXT

North Tipperary County Council

February 2012

NDP National Development Plan 2007 - 2013

An Roinn Iompair Turasóireachta agus Spóirt
Department of Transport, Tourism and Sport

Roughan & O'Donovan

Acknowledgements

This Environmental Impact Statement has been prepared with inputs from all of the following team members:

Roughan & O'Donovan, Consulting Engineers

Team Leaders, Statement Authors and Scheme Designers

Clare County Council / North Tipperary County Council

Overall Project Management

AWN Consulting Ltd

Noise and Vibration and Air Quality Assessment

EirEco Ecological Consultants

Flora and Fauna Assessment

Faith Wilson Ecology

Four Season Bat Survey

TVAS Ireland Ltd

Archaeology, Architectural and Cultural Heritage Assessment

Murray and Associates

Landscape and Visual Assessment

Philip Farrelly & Partners

Agricultural Impact Assessment

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KILLALOE BYPASS SHANNON BRIDGE CROSSING AND R494 IMPROVEMENT

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Part I
Background Information and General Description

1.0 INTRODUCTION

This Environmental Impact Statement for the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement has been prepared by Roughan & O'Donovan, Consulting Engineers on the instruction of Clare County Council and North Tipperary County Council.

The purpose of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement is to provide a high quality road for the transport of people and goods, in safety and comfort, in accordance with national, regional and local objectives. It is required to overcome the inadequacies of the existing road network in facilitating improved traffic circulation and reducing congestion and delays in Killaloe and Ballina along with the provision of improved pedestrian and cyclist facilities to improve safety in the towns.

2.0 BACKGROUND TO THE PROPOSED ROAD DEVELOPMENT

2.1 Existing Road Network

The existing road network through Ballina and Killaloe is dominated by the R494 from the R445 junction (formally N7) at Birdhill on the old main Limerick to Dublin Road to the Killaloe Bridge and the R463 in Killaloe and continuing north to Scarriff and the west.

The existing R463 Regional Road comprises a single carriageway rural road of varying standard passing through rural countryside in County Clare and the town of Killaloe. In addition to the existing R463, the mainline intercepts two existing local roads, Hill Road (L3078) and Creeveroe Road (L3076). Both of these local roads are narrow single carriageways.

The Killaloe Bridge consists of a thirteen span masonry arch bridge joining the towns of Killaloe and Ballina and linking the R494 in Ballina with the R463 in Killaloe (**Plate 2.1**). The bridge has an approximately 4.95 metre wide carriageway with a one way system controlled by traffic lights at either side of the bridge. Pedestrians share the bridge with vehicular traffic with a number of pedestrian refuges available along the length of the bridge.

The existing R494 Regional Road joins the R445 Birdhill to Nenagh, via Ballina. It generally comprises a single carriageway rural road of varying standard. The carriageway width varies, but generally is approximately 6.0m wide and without hard shoulders.

The relevant section of the existing R494, extends for a distance of just over 3.5km. At its northern end, it intercepts the existing R496 at Roolagh Junction (**Plate 2.3**); while at its southern end it intersects the existing R445 (old N7), just north of Birdhill.

The existing R496 Regional Road comprises a single carriageway rural road of varying standard. This road serves as an alternative (easterly) route from Ballina to the R445 (north of Birdhill).

Plate 2.1 Existing Killaloe Bridge

Plate 2.2 R494 junction in Ballina approaching Killaloe Bridge

Plate 2.3 Roolagh Junction, Ballina (R494 and R463)

2.2 The Need for the Scheme

The Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement is now proposed by Clare County Council and North Tipperary County Council so as to provide the appropriate road infrastructure for Killaloe / Ballina towns whose historical character and community infrastructure is threatened by heavy traffic. The scheme proposes to cater for the planned local, regional and national development in this area.

2.3 Function of the Proposed Scheme

The primary objectives of the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement scheme are:

(a) Give effect to and facilitate local, regional and national development policy/objectives;

(b) To provide a second river crossing between the towns of Killaloe and Ballina and to reduce congestion and delays on the existing Killaloe bridge;

(c) To improve traffic safety by removing through traffic from the existing route over the Killaloe Bridge;

(d) To improve the environment of Ballina / Killaloe by removing a significant portion of north/south through traffic;

(e) To upgrade the R494 to allow for better use by pedestrians and cyclists, and to improve safety aspects of the road; and

(f) To reduce travel times along the route.

3.0 DESCRIPTION OF THE SCHEME

The proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement Scheme will provide a western bypass of Killaloe, a new bridge crossing of the River Shannon and an upgrade of the existing R494 regional road from Ballina to the R445 at Birdhill. The entire scheme is approximately 6.2km and will cross the River Shannon approximately 1km to the south of the existing Killaloe Bridge.

The proposed scheme has been broken down into three sections as follows:

1. Killaloe Bypass: This part of the Scheme aims to create a western bypass around the town of Killaloe which will connect the R463 to the north of town with the proposed Shannon Bridge Crossing section and R463 to the south of the town.
2. Shannon Bridge Crossing: This section of the Scheme will cross the River Shannon approximately 1km south of the existing Killaloe Bridge and will connect the proposed Killaloe Bypass with the R494.
3. R494 Upgrade: This section will involve widening, regrading and local realignment of the R494 from its junction with the R496 and proposed Shannon Bridge Crossing south of Ballina, as far as the junction with the R445 north of Birdhill.

The overall route of the proposed scheme is illustrated in **Figure 2.1 to 2.4**.

4.0 OUTLINE OF ALTERNATIVES CONSIDERED

The proposal for the Killaloe Bypass, Shannon Bridge Crossing and R494 has progressed through a number of stages including the Constraints Studies, followed by the Route Selection Studies, which has been followed by preliminary design of the Preferred Route Option. The assessment of several alternative Routes considered the following factors:

- Engineering suitability
- Traffic Safety
- Traffic Impact
- Archaeology and Cultural Heritage
- Ecology
- Landscape and Visual impact
- Agricultural Land-Use
- Geology, Hydrology and Hydrogeology
- Economics

Following detailed investigations for a Shannon River Crossing the current proposed location was considered the favourable option. The Preferred Route was further developed during the preliminary design stage to provide the best route possible in environmental, engineering and economic terms. Determination of the location of the Shannon Bridge allowed for examination of route options for the Killaloe Bypass and the development of a preliminary design of the best route option.

5.0 TRAFFIC ASSESSMENT

The proposed Scheme will significantly improve traffic safety and congestion in Killaloe and Ballina. This will greatly enhance the residential amenity within the towns. Traffic modelling was completed taking in to account base year traffic and future predictions based on zoning and traffic demand. This allowed for the creation of a predicted future traffic demand for the towns. The future models demonstrate significant savings in journey times through the Killaloe-Ballina area on journeys that can avail of the bypass & bridge crossing.

Accident data shows that a significant portion of accidents in the vicinity of Ballina and Killaloe occurred on the main approaches to the towns along the R463, R494 and R496 between the period of 1996 and 2002. Most of these accidents occurred along tight bends and blind corners, where there was evidence that speeding was a main factor.

The proposed Scheme includes the provision of roundabouts at the intersections with the existing regional roads at the R463 on the north and south side of Killaloe and at the intersection of the R494 and R496 on the south side of Ballina. These roundabouts will provide a traffic calming effect on the approaches to the towns.

Furthermore the reduction in through traffic at Killaloe and Ballina may result in a decrease in accidents in these urban areas.

Part II
Significant Environmental Effects and Proposed Mitigation Measures

6.0 HUMAN BEINGS

As with many other towns and villages in Ireland, Ballina and Killaloe has experienced a high growth in traffic with limited associated upgrading of the public road infrastructure (**Plate 6.1**). The proximity to Limerick means they are within convenient commuting distance to the city. Ballina and Killaloe have grown as satellite towns due to their close links with Limerick. A large amount of land in Killaloe is planned for future residential development with a lesser amount in Ballina; Ballina has seen a significant increase in population in the last two census counts. Congestion is further exacerbated by regional traffic that use the bridge as a more direct access between areas of west Clare and the northeast and also as a bypass of Limerick. The success of these towns and the surrounding hinterlands of west Clare is reliant on road infrastructure for intra and inter county movement and access.

Minor delays due to traffic management and diversions will arise for the local community during the construction phase of the proposed scheme, but these will be minimised through Traffic Management Plans. There are likely to be noise and dust related impacts associated with the construction works; however these will be kept to a minimum.

Once operational, the community will experience reduced travel times and safer driving conditions along the length of the proposed Scheme. This will arise from the journeys availing of the bypass and bridge crossing compared to journeys through the towns and over the existing bridge. Removal of Heavy Goods Vehicle (HGV) traffic from the route over the existing bridge will greatly improve the journey times and safety issues currently managed through the one-way separated traffic signal system. Travel through Killaloe / Ballina for local trips will also improve by reduced traffic demand at the traffic signals on the bridge. These are considered as significant positive impacts.

Plate 6.1 Traffic on the Approaches to Killaloe Bridge junction from Ballina South

7.0 THE NATURAL ENVIRONMENT

7.1 Terrestrial Ecology (Flora, Fauna and Habitat)

The proposed road will cross the Lower River Shannon, which is part of the designated area that is the Lower River Shannon Special Area of Conservation (**Plate 7.1, Figure 7.1**). The remaining works include the provision of a bypass of Killaloe though predominantly agricultural lands and the upgrade of the existing R494 where disturbance to wildlife is limited.

With mitigation measures in place, the impact of the proposed scheme on the ecological environment along the proposed route will be moderate at specific locations, namely the River Shannon and associated habitats, Kilmastulla River and at Ballyvally Estate woodland. Over time as the landscaping at these locations matures, the impact will be lessened. There will be no significant impact on the overall integrity of the Lower River Shannon cSAC. Elsewhere along the proposed route the impacts will be minor.

Plate 7.1 Proposed location of bridge crossing over the Lower River Shannon cSAC

7.2 Noise and Vibration

The noise environment in the vicinity of the proposed scheme has been characterised by a set of traffic noise surveys. The existing noise levels are typical of a semi-rural area in the vicinity of a major road.

Noise levels with the scheme and a suitable low noise surface in place have been predicted to be within acceptable levels therefore no further remedial measures are required.

Indicative noise levels during the construction phase of the scheme have been predicted. It has been shown that it is possible to comply with construction noise limits. A Construction Management Plan will adhere to recommended noise levels and working hour restrictions.

7.3 Air Quality

The proposed road scheme will redirect traffic away from the towns of Killaloe and Ballina, to areas where fewer people are exposed to traffic emissions, which will benefit the majority of the local population without exposing people living near the new route to significant levels of emissions. By taking traffic away and reducing congestions the scheme will lead to a reduction in air pollution by enabling more efficient engine performance.

The construction phase impact for air quality will be limited through application of a dust minimisation plan.

7.4 Climate

The impact of the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement on climate will be negligible in the national context. No significant micro-climatic effects are expected as a result of the scheme.

7.5 Soils and Geology

No County Geological Sites have been identified within the proposed scheme land take area. The development will have no environmental impact on the soils and geology of the area.

The construction requirements will as far as practical maintain an earthworks balance throughout the scheme thus reducing the area of landfill required. The scheme will have an overall earthworks surplus but requirements for disposal off site will be mitigated by effective programming of construction activities. Mitigation measures are also proposed to minimise erosion of soils.

8.0 LANDSCAPE AND VISUAL IMPACTS

The scheme crosses through an area whose landscape has a significant visual amenity resulting from natural and cultural heritage. The most outstanding features include the Slieve Bernagh and Arra Mountains, the River Shannon and in the distance Lough Derg.

The scheme begins at a proposed roundabout on the R463 north of Killaloe town. This stretch of regional road (Ogonelloe to O'Briensbridge) contains scenic views of high value. However there are no outwards views located at the starting point of the scheme as it is flanked on both sides of the road by mature hedgerows and semi-mature woodland. These existing trees hide the Killaloe Bypass from a large number of surrounding visual receptors. In the short term the scheme will cause the removal of woodland but these will be replanted and the impact in the long term will be neutralised.

The scheme significantly cuts into the foot of the Slieve Bernagh Mountains and dissects the mature wooded boundary of Ballyvally Demesne. This will generate a negative landscape impact. In the short term, sensitive receptors on the Ballina side of the valley will experience a moderate to slight visual impact as the scheme cuts through the southern mature boundaries of Ballyvally and through a large adjacent field. In the long term however; this impact will be mitigated against since the steep embankments and boundary line of the bypass will be planted with woodland mixes to integrate it into the landscape.

As the scheme crosses existing local roads visual negative impacts are created where the local road is crossed to connect with the proposed road. The mitigation planting proposed for these sections will unite with the surrounding existing vegetation and screen adjacent dwellings to reduce their affect. In most cases this will result in a slight permanent neutral visual impact although in a minority of situations this will be a moderate permanent negative visual impact.

The Shannon bridge crossing will create a landscape impact and a significant visual impact. However there are a limited number of views of the proposed bridge. The bridge will have a positive impact on Killaloe and Ballina towns as it will reduce the traffic congestion experienced within the towns. Another long term improvement may include the provision of panoramic views for motorists to heighten their travel experience and the creation of further opportunities for pedestrian and cyclists along the road corridor to appreciate the high scenic quality of the surrounding landscape.

The upgrading of the R494 for the most part follows the existing road. However to improve its safety it must be widened and realigned in places causing the removal of a large area of existing roadside vegetation, which previously screened dwellings from roadusers. In the short term the strong sense of enclosure felt along the R494 from the touching tree canopies will be lost. In the long term however; the mitigation measures put in place will reduce these negative affects on the visual amenity of the locality once planting has established resulting in a permanent moderate neutral impact. In some instances positive views of adjacent hills and pasture will be opened up which will have a positive visual impact.

9.0 MATERIAL ASSETS

The Killaloe Bypass section of the scheme impacts predominantly on agricultural land and will have a major impact on one farm in particular. Twenty two farms will be impacted in total although to varying degrees many of which are minor to not significant.

There will be two currently used dwellings acquired as part of the scheme. House curtilage will be acquired from a number of other properties.

10.0 ARCHAEOLOGY, ARCHITECTURAL AND CULTURAL HERITAGE

On the Clare side of the river the proposed road is predominantly in green fields. The scheme will be within 20m of the Gate Lodge of Ballyvally and will breach the estate boundary. A possible enclosure (Recorded Monument CL045-057 – H7) (**Plate 10.1**) is adjacent to the route in Knockyclovaun townland. Other than these, there are no known archaeological monuments or architectural structures within 50m of the preferred route. The route will be more than 100m from Clarisford House, the former bishop’s palace, but will sever the direct road link between the palace and Killaloe Cathedral, breaching the western demesne boundary. The route will also cross the Limerick-Killaloe canal and involve the removal of the remains of some adjacent buildings, possibly including a lime kiln. A number of structures marked on 19th and early 20th century maps may be impacted by the scheme. The site of a stone cross in the grounds of Clarisford Palace may lie within the footprint of the scheme, although the cross itself was probably only erected there in 1820 and removed in the 1930s.

The scheme will have a positive impact on the historic town of Killaloe and, in particular, the existing bridge, both of which currently suffer the effects of heavy traffic and would benefit from the routing of vehicles away from the town.

The River Shannon should be considered to be of archaeological potential and three potential sites that may be impacted were identified in an earlier underwater survey, a collapsed dry-stone wall a dry-stone culvert and a magnetic anomaly seen by a geophysical survey of the river bed. The crossing is close to the location of Friar’s Island, an early ecclesiastical centre, submerged by the Shannon Hydro Electric Scheme in 1929.

On the Tipperary side of the River Shannon the scheme mostly involves the upgrading of an existing road (R494). The major impact will be on the strip of land immediately adjacent to the road where there are several structures shown on 19th and early 20th century maps that no longer have surface expression but may have sub-surface remains. There may also be remains of buildings facing onto the road that pre-date the earliest detailed maps. Road upgrading will also impact on a number of bridges and culverts and a stone farm building will be removed. As with Killaloe, the historic town on Ballina will benefit from reduced traffic volumes, creating a positive impact.

Plate 10.1 Location of CL045-057 (possible enclosure)

11.0 MITIGATION MEASURES – SUMMARY

The principal mitigation measures proposed in the scheme are as follows:

- Pre-construction surveys will be required to confirm the locations for mammal underpasses, relocation of badger setts, wildlife fencing, bat protection etc along with any new mitigation requirements due to more recent activity of mammals.
- Extensive landscape planting of the route will be undertaken to compensate for trees and hedgerows that will be removed.
- Pre construction surveys and test excavations will be carried out as part of archaeological investigations.
- Pollution control measures will be provided to protect the River Shannon and tributaries both during the construction and operational phases as required in NRA Guidance documents.
- Appropriate traffic management measures will be taken during the construction period to ensure that any traffic disruption is kept to a minimum.

12.0 FURTHER INFORMATION

The full Environmental Impact Statement and the Natura impact Statement will be on display and available for inspection for not less than six weeks from the date of publication at the following locations as detailed in the published newspaper notices:

- Clare County Council, New Road, Ennis, Co. Clare;
- North Tipperary County Council, Nenagh, Co. Tipperary;
- South East Clare Area Office, Westbury Centre, Knockballynameath, Co. Clare;
- Scarriff Area Office, Mountshannon Road, Scarriff, Co. Clare;
- North Tipperary County Council, Civic Offices, Limerick Road, Nenagh, Co. Tipperary;
- Newport Area Office, Main Street, Newport, Co. Tipperary.

The Environmental Impact Statement (or parts thereof) and Natura Impact Statement are available for purchase from the above addresses. The Environmental Impact Statement (Volumes 1 - 3) may be purchased on payment of a fee of €50. Copies are also available on CD for purchase on payment of a fee €10. The Natura Impact Statement and Environmental Impact Statement Non Technical Summary may be purchased on payment of a fee of €10 each.

Alternatively the Non-Technical Summary of the EIS can be viewed on the Clare and North Tipperary County Council websites (www.clarecoco.ie and www.tipperarynorth.ie).

13.0 WHAT HAPPENS NEXT?

Written submissions relating to the likely environmental effects of the proposed road development may be made to An Bord Pleanála (the Board) by the public or by prescribed bodies prior to the date specified in published newspaper notices. An Oral Hearing may be held should the statutory requirements for one be met. Written submissions, together with any representations made at any oral hearing, will be considered by the Board in making its decision on whether or not to approve the scheme with or without modifications. The Board's decision will be published in one or more newspapers circulating in the area, including where appropriate, particulars of any modifications to the scheme.

All submissions in relation to this development should be sent to the Board at the following address:

An Bord Pleanála,
64 Marborough Street,
Dublin 1.

Part I

Background Information
General Description

Chapter 1

Introduction

Chapter 1 Introduction

1.1 General

This Environmental Impact Statement (EIS) for the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement (hereafter referred to as "the Scheme") is a statement of the likely effects and significant impacts on the environment of the proposed road development and has been prepared as part of the Environmental Impact Assessment (EIA) undertaken in respect of the construction and operation of the proposed new road. The EIS, as presented has been prepared by Roughan & O'Donovan Consulting Engineers and a team of specialist sub consultants, with the assistance of Clare County Council and North Tipperary County Council.

The EIS is presented in three volumes; Volume 1 is the Non technical Summary, this Volume (Volume 2) contains the main text including the Non-Technical Summary, while Volume 3 contains the associated figures. The following text describes in detail the layout of this EIS with the following sections.

Volume 1: Non Technical Summary

Volume 2: Main Text

Non – Technical Summary

Part I "Background Information and General Description"

There are five chapters to this part of the document.

Chapter 1: Introduction
Chapter 2: Background to the Proposed Road Development
Chapter 3: Description of the Scheme
Chapter 4: Outline of Alternatives Considered
Chapter 5: Traffic Assessment

Part II "Significant Environmental Effects and Proposed Mitigation Measures"

This part of the document sets out the likely significant environmental effects of the scheme under the headings:

Chapter 6: Human Beings
Chapter 7: The Natural Environment
Chapter 8: Landscape and Visual Impact
Chapter 9: Material Assets
Chapter 10: Archaeology, Architectural and Cultural Heritage
Chapter 11: Interrelationships/Interactions
Chapter 12: Mitigation Measures - Summary

Volume 3 "Figures"

1.2 Purpose of the Scheme

The purpose of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement is to provide a high quality road for the transport of people and goods, in safety and comfort, in accordance with national, regional and local objectives. It is required to overcome the inadequacies of the existing road network in facilitating improved traffic circulation and reducing congestion and delays in Killaloe and Ballina along with the provision of pedestrian and cyclist facilities to improve safety throughout the proposed route. See **Figure 1.1** for a location plan of the proposed scheme.

1.3 National Policy Context

1.3.1 National Spatial Strategy (2002 – 2020)

The National Spatial Strategy (NSS) for Ireland is a twenty year planning framework designed to achieve a better balance of social, economic, physical development and population growth between regions. Amongst other things, the NSS sets out a future spatial strategy in the form of a proposed National Transport Framework. The NSS provides the basis for the roads programme contained in the National Development Plan which is a key element in enhancing regional accessibility and better regional development.

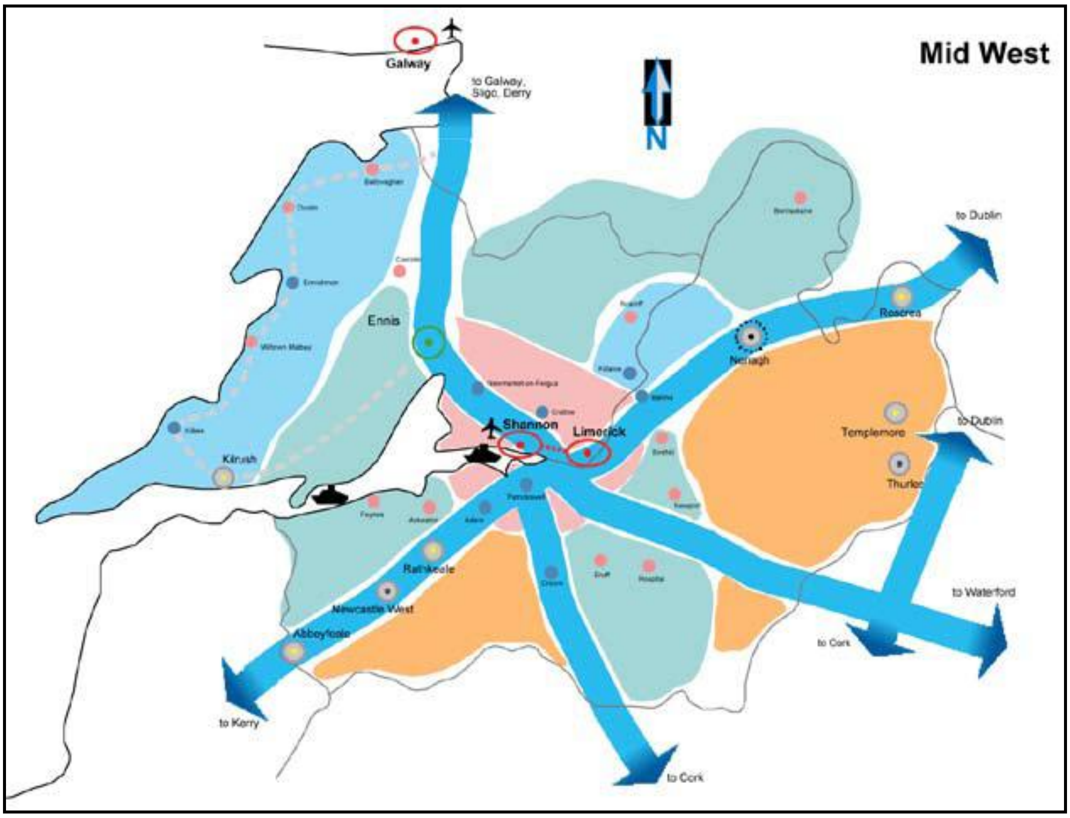

Plate 1.1 - NSS Map of the Mid-West Region

The NSS has identified the Limerick/Shannon Region as a gateway region and the town of Ennis as a hub for its environs. This results in the promotion of growth for the region as well as promoting the existing links with education, industry, retail, health and transport including international arrival/departure point for tourists. The proximity of the Limerick/Shannon Gateway and Ennis hub provides opportunity for Killaloe/Ballina and Scarriff to develop; this requires strong transport links to the area. Strategic opportunities existing with Shannon Airport offering an opportunity to build on the success of the Lough Derg tourism area through effective management and sustainable development of assets such as natural and cultural heritage in Killaloe and Ballina.

1.3.2 The National Development Plan 2007 – 2013

The National Development Plan (NDP) 2007 – 2013 has identified the need to address the weakness in transport infrastructure in rural communities. General objectives of the plan include:

- The upgrading of national primary and secondary routes with particular regard to enhancing connectivity for rural areas within the gateway/hub town catchments;
- Provide a non-national road network which will support economic and social development at regional and local levels and to assist Local Authorities in progressing new major strategic non-national road projects.

The Strategy for National Roads in the NDP 2007 – 2013 identifies a key objective as the improvement of the non-national road network. Good transport infrastructure has been identified as crucial to the promotion of national competitiveness and sustainable development. The roads sub programme identifies principal objectives as:

- Targeted improvements of a number of key national secondary routes;
- Improvement and maintenance of the non-national roads network; and
- Investment in strategic non-national roads which will complement the national roads investment.

The Killaloe Bypass, Shannon Bridge Crossing, and R494 Improvement is not listed in the National Development Plan (2007-2013) as a key route in strategic terms, however, at a local and regional level the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement would be consistent with the general objectives of the NDP.

1.3.3 Smarter Travel – A Sustainable Transport Future (2009 – 2020)

Smarter Travel, A Sustainable Transport Future, presents a transport policy framework for Ireland covering the period up to 2020. The policy, launched by the Department of Transport in 2009, sets out a vision, goals and targets to be achieved, and outlines 49 actions that form the basis of achieving a more sustainable transport future.

To achieve the set out level of sustainability in travel and transport, change in personal behaviour will be necessary, changes in public policy in relation to settlement patterns will be required and continued investment in public transport will be needed.

In the Plan the Government outlines its vision for sustainability in transport and sets out five key goals:

(i) to reduce overall travel demand;
(ii) to maximise the efficiency of the transport network;
(iii) to reduce reliance on fossil fuels;
(iv) to reduce transport emissions; and
(v) to improve accessibility to transport.

The proposed scheme will support Smarter Travel through the provisions for cycleways and footpaths. The alignment of the scheme will support consolidation of development within Killaloe and its surrounding environs. The scheme will support an improved potential for a strong growth in cycling and walking and will seek to link the area to places such as Limerick and Nenagh. The scheme will tie into the proposed Limerick to Nenagh Cycle Route on the R445.

1.4 Regional Policy Context

1.4.1 Mid West Regional Planning Guidelines 2010 - 2022

The Mid West Regional Planning Guidelines aim to implement the objectives of the NSS and have identified subzones within the region to support the growth of the Limerick/Ennis/Shannon corridor and promote rural development. Killaloe has been identified as a key town acting as a major service centre. The Guidelines have identified the need to improve linkages to Killaloe to allow for the promotion of small enterprises, agri-business and tourism and provide high quality residential locations close to a major city. The Guidelines specifically identify the need for “the link and new bridge between the Killaloe/Limerick route and Nenagh Limerick route to facilitate access from the north west of the region to the gateway. This development will also involve the provision of a bypass for Killaloe” (See **Plate 1.2**).

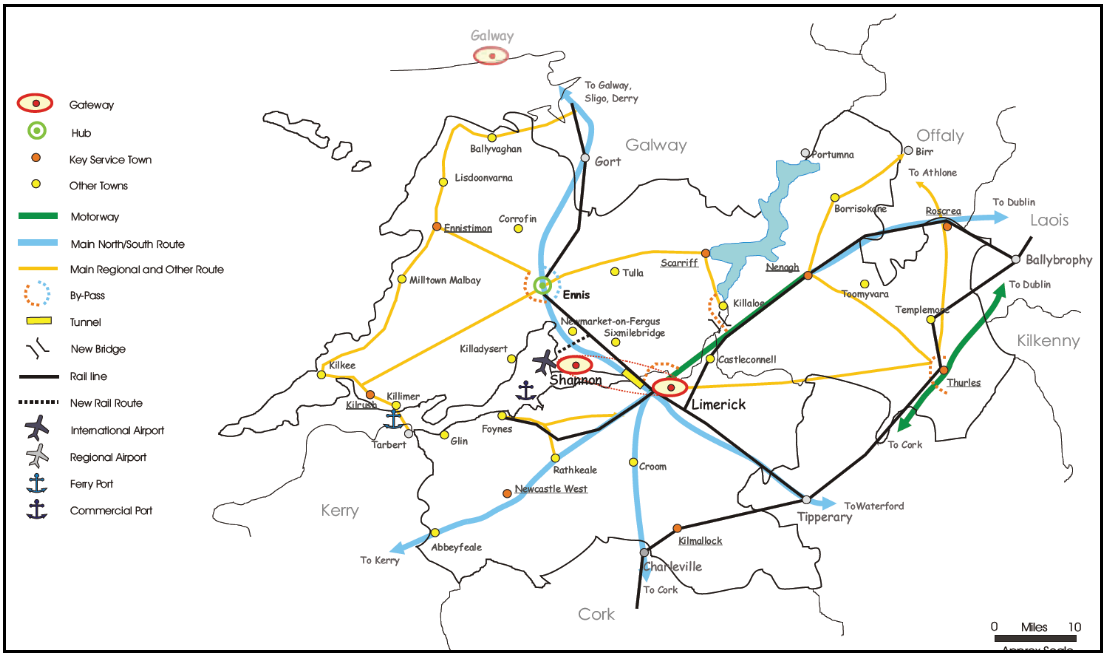

Plate 1.2 - Transport and Infrastructure Strategy Diagram

1.5 Local Planning Policy

1.5.1 Clare County Development Plan (2011 – 2017)

Clare County Development Plan has recognised the need for an efficient road network which is essential to the economic development of the County. The Planning Authority will seek to provide a safe and convenient road network for pedestrians, cyclists, public transport, private and commercial vehicles and other road users. The development has identified under its Strategic Policies the Shannon Crossing as a key network element.

The Plan recognises that the maintenance and upgrade of the existing road network and, where necessary, the provision of new road networks or re-alignments are essential to realise modern high standards. The Western By-pass of Killaloe and the Shannon crossing south of Killaloe have been identified as a proposed project for future development. The Planning Authority will seek to:

> *"Provide a safe and efficient network of transport to serve the needs of the people, goods and services travelling to and within County Clare;*
>
> *To safeguard the strategic transport function of the motorway and national road network and associated junctions in order to cater for the safe and efficient movement of inter-urban and inter-regional traffic."*

1.5.2 North Tipperary County Development Plan 2010 – 2016 (including Variation Number 1)

The North Tipperary County Development Plan including Variation Number 1 identifies the crossing of the Shannon River as outlined in the EIS and in the plan:

> "*It commences on the R494 at its junction with R496, approximately 1 km south of the existing Killaloe/Ballina Bridge.*
>
> *In addition to the Bridge, construction of this scheme also includes the upgrade of the R494 regional road from Birdhill to the junction with the -R496 Ruaille junction.* The proposals here allow for the widening, upgrading and possible local realignment over some sections."

The scheme is identified under Transport Policy No 7 for Class 1A Regional Roads and as a Specific Objective:

> "*INF9 To continue to pursue the provision of a new bridge over the Lower Shannon at Ballina and to seek to provide for the widening, upgrading and possible local realignment over some sections of the R494 regional Road for Birdhill to the junction with the R496 Ruaille junction."*

1.5.3 East Clare Local Area Plan 2011 - 2017

The East Clare Local Area Plan aims to provide safe and convenient access to and between settlements, employment, services and education through the establishment and maintenance of a road network and the encouragement of alternative means of travel to private motorised transport. The Killaloe Bypass and Shannon Bridge Crossing is identified in the Plan as a scheme which is well progressed in order to relieve the traffic congestion occurring in the area. The local area plan provides an Infrastructure Safeguard for the route of both the relief road and the river crossing.

The plan identifies that once in place there will be future opportunity for further development in both Ballina and Killaloe which will meet the needs of current and future residents.

The general objectives for Killaloe include the following statements:

- *"To secure the provision of a Shannon Bridge crossing and the Killaloe eastern relief road;*
- *To work in coordination with North Tipperary County Council to progress the development of Killaloe and Ballina as linked settlements"*

1.6 Legal Requirements

1.6.1 Legislative Requirements for an Environmental Impact Statement

The legal requirements for Environmental Impact Assessment of a road development is defined by the Roads Act (1993), and amended by the Planning and Development Acts (2000 – 2010) and the Roads Act (2007), and by Regulations made under the Roads Acts sets out provisions for the preparation of an Environmental Impact Statement (EIS) by a Road Authority.

A summary of the relevant provisions of the Roads Act, 1993, as amended by the Roads (Amendment) Act 1998, the Roads Act 2007 and SI No. 93 of 1999, in relation to Environmental Impact Statements for a public road development is set out below. (As only an abbreviated selection is presented here, the reader is advised to consult the Acts and the Statutory Instruments for the full text).

Environmental Impact Statement (EIS) Section 50 of the Roads Acts, 1993 as amended by Section 9 (d) (i) of the Roads Act, 2007 states:

"A road authority or the Authority shall prepare a statement of the likely effects on the environment ('environmental impact statement') of any proposed road development consisting of:

(i.) the construction of a motorway,

(ii.) the construction of a bus way,

(iii.) any prescribed type of proposed road development consisting of the construction of a proposed public road or the improvement of an existing public road."

The prescribed type of proposed road development as defined in S.I. No.119 of 1994, paragraph 8, is defined for the purpose of subsection (1) (a) (iii) of section 50 of the Act as follows:

"(a) the construction of a new road of four or more lanes, or the realignment or widening of an existing road so as to provide four or more lanes, where such new, realigned or widened road would be eight kilometres or more in length in a rural area, or 500 metres or more in length in an urban area;"

"(b) the construction of a new bridge or tunnel which would be 100 metres or more in length."

The relevance of the above to the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement Scheme is that an EIS is required under the Roads Act 1993 for the construction of a new bridge 100m or more in length.

1.7 Public Consultation

Section 51 of the Roads Act, 1993, as amended by the Roads Act 2007 and Section 215 of the Planning and Development Act 2000 requires that a public notice should be issued stating:

(a) that such application is approved by An Bord Pleanála;

(b) that an environmental statement has been prepared in respect of the proposed road scheme;

(c) that copies of the statement be available for inspection for a specified period not less than six weeks;

(d) that copies are available for sale at a cost not exceeding the reasonable cost of making a copy;

(e) that submissions may be made in writing to An Bord Pleanála in relation to the likely effects on the environment of the proposed road development before a specified date.

A copy of this Environmental Impact Statement is provided to the prescribed bodies as required by Section 51 (3) of the Roads Act 1993, as amended by Section 9 (e) Roads Act 2007, and by Article 9 of the Road Regulations 1994 (S.I. 119 o f 1994) and 2008 (S.I. 49 of 2008).

In addition to the statutory consultations, non-statutory consultations were held at various stages during the development of the proposed road development and these are discussed in Chapter 4.

1.8 Difficulties Encountered

Access to lands was not permitted for a small number of sites throughout the scheme for ecological assessment. Remote views of these lands were used along with aerial photography. Given that the land is used for intensive agricultural purposes and is considered to be of poor ecological value, it is not considered as a significant constraint in the compilation of this EIS.

Chapter 2

Background to the Proposed Road Development

Chapter 2 Background to the Proposed Road Development

This chapter of the EIS briefly sets out the background to the proposed road development. **Figures 2.1 to 2.5** outline the proposed scheme.

2.1 Existing Road Network

The existing road network through Ballina and Killaloe consists of the R494 from the R445 junction at Birdhill (former N7 junction) to Killaloe Bridge and the R463 through Killaloe, continuing north to Scarriff and the west.

2.1.1 R463

The existing R463 Regional Road comprises a single carriageway rural road of varying standard. The carriageway width varies but generally is approximately 5.5 metres wide without hard shoulders and follows a sub-standard horizontal and vertical alignment that includes extensive frontal development (See **Plate 2.1**). In general, the existing R463 passes through rural countryside in County Clare and Limerick, with major/minor priority type junctions linking it to the road network. The existing R463 also passes through the town of Killaloe where it takes on a typical urban character with a narrower carriageway and adjacent footways.

The national speed limit for regional roads of 80kph applies to the existing R463 with stricter speed limits of 60kph on the approaches to the town of Killaloe. This speed limit is further reduced to 50kph through the town.

In addition to the existing R463, the mainline of the Killaloe Bypass intercepts two existing local roads, Hill Road (L3078) and Creeveroe Road (L3076). Both of these local roads are narrow single carriageways.

2.1.2 Local Roads

The existing local roads L3078 and L3076 are intercepted by the proposed Killaloe Bypass mainline. These roads have cross-sections varying from 3.0m to 5.0m in width with limited verges and no hard shoulders and generally follow a sub-standard horizontal and vertical alignment (**Plate 2.2**). Accesses to fields, agricultural and residential holdings are regular features along these local roads. Both of these local roads serve the town of Killaloe where they take a more urban character with narrower carriageway and adjacent footways.

2.1.3 Killaloe Bridge

The existing Killaloe Bridge consists of a thirteen span masonry arch bridge joining the towns of Killaloe and Ballina and linking the R494 in Ballina with the R463 in Killaloe (**Plate 2.3**). The bridge has a 4.95 metres wide carriageway with a one way system controlled by traffic lights at either side of the bridge. Pedestrians share the bridge with vehicular traffic with six pedestrian refuges available along the length of the bridge.

The speed limit for vehicular traffic is 50kph at the bridge location.

2.1.4 R494

The existing R494 Regional Road joins the R445 at Birdhill. It generally comprises a single carriageway rural road of varying standard. The carriageway width varies, but generally is approximately 6.0m wide and without hard shoulders. The road follows a sub-standard horizontal and vertical alignment and includes extensive frontal development, particularly where it approaches the southern environs of Ballina. Here it takes on a typical urban character with a narrower carriageway and adjacent footways (**Plates 2.4 and 2.5**).

The national speed limit for regional roads of 80kph applies to the existing R494. Speed limits of 60kph are in place on the approaches to the town of Ballina and reduced to 50kph through the town.

The relevant section of the existing R494 extends for a distance of just over 3.5km. At its northern end, it intercepts the existing R496 at Roolagh Junction (**Plate 2.6**); while at its southern end it intersects the R445, just north of Birdhill.

2.1.5 R496

The existing R496 Regional Road comprises a single carriageway rural road of varying standard. This road serves as an alternative route from Ballina to the R445 further north and is similar in characteristics to the R494, though generally narrower in cross-section.

Plate 2.1 – R463 at northern extents of Killaloe town

Plate 2.2 – Local Road (Hill Road) L3078

Plate 2.3 – Existing Killaloe Bridge

Plate 2.4 – R494 junction in Ballina approaching Killaloe Bridge

Plate 2.5 – Traffic on the Approaches to Killaloe Bridge junction from Ballina South

Plate 2.6 – Roolagh Junction, Ballina (R494 and R463)

Plate 2.7 – Existing R494 approximately 1km from the R445 junction looking southward

2.2 The Need for the Scheme

The town of Killaloe is made up of narrow streets and difficult turns, which does not accommodate free movement of traffic, in particular heavy goods vehicles, thus compromising the historical character of the town. A bypass of the town is considered a necessary part of the scheme, assisting in the reduction of traffic within Killaloe/ Ballina making it a more attractive place to live and visit. A bypass also allows for access to areas of development potential in Killaloe and improved access to the hinterlands of Killaloe / Ballina including Scarriff and Tulla.

Killaloe and Ballina are linked by a long narrow bridge over the River Shannon. The Killaloe Bridge and its approaches in Ballina and Killaloe experience heavy congestion during morning and evening peak periods. The narrow bridge has a one way traffic system in operation and provides minimal separation between pedestrians and vehicles which further contributes to congestion. It is particularly difficult for large vehicles as they are unable to pass other large vehicles and experience difficulty negotiating the sharp turn at the end of the bridge on the Killaloe side. Regular damage occurs at this point to the parapets. Killaloe Bridge is a protected structure and cannot be widened or improved to accommodate present traffic requirements.

The R494 consists of a substandard vertical and horizontal alignment resulting in associated safety concerns; this can be seen in particular along the railway bridge at the southern section of the scheme. The R494 has a significant number of residential dwellings along the road as well as businesses. The frequent use of this road results in reduced potential for use by pedestrians and cyclists as a result of poor safety. The proposed scheme aims to provide improved safety by upgrades in vertical and horizontal alignments of the R494. Measures will also be introduced to mitigate against current flooding problems that have been identified and pedestrian and cyclists facilities will be improved.

The Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement is now proposed by Clare County Council and North Tipperary County Council so as to provide the appropriate road infrastructure for Killaloe / Ballina towns whose historical character and community infrastructure is threatened by heavy traffic. The scheme proposes to cater for the planned local, regional and national development in this area.

2.3 Function of the Proposed Road Development

The primary objectives of the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement Scheme are:

(a) To give effect to and facilitate local, regional and national development policy/objectives;

(b) To provide a second river crossing between the towns of Killaloe and Ballina and to reduce congestion and delays on the existing Killaloe bridge;

(c) To improve traffic safety by removing through traffic from the existing route over the Killaloe Bridge;

(d) To improve the environment of Ballina / Killaloe by removing a significant portion of north / south through traffic;

(e) To upgrade the R494 to allow for better use by pedestrians and cyclists, and to improve safety aspects of the road; and

(f) To reduce travel times along the route.

Chapter 3

Description of the Scheme

Chapter 3 Description of the Scheme

3.1 General Description of Scheme

The proposed Killaloe Bypass (chainage ref: K), Shannon Bridge Crossing (chainage ref: S) and R494 Improvement (chainage ref: R) Scheme will provide a western bypass of Killaloe, a new bridge crossing of the River Shannon and an upgrade of the existing R494 regional road from Ballina to the R445 (previously the N7) at Bridhill. The entire scheme is approximately 6.2km in total and will cross the River Shannon approximately 1km to the south of the existing Killaloe Bridge.

The proposed scheme has been broken down into three sections as follows:

1. Killaloe Bypass: This part of the Scheme aims to create a western bypass around the town of Killaloe which will connect the R463 to the north of town with the proposed Shannon Bridge Crossing section and R463 to the south of the town. This section of the scheme is illustrated in **Figure 3.2 to 3.4** chainage 0+00 K to 2+030 K.
2. Shannon Bridge Crossing: This section of the Scheme will cross the River Shannon approximately 1km south of the existing Killaloe Bridge and will connect the proposed Killaloe Bypass with the R494. This section of the scheme is illustrated in **Figure 3.5 to 3.6** Chainage 0+000 S to 0+840 S.
3. R494 Upgrade: This section will involve widening, regrading and local realignment of the R494 from its junction with the R496 and proposed Shannon Bridge Crossing south of Ballina, as far as the junction with the N7 north of Birdhill. This section of the scheme is illustrated in **Figure 3.7 to 3.11** Chainage 0+000 R to 3+300 R.

The overall route of the proposed scheme is illustrated in **Figure 3.1**.

3.2 General Route of the Proposed Scheme

3.2.1 Killaloe Bypass

Detailed plans of the proposed Killaloe Bypass are shown on **Figures 3.2 to 3.4**. Commencing at the R463 north of Killaloe at chainage 0+000 K, the mainline exits the proposed at-grade roundabout in a south-westerly direction **(Plate 3.1)**.

The mainline rises steeply to minimise the impact on Ballyvally Estate whilst also minimising the adverse impact of Knockyclovaun Hill **(Plate 3.2)**, both to the west. This section of the road is in deep cutting, up to approximately 17.7m. The proposed route at this location necessitates the acquisition of one private dwelling at chainage 0+350 K.

As the mainline moves away from Knockyclovaun Hill in a southerly direction through agricultural land, the road takes a gentle left-hand curve, followed by a section of straight road, where it crosses two local roads (Hill Road and Creeveroe Road) at chainage 1+100 K and chainage 1+500 K respectively, with at-grade major/minor priority junctions **(Plate 3.3)**.

After the second local road crossing, the road veers left to face a south-westerly direction as it approaches the tie-in to the existing R463 south of Killaloe and the proposed Shannon Bridge Crossing section of the Scheme **(Plate 3.4)**. The lands along this section are generally a mix of agricultural and woodland.

Plate 3.1 Northern Tie In point at Ballyvalley Estate

Plate 3.2 Location of Proposed Killaloe Bypass at Knockyclovaun Hill looking south

Plate 3.3 Local Road L3078 (Hill Road) Tie In point

Plate 3.4 Proposed southern Tie In with the R463

3.2.2 Shannon Bridge Crossing

Detailed plans of the proposed Shannon Bridge Crossing are shown on **Figures 3.5 to 3.6**. This Section continues from the southern tie-in point of the Killaloe Bypass with the R463 1.0km south of the existing Killaloe Bridge. From this roundabout the route travels in an easterly direction towards the River Shannon. It follows the boundary between a newly developed residential estate and a disused warehouse for approximately 150m before continuing in a north easterly direction through agricultural lands where it reaches a private road (access to Clarisford Palace and other private dwellings). The route continues in an easterly direction necessitating the acquisition of one private dwelling located at chainage 0+620 S. Immediately after the private dwelling, the route will cross the disused Killaloe Canal before reaching the western shore of the River Shannon at approximately chainage 0+660 S **(Plate 3.5)**.

The crossing of the River Shannon takes the form of a 5 span steel-arched bridge structure. From the eastern banks of the River Shannon the road continues through a vacant parcel of land with private dwellings located to the north and south of the route. The route joins the R494 at a junction with the R496 (Roolagh Junction) where a four-armed roundabout is proposed **(Plate 3.6)**.

See **Figure 3.20 to 3.26** in Volume 2 for Bridge Photomontages.

Plate 3.5 Proposed location of Shannon Bridge Crossing with disused Killaloe Canal to the right

Plate 3.6 Roolagh Junction tie-in point looking east towards proposed Shannon Bridge Crossing

3.2.3 R494 Improvement

From the proposed 4 arm roundabout junction at Roolagh to the R445 Roundabout at Birdhill on the R445, the R494 Improvement section of the scheme will largely involve an on-line upgrade to the existing R494 regional road. Details of the R494 Improvement are shown on **Figures 3.7 to 3.11**. Between chainage 1+000 R and chainage 1+500 R the proposed roadway design is off-line west of the existing roadway, to improve safety.

Between chainage 1+500 R and chainage 2+300 R, the existing alignment is virtually straight and the main features along the road way in this area are the relatively new single houses located directly off the road but with their boundary walls set back from the existing road.

Between chainage 2+300 R and the tie-in with the R445 / R494 roundabout **(Plate 3.8)**, the road will cross the Kilmastulla River **(Plate 3.7)** and the Limerick to Nenagh Railway Line between numerous single houses and a business park. In order to minimise disruption during construction and to limit the impact on existing houses the alignment is located off line at the Kilmastulla River Bridge. Online improvement of the existing railway bridge is proposed. The existing roadway is to be upgraded by widening and improving the vertical and horizontal alignment.

Plate 3.7 R494 approaches to Kilmastulla River Bridge looking northwards

Plate 3.8 View looking south on R494 to proposed tie-in point with the R445

3.3 Road: Cross Section

The mainline road is classified as a reduced single carriageway and is required to be designed in accordance with the geometric standards of the NRA DMRB TD 9/07 and TD 27/07. The cross sections of the various parts of the scheme along with the design limit are stated below (**Figure 3.19**)

Killaloe Bypass, 70 kph Design Speed:

- 2 x 3.5m Traffic Lanes
- 2 x 0.5m Hard Strip
- 2 x 1.5m Cycleway (off road)
- 1 x 1.5m Footpath (east side)
- 1 x 1.5m Grass Verges (west side)

Shannon Bridge Crossing Main line cross section 70 kph Design Speed:

- 2 x 3.5m Traffic Lanes
- 2 x 0.5m Hard Strip
- 2 x 1.5m Cycleway (off road)
- 2 x 1.5m Footpath

Bridge Cross Section, 60kph Design Speed

- 2 x 3.5m Traffic Lanes
- 2 x 0.5m Hard Strip
- 2 x 1.5m Cycleway (off road)
- 2 x 1.5m Footpath
- 2 x 0.5 Parapet beams

R494 Section with 60 kph Design Speed:

- 2 x 3. 0m Traffic Lanes
- 2 x 0.5m Hard Strip
- 2 x 1.5m Cycleway (off road)
- 2 x 1.5m Footpath

R494 Section with 85 kph Design Speed:

- 2 x 3.0m Traffic Lanes
- 2 x 0.5m Hard Strips
- 1 x 2.5m Grass Verge (east side)
- 1 x 1.0m*/1.4m* separator verge (west side, * depending on safety barrier)
- 1 x 2.5m combined 2 way cycleway/footway (west side)
- 1 x 1.5m*/1.1m* grass verge (west side, * depending on safety barrier)

The design of the mainline generally provides where possible a working space requirement of 3 metres from the edge of earthworks line to the boundary fenceline to allow for future maintenance along the entire scheme. For the Killaloe Bypass, an additional 2 metre wide strip is provided on the western boundary fence line to allow for interceptor drainage ditches where required.

3.3.1 Side Road: Cross sections

Table 3.1 Side Road Cross-sections and Design Speeds

Road No.	Townland	Existing c/way cross section (m)	Realigned Length (m)	Realigned Cross Section (m)	Design Speed (km/h)
R463	Kincora	6.0-6.5	430	8.0 plus 3.0 verge	70
L3078	Knockyclovaun (Hill Road)	3.5-4.0	170	5.0 plus 1.0 verges	50
L3076	Shantraud (Creeveroe Road)	4.5-5.5	230	5.5 plus 1.0 verges	50
R463	Shauntraud	5.5-6.0	430	8.0 plus 3.0 verges	70
R496	Roolagh	4.0	100	6.0 plus verges	50

See **Figures 3.19** for cross section drawings.

3.4 Earthworks

3.4.1 Killaloe Bypass

Due to the topography and alignment restrictions of the route there is one major cutting along the Killaloe Bypass at the beginning of the proposed route at Knockyclovaun (chainage 0+60 K to 0+640 K) which has a depth of approximately 17.7m. This cutting generally consists of topsoil over dense sandy and silty/clayey gravel with cobbles. The underlying siltstone/sandstone bedrock is encountered at approximately 10m depth. The remaining cuttings along the proposed route are generally shallow (<3m depth). These cutting are located at Knockyclovaun (chainage 0+740 K to 1+000 K), Shauntraud north (chainage 1+400 K to Ch 1+510 K) and Shauntraud south (chainage 1+400 K to 1+510 K).

Many small embankments are required along the alignment in this section with typical heights of less than 3m. The embankments along the route include Ballyvally (chainage 0+000 K to 0+060 K) of height 2m along the mainline and up to 6.5m on the roundabout and approach roads, at Knockyclovaun (chainage 0+640 K to 0+740 K); at Knockyclovaun south and Shauntraud north (chainage 1+000 K to 1+400 K); at Shauntraud south (chainage 1+510 K to 1+800 K); and at Shauntraud Woods (chainage 2+000 K to 2+026 K).

The fill quantities required along the route are significantly less than the cut quantities resulting in a surplus of material is this section of the scheme. Some of or all of this generated cut could be suitable for reuse elsewhere along the Scheme, including the Shannon Bridge Crossing section and the R494 Improvement section, and assuming appropriate programming of construction activities. Should the project be phased due to funding or any other constraints, such that the Killaloe Bypass Section is constructed in advance of the other two sections of the Scheme, any surplus material which requires disposal will be collected and disposed of at a suitably licensed facility.

3.4.2 Shannon Bridge Crossing

This section of the scheme is dominated by an underlying geology of Old Red Sandstone formations. Bedrock in the river was assessed where shale was encountered at a depth of approximately 21.0m below the riverbed.

There is one area of cut within this section of the Scheme from chainage 0+375 S to chainage 0+440 S which has a depth of 2m. This cutting generally consists of topsoil over soft to firm sandy clay with gravel and cobbles.

There are three areas of embankment within this section of the Scheme. A small embankment with a height of up to 2m occurs from chainage 0+000 S to chainage 0+375 S. There are also two embankments either side of the proposed river crossing, from chainage 0+440 S to chainage 0+660 S and from chainage 0+790 S to chainage 0+860 S. These embankments are up to 7m in height adjacent to the proposed bridge abutments.

There is an earthworks deficit in this section of the Scheme. However the required fill quantities may be obtainable from the surplus which would be available from the Killaloe Bypass section of the Scheme, should this be feasible. This would depend on phasing and will be subject to availability of funding for the Scheme.

3.4.3 R494 Improvement

The underlying bedrock east of the river consists of Lower Carboniferous limestone and shale at the northern end and muddy limestone for the majority of the remainder of the route. There are two areas of at grade construction that should encounter no significant difficulties where between Ch 1+600 R and 1+850 R and will have to be excavated and replaced if it is determined to be unsuitable for use as founding stratum.

One cutting is required with a depth of approximately 2m consisting of topsoil over firm to stiff sand gravelly clay with cobbles at Ch 0+330 R to 0+650 R. It is not anticipated that groundwater will be an issue in this area.

A number of small embankments are required along the alignment in this section with typical heights of less than 1m associated with the realignment of the existing road. Many of these have embankments on one side of the existing road and occasional cutting on the other side of the road.

Three significant embankments along the alignment are required. These are located between Ch. 0+200 R and 0+330 R with a height of less than 1m, between Ch. 0+650 R and 1+350 R with a height of 3m, and between Ch. 2+450 R and 3+300 R with a height of greater than 7m. The latter embankment includes the structures for crossing the Kilmastulla River and the existing Limerick to Nenagh Railway Line.

Fill material to be used in earthworks will satisfy acceptability criteria and detailed in the NRA Specifications.

As very little cut is generated along the R494 a deficit will arise due to fill requirements. However any requirement for importation could be avoided by prioritising the construction of the Shannon Bridge in programme terms. This will facilitate the surplus material from the Killaloe Bypass section of the scheme being transported across the River Shannon and utilised for the construction of the embankments of the R494 Improvement section.

Some sections of the cut on the R494 Section could be suitable for reuse, however due to the shallow nature of the majority of the earthworks along the proposed route, some of the excavated fine grained till material generated may be unsuitable for reuse due to its moisture characteristics

3.4.4 Earthworks Balance

As stated above an earthworks surplus exists for the Killaloe Bypass section of the Scheme. There is a shortfall of available fill material for the embankments to be constructed on the Shannon Bridge Crossing and the R494 Improvement. This scenario allows for some cut material to supply areas of fill and provides opportunities for the process of cut materials to provide road construction materials. These options are dependent on the phasing of the overall scheme.

In any event it is possible that areas of land will be required to dispose of surplus cut materials arising from excavations for the Killaloe Bypass section of the Scheme. Clare County Council has identified a number of licensed quarry locations in the vicinity which may be suitable for the disposal of these surplus materials.

Some materials arising from excavations are very weather dependant, in particular silty boulder clays. Excavations and handling of such material will be carried out during the drier months of the year, i.e. April to September.

Any topsoil stripped from the site will need to be stored in suitable areas before deposition on the completed earthworks slopes and verges. Any surplus material from the scheme can be disposed of appropriately off site.

Any excess volume of soil and rock will have to be excavated, loaded and transported for disposal in a licensed facility. Excavated material that is unsuitable for reuse as road fill can be used for landscaping along the route corridor. Any excess of material will be disposed of offsite in accordance with the Waste Management Acts, 1996 to 2008, the NRA *Guidelines for the Management of Waste from National Road Construction Projects* (2008) and all other relevant legislation.

Any shortfall of material will be made up by importing material from outside sources or the excess resulting from the Killaloe Bypass. However it should be noted that no haulage of earthworks material will be permitted though Killaloe town or on the existing bridge crossing between Killaloe and Ballina.

The earthworks balance is discussed in more detail in **Chapter 7.6** of this Environmental Impact Statement.

3.5 Shannon River Bridge

The proposed Shannon Bridge crosses the River Shannon where it is 143 metres wide. The land is moderately sloping on the east side, falling a height of 11.5 metres over a distance of 94 metres between the R494 and the east bank of the river. On the west side the terrain is gently sloping falling a height of 6 metres over a distance of 170 metres between the existing residential access road at Moys and the bank of the river. In addition there are the remains of an inundated canal running parallel to the river bank.

The proposed bridge structure consists of a slender reinforced concrete deck supported on a system of secondary steel beams at deck level connected to primary steel arches.

The superstructure is supported on four reinforced concrete piers in the river channel, and two reinforced concrete abutments at the river banks. The three interior span lengths are approximately 42 metres long and the two end spans are approximately 21 metres long.

The length of the bridge lends itself to a form of structure that is appropriate in terms of the span lengths selected. The choice of an odd number of spans avoids a pier coinciding with midstream, a design requirement which is always considered appropriate for river crossings and particularly for the River Shannon.

The existing bridge at Killaloe has pedestrian refuges, or small local widenings, at each pier above the cut-waters. This theme has been reflected in the proposed bridge by the provision of small balconies on the deck supported by extensions of the piers. As the bridge is in a particularly scenic location, the balconies provide space for pedestrians to stop and take in the views upstream and downstream from the bridge. Seating will be provided for pedestrians on the balconies. Protection is also provided to the balcony area from vehicular traffic by deployment of suitable of suitable safety barriers. This allows for a lighter handrail on the balcony, which is more appropriate to a pedestrian area than the main parapet along the rest of the deck.

The impact of the bridge structure on the Lower River Shannon SAC is discussed under **Chapter 7** of this EIS.

3.6 Road Drainage System

3.6.1 Introduction

The proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement will be constructed within the catchment of the River Shannon. The road drainage system will ultimately discharge to the River Shannon. The sub - catchment traversed by the proposed road is predominantly rural and is characterised by steep falls on the Killaloe side where the scheme crosses 2 minor watercourses. The route of the R494 Improvement crosses the Kilmastulla River and five other watercourses, which are all part of the River Shannon Catchment system.

3.6.2 Carriageway Drainage

The proposed carriageway drainage system shall be designed in accordance with the NRA DMRB, NRA Addendum to HD 33/06 and the current best practice guidance for drainage i.e. “Sustainable Urban Drainage Systems” or SUDS, which takes forward the issues arising from the EU Water Framework Directive (WFD) issued in October 2000.

A combination of kerb and gully systems with a carrier pipe, filter drains and over the edge drainage will be used to drain the carriageway.

Cut- off filter drains or channels are provided at the top of cuttings slopes where the adjoining land slopes towards the embankment. These cut-off drains will where possible discharge to existing watercourses and not to the road drainage system.

Where the road is in cut intersecting land drains and ditches are diverted into cut-off drains and taken to drainage outfalls.

3.6.3 Culvert Design

The Scheme will involve the culverting of a number of minor watercourses.

The design standards for culverts of OPW watercourses and the canal have been established in consultation with the Office of Public Works. The OPW's minimum requirements are:-

- Minimum Culvert Size of 900mm diameter;
- Culverts are to be designed to convey the 1 in 100yr design flow;
- Calculated flows are to be increased by a factor of 1.2 to allow for climate change, 1.6 to allow for maintained channels and the appropriate statistical error factor;
- Maximum allowable afflux of 300mm for Bridgeless (desirable on culverts);
- Minimum 300mm Freeboard on Bridge Structures (desirable on culverts); and
- Section 50 applications are required for all OPW watercourses.

Culverts at watercourses that have been identified as being of importance to fisheries are provided with a low flow channel at the base. Such channels have a minimum effective depth of 500mm below the invert of the culvert and are 1m wide. Detailed design works and construction for such culverts shall be undertaken in conjunction with the Shannon Regional Fisheries Board.

Generally culverts are constructed directly along the line of the watercourse being culverted and are not offset. However, where necessary, ditches and streams may have to be realigned. To prevent contamination of watercourses by silting, each watercourse will be temporarily diverted during the construction of the associated culvert.

The culverts on the scheme shall be designed to be inlet controlled in the 1 in 100 yr flood event using the methodology outline in CIRIA Report 168 – The Culvert Design Guide. Where required in order to achieve the required finished road level some minor stream re-grading works may be required. **Table 3.2** presents the 1 in 100 yr flow and size for culverts on the Scheme for the purpose of the preliminary design.

Table 3.2 Preliminary Culvert Sizes

Culvert Ref.	Road & Chainage	1 in 100yr Flow	Culvert Size
KBP CA1	KB Ch 0+000	0.96 m^3	1.5m diameter
KBP CA2	KB Ch 1+760	2.35m^3	1.2m high x 3.0m wide
KBP CB1	R463 North Ch 0+020	2.4m^3	1.2m high x 3.0m wide
R494 CC1	R494 Ch 0+980	3.6m^3	1.5m high x 3.3m wide
R494 CC2	R494 Ch 1+120	7.3m^3	1.8m high x 4.5m wide
R494 CC2A	R494 Ch 1+170		1.2m diameter
R494 CC3	R494 Ch 1+720	1.8m^3	1.5m high x 1.5m wide/1.8m diameter
R494 CC3A	R494 Ch 1+995		1.2m diameter
R494 CC4	R494 Ch 2+300	1.27m^3	1.2m high x 1.8m wide
R494 CC5	R494 Ch 3+270	1.9m^3	1.5m high x 2.1m wide

Note: flows and culvert sizes may be subject to refinement at detailed design stage.

3.6.4 Flow Attenuation

The preliminary design of this scheme has included provision for storm water attenuation. Storm water attenuation ponds will have adequate capacity to cater for the fifty year rainfall event. Flows will be restricted to greenfield runoff rates by a flow control device at the outlet. Ponds will permanently contain a 300mm depth of water to encourage plant life develop over time which will also act as a water quality treatment facility.

3.6.5 Water Quality and Treatment

Road runoff contains suspended solids, hydrocarbons and heavy metals which should be treated prior to discharge to the receiving environment. The following is proposed as a minimum level of treatment to the road runoff prior to discharge to watercourses:-

1. A Class 2 Bypass Petrol/Oil Interceptor is to be provided at each outfall;
2. Road runoff is to go through a stilling process to allow suspended solids to settle out (this may be in open ditches, ponds, hydrodynamic separators, etc).

With regard to the protection of watercourses from pollutants, the Shannon Regional Fisheries Board requires that measures be implemented to minimise the risk of pollution of watercourses. The Department of the Marine and Natural Resources publication: '*Fishery Guidelines for Local Authority Works*" Section 8.2 suggests that soakaways or settlement ponds be installed on drains accepting runoff from heavily trafficked roads. In line with these recommendations and in an effort to minimize any impact on the receiving environment from runoff from road surfaces, pollution control is proposed at each proposed outfall location. In general, pollution control is proposed in the form of vegetative systems i.e. Infiltration Basins or Sedimentation Ponds as described in UK DMRB Vol. 4 Sect. 2 HA 103/01.

Many factors affect the selection of appropriate pollution control facilities including soil characteristics, traffic flows and characteristics, the sensitivity of the receiving environment and the expected constituents of the runoff.

Pollution control facilities that are not required to provide flow attenuation are sized based on the runoff from the first 10mm of rainfall event, often described as the 'first flush' effect of storm. This allows for any build up of pollutants on a roadway that will be washed off in the early part of a storm to be treated. The pollution control facilities shall be provided upstream of the outfall and shall be filled via a v-notch device that diverts the road surface run-off from the early stage of storm events and from insignificant storm events to the facility.

All pollution control facilities and attenuation areas shall be fitted with a penstock or similar restriction at the outfall to the receiving channel. Such devices can be used to contain pollutants in the event of an accidental spillage.

A risk assessment to quantify the likelihood of a serious accidental spillage will be carried out in accordance with UK DMRB Annex III Volume 11Section 3 Part 1.

Vehicular drainage maintenance access from the public road network to all pollution control facilities and attenuation ponds will be provided and boundary fencing for safety will also be incorporated. Similarly vehicular access will be provided around all such facilities and ponds. The areas containing attenuation ponds and pollution control facilities shall be securely fenced to prevent access by all with the exception of those responsible for maintenance.

Mitigation measures required for maintenance of water quality and treatment are discussed further in **Chapter 7.**

See **Figures 3.2 to 3.18** for drainage and road layouts.

3.7 Construction Phase

3.7.1 Introduction

This section outlines the significant factors that need to considered for the planning of the construction phase of the proposed project. While progress to construction is clearly dependant on both planning and funding approvals for ease of language the following chapter is prepared on the basis that these approvals would be in place.

3.7.2 Duration of the Works

It is possible that the construction of the proposed road development will be progressed as a single construction contract with the construction phase potentially lasting between 24 - 30 months (2 – 2.5 years), however this is dependent on availability of funding for the project and a resulting requirement to phase the works.

Pre-Construction Works

It is proposed that archaeological investigation works including testing and any follow-on resolution works will be undertaken prior to the main works contract commencing on site. Pre-construction works will also include certain diversion works of services and utilities including electricity, gas, telecommunications, watermains and other sanitary services. Due to the nature of some of the diversions a number of these service diversions will only be possible during the main construction works.

Advanced tree clearance, hedgerow clearance and fencing contracts may also be undertaken dependant on the anticipated seasonal timing of the award of the main contract. If appropriate, these advance works contracts would be used as a means to clear the site of vegetation during permitted seasonal periods so as to enable the main construction contract to proceed with reduced impediment on the main works.

Main Construction Works

The main construction will involve the excavation and placement of material for the construction of cuttings and embankments as well as the hauling of materials and importation of materials to complete the road formation. Materials for the road construction will include materials that will be brought to site including gravels and bituminous pavement and surfacing materials. In addition to the earthworks construction the main activities will involve the following:

- Road Works – sub-base and base construction, bituminous pavement, surfacing.
- Drainage – the installation of pipe culverts, filter drains, ditches and attenuation ponds.
- Structures – the construction of retaining walls, piling works, construction of bridges including their foundations, piers, abutments and the installation of large precast beams and other reinforced concrete works.
- The diversion and construction of utilities and services.
- Ancillary roadworks including the installation of safety barriers, public lighting, signage and road marking.

- Accommodation works for affected landowners such as replacement of septic tanks, access roads, entrances, fences, gates, walls, ducting and reconnection of severed services.

Should a single contract be envisaged for the whole Scheme. the overall construction period would be approximately 30 months. i. The Killaloe Bypass will take approximately 15 months for construction, the Shannon Bridge Crossing will take up to 18 months and the R494 will take approximately 12 months for the construction phase. Construction operations of these phases would overlap in order to optimise use of resources.

The scheme would be divided into works areas as follows:

Works Area A (24 months):	Construction of significant structures: Shannon River Bridge, Kilmastulla River Bridge (R494) and Railway Bridge(R494).
Works Area B: (15 months):	Construction of Killaloe Bypass
Works Area C (12 months):	Construction of R494 Improvement

Work in these areas would be phased to reflect limitations set by access considerations and anticipated availability of earthworks materials.

Should unforeseen circumstances arise which would change the reusability of excavated material, for example the occurrence of inclement weather during construction, or unforeseen ground conditions, the contractor may be required to import fill material from suitable borrow pits, including a number of suitable licensed pits already in existence in the region.

A decision to phase the works, due to funding or other constraints, would have a bearing on the above considerations. Various phasing options exist, involving building the sections of the Scheme individually or in appropriate paired combinations.

An earthworks import requirement will arise in this case, generated by the requirement to source the fill required to construct the Shannon Bridge Crossing section and the R494 Upgrade.

3.7.3 Site Construction Compounds

Main Compound

A main site construction compound will be required during the construction phase to provide office, canteen and possibly testing facilities. The construction compound will also provide facilities for material storage and maintenance of construction plant. This principal site construction compound will be established at the commencement of the contract, and remain in place throughout the construction period. An area of land has been identified which is considered a suitable location for a site compound for the project adjacent to the interface of the Killaloe Bypass Section and the Shannon Bridge Crossing sections of the Scheme. Acquisition of these lands has been included in the Compulsory Purchase Order as published, and the impacts of this proposal have been considered in the Environmental Impact Statement carried out.

Satellite Compounds

Other satellite compounds will be established along the route to suit the programme and nature of the works. The proposed sites will be located away from residential property and watercourses and will comply with the requirements described in the EIS including Chapter 7.2 Aquatic Ecology and Chapter 7.3 Noise, together with the Conditions of any Approval as may be granted by An Bord Pleanála.

Shannon River Crossing Satellite Site Compound

It is envisaged that a satellite compound will be required close to the River Shannon Bridge to facilitate construction of the bridge. It is considered that there are sufficient lands available within the permanent land take on the western approach to the bridge location. By means of suitable construction programming, earthworks operations in this area will be delayed to facilitate access for plant and materials to the bridgeworks area.

Any additional lands required by the contractor during the construction phase will not be permitted within the Lower River Shannon SAC.

3.7.4 Construction of Bridge Structures

Kilmastulla River Bridge (Chainage 2+630 R on the R494 Improvement)

The construction of the Kilmastulla River Bridge will involve excavation for the foundations of the bridges on both banks of the river. No working in the river channel itself will be required for this purpose. Some dewatering of foundation excavations may be required due to ingress of water. Mitigation measures will be made to ensure there is no contamination of the water by the materials and equipment used in the construction. The bridge foundations are piled, a system of either bored or driven piles will be utilized for this purpose. These works will have minimal impact on the environment, though significant noise levels could be generated by the equipment used. Restrictions will be placed on working times in order to minimize disruption to households in the area.

Following installation of the piling the reinforced concrete pilecaps will be constructed using conventional methods. The reinforced earth abutments will follow, followed by construction of the deck. This will comprise a composite system of precast concrete beams and infill reinforced concrete. A mobile crane will be used for installation of the precast beams.

Closure of the R494 road will not be required for the construction of the Kilmastulla River Bridge, nor will demolition of the existing river bridge be necessary. Traffic will be diverted onto the newly constructed bridge following its completion, and as part of the overall construction sequence for the works on the R494.

Railway (Chainage 3+035 R on the R494 Improvement)

The construction of the Limerick to Nenagh Railway Line Overbridge on the R494 will require the existing R494 to be closed, with temporary diversions put in place using the R496 Ballina/R445 road, while guaranteeing local access for residences and other properties at all times. Access for pedestrians will also have to be considered, perhaps in the form of a managed level crossing or a temporary footbridge.

Careful liaison with Iarnród Éireann will be required at all stages of the construction of the bridge. This will form part of the formal Bridge Agreement which will be entered into between Iarnród Éireann and Clare County Council/North Tipperary County

Council for the Scheme, prior to commencement of construction. All works in the vicinity of the railway line will be carried out under agreed possessions with relevant Iarnród Éireann staff in attendance.

The first phase of operations will be to divert existing service lines including gas, electricity and telecom lines together with existing water mains. The existing gas main crosses under the existing railway and the required diversion, also under the railway, will require to be installed by recognized pipe jacking techniques, and in agreement with a methodology approved by Iarnród Éireann. Diversion of the water main could also be carried out under the railway by pipe jacking, or alternatively by a temporary diversion over the railway line supported on a temporary pipe bridge.

Demolition of the existing railway bridge will follow using phased agreed possessions for the removal of the existing parapets, deck structure and abutments in turn. All demolition rubble will be removed to a licensed refuse facility.

The bridge abutments are reinforced earth structures supported on piles. These works will have minimal impact on the environment, other than noise levels which could be generated by the equipment used. In addition to addressing any Iarnród Éireann requirements for nighttime working under agreed possessions, restrictions will be placed on working times in order to minimize disruption to households in the area.

Following completion of the abutments deck construction will be carried out. The proposed deck is of composite precast construction which will facilitate the shortest possible period of construction activities directly over the railway.

The most significant impact at this location will be from noise and dust in the vicinity of houses east and west of the road, and the Shannonside Business Park. These works will be required to be undertaken in a sensitive manner and mitigation measures (See **Chapter 7.2 and 7.3**) are included to ensure this.

Construction Sequence for the Shannon Bridge

The following represents the anticipated methodology for the construction of the Shannon Bridge which is a critical part of the Scheme.

Stage 1: Establishment of bridge site compound

- This will be constructed at the western approach to the bridge within the lands made available.
- A working area will also be established adjacent to the east abutment location; land is available for this purpose within the lands made available and immediately to the north of the abutment location.

Stage 2: Foundation Construction- Abutments

- Both the east and west abutments require piled foundations; piling will be carried out using pile driving techniques; restrictions will be placed on working times in order to minimize noise disruption to households in the area.
- The abutment pilecaps are of conventional reinforced concrete construction; it is likely that a mobile crane would be used for heavy lifts including shuttering and reinforcement cages; concrete would be delivered by road from an offsite readymix plant.

Stage 3: River Piers

- Piling for the piers can be carried out from floating plant mounted on Uniflote pontoons or similar; both raking and vertical piles will be required depending on pier position.
- Construction of reinforced pilecaps will be carried out using suspended shuttering techniques; once the formwork is in place dewatering would take place to allow concreting operations to take place in dry conditions.
- Construction of reinforced concrete piers would follow; dewatering techniques would be deployed as required for the parts of the piers which are below normal water level of the river.

Stage 3: Superstructure Construction

- Installation of the structural steel arches would be achieved by preassembly of either full-span or half-span units comprising the arch members, vertical struts, deck level steelwork and appropriate temporary cross-bracing. The potential for difficulty in transportation would dictate the units are likely to be assembled in the works area on the west side of the Shannon, following delivery to site of the structural steel members by public road. This operation would be carried out on a phased basis as construction of the superstructure progresses on site.
- A possible construction sequence for the installation of the arches (whether in whole spans or half spans) would involve the activities listed below, progressing from west to east in the sequence shown:
    - Install first full span assembly (Pier 1 to Pier 2) by land-based or barge-mounted crane
    - Install end span assembly at west end (west abutment to Pier 1) by land-based or barge-mounted crane
    - Install precast concrete deck slabs to end span (west end) and to span between Piers 1 and 2, progressing from west abutment
    - Place in-situ concrete to make top slabs composite
    - Install arch assembly for second full span (Pier 2 to Pier 3) using mobile crane located on deck span between Piers 1 and 2.
    - Install precast concrete deck slabs to second full span i.e. between Piers 2 and 3, and place in-situ concrete to make top slabs composite.
    - Install arch assembly for third full span (Pier 3 to Pier 4) using mobile crane located on deck between Piers 2 and 3.
    - Install precast concrete deck slabs to third full span i.e. between Piers 3 and 4, and place in-situ concrete to make top slabs composite
    - Install half-arch assembly for west end-span (Pier 4 to East Abutment) using mobile crane located on deck between Piers 3 and 4.
    - Install precast concrete deck slabs to end span (east end) and to span between Piers 1 and 2, progressing from west abutment.
- Construct bridge parapet plinths.
- Lay bridge deck waterproofing.
- Install all deck finishes including road surfacing (except wearing course).
- Install bridge parapet railings.
- Install wearing course.

As an alternative to the above sequence, the contractor may opt to assemble and install arch assemblies for the east end-span and the span between Piers 3 and 4 by working on and from the east bank of the Shannon. This would entail transportation of steel elements from the south east using a diversion of the R496, assuming the R494 were closed at its southern end to facilitate construction of the river and railway bridges.

3.8 Lighting

For the safety of road users road lighting will be provided at the following locations:

- Throughout the extent of the Killaloe bypass;
- At the R463 Roundabout junction north of the town and along the approaches to this roundabout junction;
- At the R463 Roundabout junction south of the town and along approaches to this roundabout;
- Along the full length of the Shannon Bridge Crossing section of the scheme;
- At the R494/R496 junction south of Ballina and along the approaches to this roundabout junction.

Lighting is proposed to utilise columns no higher than 14 metres and to use high-pressure cut-off sodium lanterns. The installation is to comply with the requirements of Series 1300 and 1400 of the ‘Specification for Road Works’ as published by the NRA and in accordance with the recommendations of BS 5489 and BS 5649.

Chapter 4

Outline of Alternatives Considered

Chapter 4 Outline of Alternatives Considered

4.1 Development of Possible Route Options

The Killaloe Bypass, Shannon Bridge Crossing and R494 Upgrade Scheme has undergone a number of stages in the constraints, route selection and design process.

A Traffic Management Strategy was carried out by Consulting Engineers: Barry and Partners, in 2003. This report identified that a new bridge crossing was required in the region, downstream of the existing Killaloe Bridge. It further recommended as part of the long term strategy for Killaloe and Ballina, a bypass of Killaloe and the need to upgrade the R494 from the R445 to Ballina.

In 2005, RPS Consulting Engineers published a Constraints Study Report for the Shannon Bridge Crossing (**Figure 4.1**) and a subsequent Route Selection Report in 2006, recommending the proposed route for the Shannon Bridge Crossing. The purpose of the 2005/2006 study was to find the preferred route of the Shannon Bridge Crossing linking the R525, R466 or R494 with the R463 via a new bridge across the River Shannon in the vicinity of Killaloe / Ballina and O'Briensbridge / Montpelier.

Two Public Consultations were carried out as part of the constraints and route selection phase of the Shannon Bridge Crossing in 2004 / 2005 providing information to elected representatives and to members of the public.

Identifying the Shannon Bridge Crossing as a key tie-in point, a Constraints Study for the Killaloe Bypass was carried out by Roughan and O'Donovan in early 2008. A subsequent Route Selection Report identifying the preferred route for the Killaloe Bypass was published in 2008.

As part of the 2008 process, public consultations were carried out at various stages making information available on each stage of the process for the Killaloe Bypass, and the R494 improvements.

The step-by-step development towards the alignment which has been taken to preliminary design stage is discussed in the following section.

4.1.1 Constraints to the Route Options

The Constraints Study for the Shannon Bridge Crossing was carried out in 2004/2005 (RPS, 2005) while the Constraints Study for the Killaloe Bypass and R494 Improvements was carried out in 2008 by Roughan & O'Donovan (**Figure 4.3**). These reports have provided a comprehensive record of environmental and engineering constraints in the area. They have assembled existing data such as traffic counts, geotechnical data, etc., that were then used in the Route Selection stages of the scheme.

The following were the main constraints identified:

- Watercourses & drainage;
- Archaeology;
- Flora & fauna;
- Landscaping;
- Geology;

- Planning Constraints, i.e. settlements and future development;
- Existing roads and traffic;
- Utilities;
- Recreation & tourism.

The Constraints Study focussed on constraints which could affect the design of the scheme and which had potential to delay the progress of the scheme and influence the cost of the project.

The principal constraints identified in the Killaloe / Ballina area during the Constraints Study were:

- The Lower River Shannon (Special Area of Conservation) SAC and Lough Derg (Special Protection Area and proposed Natural Heritage Area);
- Sites of Archaeological and Architectural heritage;
- Existing/Future sites for residential development;
- Wildlife Habitat Areas;
- Ecologically sensitive areas;
- Potential for Architectural, Archaeological and Cultural heritage;
- Protected Views;
- Landholdings;
- Existing dwellings.

A drawing identifying the constraints is shown in **Figure 4.4**.

4.1.2 Constraints Phase Public Consultation

Shannon Bridge Crossing (2005)

During the preparation of the Constraints Report, Clare County Council in conjunction with North Tipperary County Council and Limerick County Council held a Public Consultation Meeting on the 19th of April 2005 which consisted of:

- A session for elected representatives; and
- A session for the general public.

Each of the 13 elected representatives and 36 members of the public who attended the meeting were given an information leaflet and Questionnaire detailing the study area and the selection process.

Killaloe Bypass and R494 Improvement (2008)

As part of the Constraints Report for the Killaloe Bypass and R494 Improvement, a Public Consultation was carried out.

An information leaflet outlining the history of the project to date and the area covered as part of this study with a questionnaire was made available to the public. The consultation process was advertised in the Clare Champion and Nenagh Guardian on Friday 14th of March 2008. The Questionnaire was made available at 6 Local Area offices and a map of the scheme was on display from 14th of March to the 11th of April. The leaflet was also sent out to a number of statutory and non statutory consultees.

4.2 Alternative Route Options

Section 50(2)(d) of the Roads Act,1993, as amended, states that an EIS shall contain: "*an outline of the main alternatives studied by the road authority concerned and an indication of the main reasons for its choice, taken into account the environmental effects"*. Under this consideration the following options have been considered:

- On-line Widening of the existing Killaloe Bridge;
- 8 route options for the Shannon Bridge Crossing;
- 5 route options for the Killaloe Bypass.

4.2.1 Initial Assessment of Options:

On-Line Widening

The existing Killaloe Bridge provides the only direct link between the towns of Killaloe and Ballina. The bridge was constructed during the mid 18^{th} Century and consists of 13 spans, including the span over the canal on the Killaloe side of the river and another over the disused railway line to the Ballina side of the river. The bridge has a length of approximately 165 metres, excluding the first canal and railway spans. The carriageway width is approximately 5.0 metres with some sections reducing to 4.8 metres.

A report on the feasibility of widening the Killaloe Bridge was prepared by Michael Punch and Partners in 1996. Furthermore an EIA was carried out in 2000 by Clare County Council to widen Killaloe Bridge and facilitate two lanes of traffic and a pedestrian footpath. The EIA concluded that from a cultural heritage perspective the proposed widening would have a serious impact on the archaeological, architectural and historical integrity of the Bridge and that that character of the narrow Bridge would be diminished with the proposed widening. (The bridge is an historic masonry arch bridge with a Regional Rating in the National Inventory of Architectural Heritage (NIAH) and consequently is a protected structure).

Shannon Bridge Options

A number of options were considered for the Shannon Bridge Crossing and are shown in **Figure 4.2**. The route descriptions are as follows:

Route 1

Approximately 1,050m long, including a 60m long crossing of the headrace canal and a 120m long crossing of the River Shannon, this route commences on the R463 in Co. Clare approximately 0.7km south of the existing bridge in O'Briensbridge / Montpelier. It travels in a south-easterly direction over the Canal and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a southerly-easterly direction to join with the R525 approximately 0.6km south of Montpelier.

Route 2

Approximately 1,100m long and includes a 106m long crossing of the headrace canal and a 116m long crossing of the River Shannon. It also includes a 20m long crossing over the existing R463 at its western end. It commences on the R463 in Clare approximately 0.75km north of the existing bridge in O'Briensbridge. It travels in a south-easterly direction over the canal and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a south-easterly direction to join with the R466 approximately 0.25 km east of Montpelier.

Route 3

This route is approximately 1,450m long and includes a 106m long crossing of the headrace canal and a 132m long crossing of the River Shannon. It commences on the R463 in Co. Clare just south of Parteen Weir. It travels in a south-easterly direction over the canal and across a narrow strip of land to the western shore of the River Shannon. It crosses the Shannon and continues in a south-easterly direction to join with the R466, 1.5 km of Montpelier.

Route 4

This route is approximately 2,550m long and includes a 200m long crossing of the River Shannon. The river basin is 550m wide at this location and 350m of the length of the roadway is founded on causeways constructed within the river basin area. It commences on the R463 in Co. Clare about 2.2km north of Parteen Weir. It travels in a south-easterly direction crossing the Shannon and the Realigned Kilmastulla River to join with the R466, 0.6 km south of Birdhill.

Route 5

This route is approximately 2,480m long and includes a 200m long crossing of the River Shannon. The river basin is 820m wide at this location, and 620m of the length of the roadway is founded on causeways constructed within the river basin area. It commences on the R463 in County Clare about 2.7km north of Parteen Weir. It travels in a south-easterly direction, crossing the Shannon to join with the R494, 1.6 km north of Birdhill.

Route 6

This route is approximately 1,090m long and includes a 275m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.4 km south of the existing bridge in Killaloe/Ballina. It travels in a south-easterly direction, to the south of Clarisford Estate though the Townlands of Moys, reaching the western shore of the River Shannon. It crosses the River Shannon and continues in an easterly direction across to join with the R494 in Co. Tipperary, approximately 1.6 km south of the existing Killaloe /Ballina Bridge. This route runs alongside on the north of the existing high voltage ESB line between Dunstown and Moneypoint.

Route 7a

This route is approximately 910m long including a 182m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1 km south of the existing bridge in Killaloe / Ballina (250m north of Route 6). It travels in a south easterly direction, passing approximately 70m north of Clarisford Palace, continuing though a vacant site to the western shore of the River Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0km south of the existing Killaloe /Ballina Bridge.

Route 7b

This route is approximately 890m long including a 170m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1km south of the existing bridge in Killaloe/Ballina (same location as Route 7a). It travels in an easterly direction passing approximately 160m north of Clarisford Palace, continuing between two existing residential properties to the western shore of the River

Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0km south of the existing Killaloe /Ballina Bridge (same location as Route 7a).

Route 7c

This route is approximately 890m long including a 166m long crossing of the River Shannon. It commences on the R463 in Co. Clare approximately 1.1km south of the existing bridge in Killaloe/ Ballina (same location as Route 7a). It travels in an easterly direction passing approximately 180m north of Clarisford Palace, continuing through an existing residential property, to the western shore of the River Shannon. It continues in an easterly direction across the River Shannon to join with the R494 at its junction with the R496 in Co. Tipperary, approximately 1.0km south of the existing Killaloe/Ballina (same location as route 7a).

Route 8

Route 8, the northernmost route and north of Killaloe/Ballina is a hypothetical route and was proposed for traffic modelling purposes only. It is physically difficult to plan a route though this area, due to the high level of development, and the link was inserted only to test the traffic demand on such a link. The rationale was that should the traffic model indicate that such a link would be desirable; the geometric feasibility would be investigated further. This turned out not to be the case and thus no physical alignment was determined.

Killaloe Bypass Options

A number of options were considered for the Killaloe Bypass, as shown in **Figure 4.5**. The route descriptions are as follows:

Route Option A

This is the most easterly and the shortest route. Going from north to south, the route option starts off at R463 North, this option travels south westwards for 175m approximately before curving south on a 360m radius. The route continues southwards leading to a 555m long straight. A further 360m radius brings the route in a south easterly direction before rejoining the R463 at Shantraud. The length of the option is 1.85km approximately.

Route Option B

This is the second most easterly route. The northernmost section of this option is a composite alignment comprising a series of straights and 360m radius curves giving a general south westerly movement before travelling due south on a straight of approximately 690m in length. The route then curves south eastwards at 360m radius before rejoining the R463 at Shantraud. The option length is 2.025km approximately.

Route Option C

This option starts off at the R463 North and commences with a triple compound curve (radius of 360m, 720m and 360m respectively) before rejoining the line of Route Option B. The route severs the main access driveway of Ballyvally Demesne. The total length of the route is 2.45km.

Route Option D

This route connects to the existing R463 at a location further north than A, B or C. Commencing with a westbound straight section the route then curves southward behind Ballyvally House. The route continues southwards on a series of three straight sections separated by a 1020m radius right hand curve and a 900m radius left hand curve respectively. The route rejoins the R463 at a location 250m approximately from the proposed tie-in to the Shannon Bridge Crossing. This option would therefore require upgrade of the existing R463 between the two tie-in points. The total length of the option is 2.515km.

Route Option E

This route is a considerably longer option, tying in to the R463 some 1.5km further northwards than the other routes examined. The option commences with a straight section 1.2km long approximately travelling roughly south westwards before curving southwards on a 360m radius curve. The central section comprises two straights connected by a 1020m radius curve, before the route heads south eastwards, rejoining the line of Option D on the approach to the R463 tie-in.

It should be noted that the above Route Options A-E are interchangeable along the length of the corridor. For example, the northern half of Route Option A can link with the southern half of Route Option B.

4.2.2 Public Consultation (Route Selection Stage)

Non-statutory public consultations were arranged following the identification of the alternative routes for the Shannon Bridge Crossing in 2005 and for the Killaloe Bypass in 2008. The objectives of the Public Consultations were:

- To present the route corridor options to the public;
- Inform them of the process and the expected programme;
- Invite submissions on the options considered; and
- Gather local information, which may not have been known to the design team.

Shannon Bridge Crossing

A Public Consultation was held on the 6th of September 2005 at the Lakeside Hotel in Ballina, Co. Tipperary.

The purpose of this consultation was to inform the elected members and the public of the range of route options initially considered (bridge crossing options 1 to 8) and those of which had been shortlisted (bridge crossing options 1, 6 and 7).

The programme of consultations included meetings with interested parties and members of the public, the display of possible options and the distribution of a brochure and questionnaire.

The first hour of the consultation was reserved for a presentation to the Elected Public Representatives of Clare County Council, Limerick County Council and North Tipperary County Council. The display was then open to the general public for the remainder of the session.

Analysis of Preferences on Factors Affecting Route Choice

A total of 137 completed questionnaires were returned at the first public consultation phase, providing the following responses:

- Overall there was a lot of public support for the bridge with 129/137 in support of a new bridge crossing within the study area.

- The majority of people were in favour of either Route 6 or route 7 i.e. a route close to Killaloe /Ballina.
- Route 6 was favoured by more people than Route 7.

Some of the key issues raised on the questionnaires under the general section related to the following:

- The need for a bypass of Killaloe. This is clearly a very important issue raised by many people both verbally at the consultation meeting and though the responses to the questionnaires;
- Increased congestion in Killaloe after construction of new crossing due to existing narrow streets;
- The need to prohibit HGVs from using the existing bridges;
- No route option would provide relief to both O'Briensbridge / Montpelier and Killaloe/Ballina;
- Existing bridge in Killaloe / Ballina is unsafe for pedestrians.

Killaloe Bypass and R494 Improvement

Public Consultation No 2 for the Killaloe Bypass was undertaken on the 17th September 2008. The consultation invited Counties Claire and North Tipperary elected representatives and members of the public as for previous consultations. While no distinct route options were available for the R494 Improvement the public were also invited to discuss the proposed on line improvements for this section of the scheme. The consultation exhibition was advertised in the Clare Champion and the Nenagh Guardian prior to the consultation exhibition. A leaflet and questionnaire was sent to all those who had made submissions in the previous Killaloe Bypass and R494 Improvement Consultation. Advertisements were broadcast on local radio prior to the exhibitions. In addition, consultation leaflets were made available at local area offices for Clare and North Tipperary County Councils.

A total of 84 people signed the attendance sheet during the consultation process at the Lakeside Hotel. Each submission received was evaluated and the information recorded. A summary of the submission and comments made during the consultation process are as follows:

- Direct impact on homes;
- Noise, air quality and traffic impacts to residents in proximity to route options;
- Negative impacts on archaeology, architectural and cultural heritage;
- Impact on growth of tourism and facilities;
- Traffic impacts;
- Ecology / wildlife impacts;
- Visual impact on Killaloe;
- The provision of footpaths and cycle lanes;
- Concern of impact on residential space;
- Maintenance of heritage town status;
- Safety for road users in operation and in construction stages;
- Impact on water quality;
- Loss of trees;
- Construction and engineering feasibility;
- Loss of and severance of agricultural lands;

- Flooding impacts; and
- Loss of residential lands.

Analysis of the questionnaires showed that 54% of people agreed in principle with the need for the scheme, 28% were unsure and 18% disagreed with the scheme.

4.2.3 Assessment of Alternative Route Options

Shannon Bridge Crossing

The assessment of the Route Options for the Shannon Bridge Crossing was carried out in detail and reported in the Shannon Bridge Crossing Route Selection Report in January of 2006. The following is a brief summary of the reasons for the choice of the Preferred Route Option. **Figure 4.3** in Volume 2 shows the Route Options under consideration. The routes were assessed under the following headings:

- Traffic
  Based on the traffic model developed during the Constraints Phase, the capacity of any candidate route to relieve traffic volumes and improve the level of services on the road network as a whole was assessed for each route.
- Engineering
  The technical feasibility of providing a crossing at each of the route locations was assessed, except for Route 8 north of Killaloe where there was insufficient traffic demand. All other routes were considered to be feasible, although there were technical advantages and disadvantages in each case.
- Economics
  A preliminary cost estimate was prepared for each proposed route (except Route 8). The value of the benefit to the traffic on the network was calculated for each route and the resulting benefit/cost ratio produced.

On the basis of this analysis those routes which were regarded as feasible, and which would meet the objectives of the project were shortlisted. It is evident that no single route would effectively relieve the problems at both O'Briensbridge / Montpelier and Killaloe / Ballina while providing cost effective improvement to the traffic network as a whole and thus the objectives of the project cannot be met by the provision of any single route. Route 1 provides maximum relief to O'Briensbridge/Montpelier, and Routes 6 and 7 provide maximum relief to Killaloe/Ballina, but route 6 and 7 offers significantly greater benefits to the traffic network as a whole than does Route 1. Routes 1, 6 and 7 are also the cheapest and most technically feasible of the eight routes considered. Routes 4 and 5, approximately equidistant between Killaloe and O'Briensbridge, cost nearly as much as the combined cost of both Route 1 and 7, but do not provide substantial relief to either of the existing bridges. Routes 2 and 3 provide inadequate relief to Killaloe / Ballina, and route 8 serves a similar function to Route 7 but much less effectively. Routes 1, 6 and 7 were consequently shortlisted. Route 7 consists of three sub options 7a, 7b and 7c, which have the same start and end points, but follow slightly differing horizontal alignments.

Route 6 and 7 are effectively the shortest routes for the project on the basis of a single crossing being provided or prioritised, due to the greater benefits which they offer over Route 1. Recognising that these routes would do little to relieve the critical situation at O'Briensbridge / Montpelier, Route 1 was also shortlisted for detail assessment with a view to recommending an additional crossing at this location.

A junction capacity test was undertaken at each end of the proposed route and showed that in each case, a priority junction would cope with the demand up to the year 2022. However, a roundabout has been proposed at the east end of Route 7 to facilitate the 4 way layout of this junction.

Shortlisted Routes

Routes 1, 6 and 7 were assessed in further detail, and ranked in preferences, in terms of the following criteria:

- Environmental
  The environmental impacts of the shortlisted routes were assessed in terms of ecology, noise, cultural heritage, underwater archaeology, landscape and visual, human environment and agriculture.
- Site Investigations
  Geotechnical and topographic surveys were conducted at each of the shortlisted routes. These investigations included a desktop assessment of the soils, geology and hydrogeology at the route locations.
- Structures
  A preliminary assessment of the options for bridge structures were undertaken for the shortlisted route (1, 6 and 7).

Conclusions

In terms of the shortlisted routes i.e. 1, 6, 7a, 7b and, 7c the following conclusions were made:

- It was evident that no single route would effectively relive the problems at both the O'Briensbridge / Montpelier and the Killaloe / Ballina locations;
- Route 1 would provide maximum relief to O'Briensbridge / Montpelier;
- Routes 6, 7a, 7b and 7c provide maximum relief to Killaloe / Ballina;
- Routes 6, 7a, 7b, and 7c offer significantly greater benefits to the traffic network as a whole compared to Route 1.

Recommendations

The various routes were assessed and ranked in terms of the criteria listed above and following evaluation of a multi criteria framework assessment of the routes, Route 7c was selected as the preferred route for the Shannon Bridge Crossing. The primary decisions for a Route 7c preference was due to its least impact on overall area of land acquired within the SAC, and preferred impact in terms of Landscape and Visual factors. While of the Option 7 group, Option 7c is the only option that results in the acquisition of residential property, alternative options impacted on either residential properties in part (Option 7b), including one planning application (Option 7a).

Killaloe Bypass

The assessment of the Route Options for the Killaloe Bypass was carried out in detail and reported in the Killaloe Bypass Route Selection Report in March of 2009. The following is a brief summary of the reasons for the choice of the Preferred Route Option. **Figure 4.5** in Volume 2 shows the Route Options under consideration. The routes were assessed under the following headings:

- Traffic;
- Engineering;
- Economics;
- Environment.

On the basis of this analysis those routes which were regarded as feasible, and which would meet the objectives of the project identified and outlined in **Section 2.2 and 2.3**. All route options commence at the north of the town and bypass Killaloe to the west before rejoining the R463 to the south.

Based on the analysis from the route selection report it was considered that Options D and E compared unfavourably to Options A, B and C.

Option D has a severe impact on the functionality of Ballyvally Demesne which is considered a significant issue from a historical and cultural perspective and also to have a negative impact on the surrounding landscape. Similarly Option E was considered to have a strong landscape and visual impact, together with possible difficulty with rock excavation both of which are of particular concern. For these reasons Options D and E were discounted from further consideration.

Although Route Options A, B and C offer broadly similar advantages, Option C differs considerably from Options A and B in that it severs the access avenue to Ballyvally House and separates it from the Gatelodge which is a listed structure. It is considered that such severance would seriously affect the character of the Demesne. For this reason, Option C was discounted from further consideration.

Option A was the shortest route and was also the least expensive of the options considered. Option B was slightly longer than Option A and further to the west at its southern end.

In terms of impacts on properties at the northern end, Option A impacts on a total of six dwellings as well as causing considerable disruption to existing households, Option B impacts on approximately the same number of dwellings in the area, generating an unacceptable impact from Option A and B on the community in the form of these dwellings.

Determination of the above has resulted in an emerging preferred route which comprised of Option B being amended so as to reduce the impact on dwellings to only one residence, combined with the southern portion of route Option A(See **Figure 4.6**). This option was brought forward to public consultation.

4.2.4 Public Consultation No. 3 (Emerging Preferred Route)

Public consultation No 3 was held in November 2008 and included consideration of the entire scheme for the Killaloe Bypass, Shannon Bridge Crossing and the R494 Improvement. The objectives were to:

- Present the emerging preferred route to the public;
- Further inform the public on the process and the programme for the project;
- Invite submissions on the emerging preferred route;
- Gather further local information;
- Answer questions from the public; and
- Consider and review the information received.

As with previous consultations advertisements were taken out in the Clare Champion and Nenagh Guardian in advance of the public consultation exhibition at the Lakeside Hotel. Consultation questionnaires and consultation leaflets were sent to interested parties and advertisements were broadcast on local radio. In addition Advertisement Posters advertising the Public Consultation exhibition were displayed in a number of locations including shops and pubs in Killaloe and Ballina. The consultation leaflets were also made available at Local Area offices for Clare and North Tipperary County Councils.

A total of 64 people signed the attendance sheet during the consultation process and 32 responses were received from the questionnaires.

Analysis of Responses and Comments from Members of the Public

All submissions received were evaluated and the information they contained was recorded. Where letters were received without questionnaires the details were recorded including any comments made. Any submission with information referring to any specialist area was copied to the relevant specialists or design team member e.g. landscape, planning archaeology etc.

The recorded comments from the members of the public were also collated. A summary of the issues arising, as relates to the Killaloe Bypass is presented as follows:

- Loss of residential property;
- Impact on wildlife;
- Impact on trees;
- Impact on emerging preferred route on views of the gate lodge and natural light;
- Traffic impact;
- Impact on watercourses;
- Impact on landscape;
- Noise impact, request of noise barriers, low noise road surfacing and ample landscaping;
- Safety concern;
- Impact on archaeology, architecture and cultural heritage;
- Proximity of emerging preferred route to town; and
- Loss and/or severance of agricultural land.

4.2.5 Additional Informal Consultations

Consultations have been held informally with a number of members of the public who are directly affected by the scheme throughout the project duration.

4.3 Development of the Preferred Route for the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement

The preferred route corridor for the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvements (**Figure 4.6)** as described above was taken forward and design developed for Compulsory Purchase Order and the EIS application. The alignments for each section of the scheme were chosen for a number of reasons including the following:

- Reduce the impact on environmentally sensitive areas;
- To minimise the environmental impacts arising from the scheme;
- To minimise the overall impact on landholdings;
- To take into account comments from the public.

As is the case in the design of road developments such as the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement, following the route selection process and during the design process a number of minor adjustments were made to the developing design to ensure the optimal alignment was achieved.

4.3.1 R494 Improvement

As part of the preliminary design process, some minor modifications were made to the proposed R494 Improvement design after the public consultation meetings.

Following consultations with some affected landowners, modifications were made to proposed access arrangements to some properties in the vicinity of Roolagh Junction as per resident's agreement.

Options were also considered in the vicinity of Garrynatineel, where the existing roadway traverses between the curtilages of Gortna House and Fort Henry estate. Both of these properties are listed on the National Inventory of Architectural Heritage (NIAH) and were noted to be present on the Ordnance Survey First Edition 6" series (1836-1846). In order to minimise the impact on the curtilage of Gortna House and avoid the loss of mature trees which form part of that curtilage, it was agreed to locally move the alignment westwards into the curtilage of Fort Henry estate, where the impact on mature trees was significantly less.

4.4 Shannon Bridge Options

A number of different bridge forms were considered for the selected Shannon crossing. In view of the size and visibility of the structure, the scenic location of the selected site and the historic nature of Killaloe / Ballina and its architecture, considerable attention was given to the form and detailing of the bridge. An assessment of the options was carried out to identify the best option for this scheme to progress to Design Stage.

Suspended Bridges

Suspended bridges make a significant impact on the landscape where they are employed. Despite the magnitude of the impact, it is usually a positive impact, and the structure becomes an iconic part of the landscape. However this project does not set out to make major architectural impact on the landscape, and given the scenic and natural character of the landscape and setting, any proposal which would increase the visual impact more than technically necessary, will be considered very cautiously.

In view of this it was recommended that any form of suspended bridge would not be appropriate in this case.

*Precast Beam and Slab Bridge (**Figure 4.7**)*

Precast beam and slab construction would be the simplest and most economical bridge design. This form of construction is typical of bridges constructed on new road works all over Ireland. This bridge design was considered unduly plain and lacking in architectural merit, to be regarded as a viable option for the sensitive landscape in which the bridge will be situated. This form of construction was therefore not considered further.

*In-situ/Precast Hybrid Bridge (**Figure 4.8**)*

A variation of the precast beam arrangement could be considered in which a short length of in-situ concrete deck is constructed at each pier, cantilevering out on each side. This form would therefore provide for longer and more elegant spans than the conventional precast beam form, would have fewer piers and would have the aesthetic advantage of having a curved soffit.

There is a distinct architectural advantage, in the case of a river bridge, in that the number of spans is an uneven number. This allows for a span, rather than a pier to be situated in the middle of the river which appears more natural. The span arrangement above while technically appropriate does not comply with this principle. It was also considered that although the longer spans and curved soffits of the hybrid arrangement are architecturally more desirable than those of the conventional precast beam the slab option, the hybrid arrangement would still be rather plain and may be subject to similar architectural criticism in relation to the site and the existing architecture as discussed above for the precast beam and slab option.

This form of construction was therefore considered to be possible but less than ideal option in this case.

*Balanced Cantilever Bridge (**Figure 4.9**)*

Balanced cantilever construction consists of a concrete box-girder deck constructed in-situ, in short sections, with travelling formwork units. A suitable arrangement would consist of a main span of 64m with two end spans of 52m, which provides for a span at midstream.

This method of construction has high establishment costs associated with the provision of the travelling formwork units and related systems. Consequently, the method becomes more economical as the bridge length increases and /or where a pair of decks is required. For a single deck of only 168m in length this method would be uneconomical in comparison to other bridges of this form. However, the cost premium would not be out of proportion to the architectural benefits and therefore this bridge form was considered a viable option in this case.

*Steel Composite Girder Bridge (**Figure 4.9**)*

A three span arrangement could be constructed using steel plate girders with an in-situ concrete slab, and a suitable span arrangement would be 52m-64m-52m, similar to the balanced cantilever arrangements.

This form of construction would have the architectural advantage of a low number of relatively long spans, which would have slender span-to-depth ratios, with curved soffits. However, the plate girders are not architecturally advantageous as features in themselves, and would not particularly relate to the sensitive and historic environment in which the proposed bridge is sited.

This form of construction would be more expensive than the precast beam or hybrid arrangements. However the cost premium would not be excessive or out of proportion to the architectural benefits discussed above. This bridge form was considered as a viable option in this case.

*Multiple Span Arch Bridge (**Figure 4.10**)*

The proposed site is appropriate for the provision of an arch bridge, in which the load bearing arch members are underneath the bridge deck.

It is considered here because the vertical alignment of the crossing is governed by the topography of the land on the east side of the river and the tie-in to the R494, rather than clearance requirements over the river. This results in the crossing having to be high above the river, over 10 meters at the eastern shore line. This provides suffices space for an arch without having to artificially raise the road alignment.

The arch members could be of steel or concrete, but for construction of 42 metre spans over water, a steel arch would be distinctly preferable, and a concrete arch was not considered.

4.4.1 Recommended Structure

Considering the bridge forms, a multiple span steel arch bridge was taken forward for design. The structure consists of a slender reinforced concrete deck supported on struts to structural steel arches under the deck. The tied arrangement results in the end spans being supported on half-arches, which results in these spans being half as long as the interior spans. Thus although it is a five span bridge, each interior span is a quarter of the overall length. It is considered that the arch form is classical and appealing which complements the historic ambiance of the area in general and reflects the arched form of the existing bridge in Killaloe / Ballina.

Chapter 5

Traffic Assessment

Chapter 5 Traffic Assessment

5.1 Introduction

This chapter presents the existing and forecast traffic patterns within the study area and predicts traffic impact in the area of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement.

The traffic predictions were carried out through the development of an S-Paramics microsimulation traffic model to assess the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 improvement.

5.2 Receiving Environment

5.2.1 Traffic Surveys

A series of traffic surveys including automatic traffic counts, junctions turning counts and number plate observation / origin-destination surveys were undertaken at a number of locations in and on the approaches to Killaloe and Ballina in 2008 and again in September 2011.

A summary of the 2011 traffic volumes at key locations is presented in Table 5.1 below.

Table 5.1 2011 Surveyed Traffic Volumes

Location	AM two-way vehicles per hour	PM two-way vehicles per hour	24 hour - Daily Traffic
Killaloe Bridge	552	559	6,798
R494 north of the R496	589	562	6,093
R463 south of Killaloe	251	242	2,648

The results of these traffic surveys indicate the following make-up of traffic in and around Killaloe / Ballina:

- Motor car 65%
- Light goods vehicles 27%
- Heavy goods vehicles 6%
- Agricultural tractors 1%
- Buses 1%

5.2.2 Killaloe Bridge Traffic Signals

The existing Killaloe Bridge has a 4.95 metres wide carriageway with a one-way shuttle arrangement controlled by traffic lights at either side of the bridge. Pedestrians share the bridge with vehicular traffic along the length of the bridge. The traffic signal shuttle system is controlled either side of the bridge at the following junctions:

- Killaloe Bridge/Bridge Street/Canal Bank/Royal Parade Junction; and
- Killaloe Bridge/Lakeside Drive Junction.

These traffic signals are MOVA operated, which optimises the signal timings based on real time traffic volumes. Observations at Killaloe Bridge recorded an average cycle time of 215 seconds (3 minutes 35 seconds) for the shuttle system, resulting in significant queuing and delays of up to 10 minutes where at busy times it can take 3 signal cycles for traffic to pass through **(Plates 5.1, 5.2 and 5.3)**.

Plate 5.1 Killaloe Bridge with delineated pedestrian walkway

Plate 5.2 View of the traffic signals at Killaloe Bridge from east side

Plate 5.3 Queuing extending south of Ballina along the R494 from traffic signals at Killaloe Bridge

5.2.3 Base Year Traffic Model (2011)

The main routes into and through the Killaloe / Ballina were modelled in the Paramics traffic model that was prepared to assess the proposed scheme. This Paramics model includes a traffic demand matrix created by combining the surveyed origin-destination data and the surveyed traffic flows that were obtained in 2011. The base year model was calibrated and validated to ensure it accurately represented the existing conditions.

5.2.4 Future Year Traffic Model (2017 and 2032)

In terms of the assessment of the proposed Killaloe Bypass, R494 Improvement and Shannon Bridge Crossing an opening year of 2017 and a 2032 design year is assumed.

Traffic growth factors were applied to convert the established 2011 'base' network flows to corresponding future year 'base' flows. For opening year traffic flows, the traffic volumes from the 2011 traffic survey were projected to 2017 using NRA traffic 'Medium Growth' factors from the NRA Project Appraisal Guidelines.

The Clare and North Tipperary County Development Plans for zonings for Killaloe & Ballina were assessed and the TRICS database of traffic surveys was used to create a projection of the traffic generated by the full development of the zoned lands. Additional traffic generated by the development of 50% of these lands was incorporated into the 2032 design year model.

5.3 Future Traffic Forecasts

5.3.1 Traffic Link Flows

Peak hourly traffic link flows on the simulated networks are shown in **Figures 5.1 to 5.4 inclusive**. Approximately 550 vehicles cross Killaloe Bridge during the peak hour in 2011.

Traffic volumes for the AM, PM and Annual Average Daily Traffic (AADT) for the base year of 2017, and the design year of 2032 respectively are shown in Tables 5.2 & 5.3 below for Killaloe Bridge, the R494 (to the south of the R494-R496 junction), the proposed Shannon Bridge and Killaloe Bypass.

Table 5.2 2017 Forecast Traffic Flows

	AM two-way vehicles per hour		PM two-way vehicles per hour		Average Annual Daily Traffic (AADT)	
	Do Minimum	Do Something	Do Minimum	Do Something	Do Minimum	Do Something
Killaloe Bridge	516	295	585	353	6,737	3,959
R494 south of the R496	442	467	411	415	4,515	4,669
Shannon Bridge	-	423	-	376	-	3,857
Killaloe Bypass	-	368	-	286	-	3,756

Table 5.3 2032 Forecast Traffic Flows

	AM two-way vehicles per hour		PM two-way vehicles per hour		Average Annual Daily Traffic (AADT)	
	Do Minimum	Do Something	Do Minimum	Do Something	Do Minimum	Do Something
Killaloe Bridge	555	342	664	409	7,459	4,595
R494 south of the R496	486	581	474	499	5,082	5,717
Shannon Bridge	-	489	-	459	-	4,400
Killaloe Bypass	-	428	-	342	-	4,068

The above results indicate that the proposed Killaloe Bypass, Shannon Bridge Crossing will remove 40% of the traffic from the Killaloe Bridge. The traffic that continues to use the Killaloe Bridge is local traffic. This significant reduction in traffic across and in the vicinity of the existing bridge will free up capacity for town centre activities including future development and will provide a much improved environment for pedestrians and cyclists in Killaloe and Ballina.

With the completion of the proposed Shannon bridge and bypass the 2032 design year traffic simulations shows significantly reduced queuing and delays at Killaloe Bridge when compared to the 2011 conditions, even after taking into account future traffic growth over this 20 year period.

The future models demonstrate significant savings in journey times through the Killaloe-Ballina area as a result of journeys that can avail of the proposed bridge crossing and bypass, avoiding Killaloe Bridge and the associated delays at the one-way shuttle traffic signal system. An example of this is traffic from the R494 north of Ballina travelling to the R463 south of Killaloe would save on average 7 minutes during the peak periods.

The traffic model data also indicates that the proportion of HGV on the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 improvement is 7.2%, which equated to diverting approximately 500 HGV's per day from Killaloe Bridge.

The above traffic volume estimates indicate that the proposed single carriageways for both the Killaloe Bypass and R494 Upgrade are adequate for the design year traffic volumes.

5.3.2 Junction Analysis

The proposed junctions where the bypass intersects the R463 both north and south of Killaloe and at the junction of the R494, R496 and the proposed bridge are designed as roundabouts to provide adequate capacity for the design year traffic volumes and also to provide a traffic calming gateway on the approaches to Killaloe and Ballina.

An ARCADY analysis of the roundabout proposed to replace the junction of the R494 & R496 shows that the roundabout will operate well within capacity during the peak hours in the future scenarios.

The two proposed junctions Killaloe Bypass at intersections with the local roads of Creeveroe Road and Hill Road are staggered priority junctions (ghost island and simple junctions respectively) which are considered adequate for the predicted design year traffic volumes.

5.4 Accident Analysis

Accident data has been obtained from the Shannon Bridge Crossing, Constraints Study Report, 2005 and the Ballina / Killaloe Traffic Management Strategy, 2003.

This data shows that a significant portion of accidents in the vicinity of Ballina and Killaloe occurred on the main approaches to the towns along the R463, R494 and R496 between the period of 1996 and 2002. Most of these accidents occurred along tight bends and blind corners, where there was evidence that speeding was a main factor.

The proposed road scheme includes the provision of roundabouts at the intersections with the existing regional roads at the R463 on the north and south side of Killaloe and at the intersection of the R494 and R496 on the south side of Ballina. These roundabouts will provide a traffic calming effect on the approaches to the towns.

Furthermore the reduction in through traffic at Killaloe and Ballina may result in a decrease in accidents in these urban areas.

Part II

Significant Environmental Effects and Proposed Mitigation Measures

Chapter 6

Human Beings

Chapter 6 Human Beings

This chapter addresses the likely significant effects of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement on human beings in the environs of the scheme. Human beings form one of the most important aspects of the environment to be addressed in an Environmental Impact Assessment, other chapters addressing the impacts of the proposed scheme on human beings include:

Chapter 7.3 Noise and Vibration
Chapter 7.4 Air Quality and Climate
Chapter 8 Landscape and Visual
Chapter 9 Material Assets

6.1 Methodology for Impact Assessment for Human Beings

Impacts for Human Beings are essentially related to the functioning of the community. The following assessment was carried out having regard to the guidelines for community effects given in Volume 11 “Environmental Assessment” of the UK Design Manual for Roads and Bridges (DMRB), and generally having regard to the Environmental Protection Agency published Advice Notes on Current Practice (2002) in the Preparation of Environmental Impact Statements and Guidelines on the Information to be Contained in Environmental Impact Statements along with National Roads Authority Guidance documents for Environmental Impact Assessment and Construction.

Potential impacts on communities are those that could cause change in the ‘quality of life’ as a consequence of the construction and operation of the proposed road. Such impacts include significant changes to local journey times, travel patterns and accessibility to local facilities, especially for pedestrians and cyclists, resulting in changes in community severance. Such changes may be either positive or negative. For example, removal of major traffic flows from an existing road can lead to an improvement in quality of life for residents. A new road may also either increase or decrease the journey distance to local facilities.

6.2 Receiving Environment for Human Beings

County Clare has a population of 116,885 (CSO Preliminary 2011) resulting in an increase in population of 5,935 people from the 2006 Census (5.3% increase). Approximately 1,819 people live in the town of Killaloe showing an increase of 14.5% since 2006 (population of 1,587 in 2006).

North Tipperary has shown an increase of 6.4% from a population of 66,023 to 70,219 people between 2006 and 2011. Ballina Electoral Division shows a 2011 population of 2,983 with an increase of 21.3% from 2,459 in 2006. Figures from the 2002 and 2006 census for Ballina Town show an increase in population from 1,158 and 1,861 respectively showing a significant population increase of 57% during this period

In terms of population and socio economics these towns should be considered collectively as both towns are interdependent in terms of socio-economic balance.

Linked physically by the existing Killaloe Bridge across the River Shannon, these settlements have a complementary nature. The towns have great historic value (see also **Chapter 10** Archaeology, Architecture and Cultural Heritage) and are located at the mouth of Lough Derg. The area is popular for fishing and boating and is located in an attractive landscape with a rich history. These factors result in a large number of visitors being attracted to the area.

While these figures do not attempt to predict future growth, they illustrate the recent expansion of Counties Clare and North Tipperary and illustrate that while the rate of growth is unlikely to continue, significant current and future increases in population are nevertheless likely to contribute to increased pressure on roads. Future traffic predictions are provided in **Chapter 5** of this report.

With increases in populations and traffic on the roads, both Clare and North Tipperary County Councils aim as part of their Development Plan, to ensure protection of the existing road infrastructure, while improving the capacity and safety of the road network, in order to meet the future demands. The development of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement is fundamental in achieving this.

In order to examine the impacts of the proposed development on the receiving environment for human beings, impacts are broken up into community categories.

The ‘community’ can be divided into three separate (not mutually exclusive) categories in defining likely community impact as follows:

- The resident community;
- The working community; and
- The visiting community.

6.2.1 The Resident Community

Killaloe / Ballina are located about 20 km northeast of Limerick City on the River Shannon, just south of Lough Derg. At this location, the River Shannon passes between the Slieve Bernagh Mountains to the west and the Arra Mountains to the east.

As with many other towns and villages in Ireland, Ballina and Killaloe are experiencing a high growth in traffic with limited associated upgrading of the public road infrastructure. The proximity to Limerick means they are within convenient commuting distance to the city. Ballina and Killaloe have grown as satellite towns due to their close links with Limerick. A large amount of land in Ballina is planned for future residential development with a lesser amount in Killaloe; Ballina has seen a significant increase in population in the last two census counts. Residential growth is further exacerbated by regional traffic that uses the bridge for more direct access between areas of west Clare and the northeast and also as a bypass of Limerick.

The provision of a cycleway in the region will seek to encourage local residents to make the change to more environmentally friendly mode of travel which will improve overall level of fitness and will improve the health and quality of life in the population.

The success of these towns and the surrounding hinterlands of west Clare is reliant on road infrastructure for intra and inter county movement and access. Growth in the Clare and North Tipperary population has resulted in an increase in the number of vehicles on the roads creating severe congestion particularly at peak times. In order to alleviate this and to protect and develop areas such as Killaloe / Ballina from urban generated and ribbon development while maintaining the identity of the towns the scheme is considered essential.

6.2.2 The Working Community

Rural Employment in Killaloe / Ballina and nearby villages of Scarriff and Tulla consists of agriculture in the surrounding hinterland. Retail, commercial, educational and community services serve as employment sources in the area along with tourism and associated services; and light industry along the R494. In addition the proximity to Limerick means that the towns are important locations in the commuter belt for those working within the city. All these activities are to varying degrees dependent on good quality and safe transport infrastructure. The poor road conditions at the existing Killaloe Bridge and narrow streets adversely affects businesses, particularly in terms of road safety and delays associated with the large volumes of through traffic that pass over the bridge. Heavy traffic flows in the towns constrain the potential of the local commercial and tourist facilities.

The proposed Scheme will become a key section of the regional road network connecting the towns and communities both sides of the River Shannon. The Limerick, Ennis and Shannon Region are locations of major employment and attract commuters from east Clare / North Tipperary who must cross the River Shannon at this location through Killaloe / Ballina, over the existing restricted Killaloe Bridge and along the substandard road infrastructure of the R494, which are both sources of traffic congestion and poor safety.

The proposed scheme will link into the proposed Nenagh to Limerick cycleroute. This link will seek to make cycling a more attractive mode of transport and reduce the amount of private vehicular transport.

6.2.3 The Visiting Community

Visitors are attracted to the Killaloe / Ballina area by the many significant local amenities and tourist sites such as Lough Derg and the Lower River Shannon, Brian Boru’s Fort (Beal Boru), St. Flannan’s Cathedral, St. Flannan’s Oratory, St. Molua’s Church, Templecheally and Tobermurragh (Murrough Wells), and The Lough Derg Way. Killaloe is an attractive historic town with a street vernacular of architectural merit. Killaloe / Ballina offer activities such as canoeing, leisure boating, fishing, horse riding and golf, locally or within a close distance. Killaloe/ Ballina is identified as an area with opportunity for development of quality settlement capable of capitalising on a diverse tourism product mixing cultural and historic assets with high quality landscape and recreational facilities in close proximity to major transport routes including the M7 serving Dublin and Limerick and Shannon Airport. During the summer months and at other holiday times the towns are at their busiest with a high influx of tourists. It is also during these times that there is a high level of regional holiday traffic converging at Killaloe Bridge resulting in severe traffic congestion.

Killaloe and its environs has been identified as a key strategic area in terms of links between towns such as Nenagh and the city of Limerick. The provision of the cycleway along this proposed route will seek to link the area to key towns such as those mentioned above. There is the potential for the area to be utilised keen cyclists through facilitating designated cycleways which will lead to increased safety.

The provision of linked up cycleways with the Nenagh to Limerick cycleroute and provision of pedestrian facilities throughout the town will also make the area more attractive to visitors.

6.3 Types of Community Impact

A road development of this nature could give rise to the following types of impacts for the community both positive and negative: -

- Closure of sections of roads and creation of cul-de-sacs, leading to changes in journey times;
- Change in traffic levels affecting residential and tourist amenity;
- Impact upon accessibility of local services and commercial facilities.

The key issue for the resident community is the potential for community severance arising from the proposed road. Community Severance can be defined as *'The separation of residents from facilities and services they use within their community caused by new or improved roads or by changes in traffic flows'.* (DMRB, Volume 11, 1993).

6.3.1 Types of Construction Phase Community Impacts

Construction traffic has the potential to impact upon the existing community depending on its frequency, volume and routing. Many of these impacts are minor for the population in the area surrounding the proposed scheme. There will be some properties located in close proximity to the scheme and construction works will affect these more significantly.

Community severance during the construction period would mostly arise from temporary road closures and traffic diversions.

6.3.2 Types of Operational Phase Community Impacts

The provision of the Scheme will greatly reduce traffic flows on the existing route, with resultant significant positive benefits for the community. There may however, be some sections of existing road that will carry more traffic as a result of the reorganisation of the local road network, and depending on the scale of increase in traffic flow this can have a negative impact on the community along that particular route. However the provision of improved safety measures will outweight this consideration.

Accessibility to local services and commercial facilities will improve with removal of large volumes of through traffic as a result of the proposed scheme. It will become easier for people to park along streets where traffic flows are reduced, and likewise pedestrians will find it easier to cross the road and Killaloe Bridge. Reduced traffic flows will generally improve the quality of a street environment and allow for greater community interaction. Similarly for residential communities along a busy road, the removal of through traffic will greatly improve the residential amenity.

6.4 Potential Impact of the Proposed Scheme on the Community

6.4.1 Potential Impact for the Community (General) – Construction Phase

The Construction Phase and Traffic management for the scheme will affect community severance to varying degrees.

Full details of the traffic management measures will be required. There will inevitably be some impact for the local community, especially for those who use the R494 road that is to be upgraded as part of the scheme.

Traffic management measures during the construction phase will result in road closures and diversions. One-way shuttle operations / diversions routes will be required for the R494 during the construction phase.

Disruption can be expected for the construction of the at-grade roundabout at the R494 / R496 Roolagh Junction.

The Kilmastulla River Bridge replacement can be largely constructed off-line, thus minimising the impact on the existing road network. It is not proposed to demolish the existing road bridge here.

The railway bridge replacement and associated works will require construction on-line and as such will require a road closure for a period of up to 9 months. During these works, an alternative diversion route, utilising the existing R496 will be necessary, with provision for local access only on the R494.

The Shannon Bridge Crossing will be carried out largely off line in greenfield areas. The route will cross a private road at Moys which provides residential access to a number of houses. This road will be provided with a cul-de-sac where it crosses the proposed route. A small number of residents will experience minor delays while provision of a new access is made at the R463 junction with the proposed Scheme.

In general, the Killaloe Bypass traverses green field sites and can be constructed without significant impact on the existing road network. At the termination points of this section of the Scheme, the tie-ins to the existing R463 will require careful traffic management planning to ensure that the impact on the existing regional road traffic is minimised.

In addition, the Killaloe Bypass mainline intercepts the following local roads, Hill Road (L3078) and Creeveroe Road (L3076). Both of these local roads are proposed to be re-aligned as part of the Works; off-line construction of the re-aligned sections will enable them to be constructed without significant impact on the existing road network, apart from the tie-in points which will cause some limited disruption.

Construction traffic will result in heavy vehicles using the main road network in the vicinity of Killaloe and Ballina. As several of the Local Roads are not suitable for use by construction traffic, these roads will be closed to heavy vehicles associated with the construction works.

6.4.2 Potential Impact for the Resident Community – Operational Phase

The resident community will experience reduced travel times and safer driving conditions along the length of the proposed bypass. This will arise from the journeys availing of the bypass and bridge crossing compared to journeys through the towns and over the existing bridge. Removal of Heavy Goods Vehicle (HGV) traffic from the route over the existing bridge will greatly improve the journey times and safety issues currently managed through the shuttle traffic signal system. Travel through Killaloe / Ballina for local trips will also improve by reduced traffic demand at the traffic signals on the bridge. These are considered as significant positive impacts.

The residents of the houses along the existing R494, within Killaloe town and along the R463 that will be bypassed by the proposed scheme will enjoy considerably lower traffic flows through the area, and this will enhance their residential amenity. There will be improved parking opportunity as a result of considerable reductions in HGV traffic though the towns.

The opportunity for enhanced amenity in the form of footpaths and cyclepaths along the Killaloe Bypass, Shannon Bridge Crossing and the R494 for residents and amenity users is being availed of by this scheme. The provision of pedestrian facilities, along with reduced congestion within the towns, provides potential walking routes as part of a walking circuit around Killaloe / Ballina.

Residents along the proposed Killaloe Bypass and Shannon River Crossing will experience an altered environment with the presence of a road and/or bridge where there was none before. Likewise residents along the R494 will experience some alterations to the surrounding environment. This can especially be seen were junctions and roundabouts are provided. The impacts of this on human beings are further discussed in **Chapter 7.3 Noise and Vibration** and **Chapter 8 Landscape and Visual.**

The proposed Shannon Bridge Crossing crosses two local roads between chainage 0+400 S and chainage 0+450 S; leading to Clarisford Palace and private dwellings; both these roads will be realigned to form a single T-junction with the mainline. The local road running north south though Moys will become a cul-de-sac. There will be increased journey times associated with the discontinuation of the road at Moys for residents to the south of the proposed scheme. The increased journey distance is considered minor and will be approximately 300m in length and is considered to be a minor negative impact.

A set-down area is to be provided at the townland of Moys for St. Anne's Community College for vehicles to facilitate the drop off of students.

6.4.3 Potential Impact for the Working Community

The working community in Killaloe / Ballina will experience improved access and an improvement in the quality of life whilst also benefiting from a higher quality road and safer road access to the rest of the country. HGV's from local businesses will be able to avoid the town and bridge and the associated difficult driving conditions. For longer distance commuters who pass through Killaloe / Ballina to and from west Clare, the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement will provide a faster and safer route than the existing road network. The provision of improved walking and cyclists facilities along the route will provide opportunity for sustainable modes of transport for the working community.

6.4.4 Potential Impact for the Visiting Community

In common with the working community, the visiting community will benefit from the improved accessibility to and within the area. Reduced journey times and congestion leading to improved road safety will provide a significant positive impact for visitors travelling along the route.

6.4.5 'Do-Nothing' Impact

The 'do-nothing' impact in this case would maintain the existing situation of a substandard Regional Route, with tight bends which also pass through a heritage town. There would continue to be delays due to traffic signals on the existing Killaloe Bridge and the narrow streets of Killaloe town. Traffic demand will continue to grow in the future and the existing traffic and safety problems will worsen over time as a result.

The quality of the environment in Killaloe / Ballina will further deteriorate, as traffic flows increase in the future and this will adversely affect the community in the towns.

It is considered therefore that there would be significant negative impacts for all sections of the community in the Do-Nothing scenario.

6.5 Mitigation Measures for the Community

6.5.1 Construction Phase Mitigation Measures for Community Impacts

Appropriate traffic management measures will be undertaken during the construction period to ensure that any adverse impact in terms of local community severance, by reason of diversions etc. is kept to a minimum.

The contractor for the scheme will prepare a detailed Traffic Management Plan for the approval of the road authority prior to commencement of the works. The contract for the scheme will seek to minimise traffic disruption, but there will inevitably be some impact for the local community, especially for those who use minor local roads that cross the scheme, at junction tie-ins and along the R494 during improvement works.

The traffic management measures incorporated within the Traffic Management Plan will ensure measures to maintain all road and access affected by the works, or their replacements, and maintain traffic flows and existing accesses until such times as the permanent works have been completed.

Construction traffic will be limited to regional roads and will not be permitted to use the existing Killaloe Bridge. Local Roads, where possible, will be closed to heavy vehicles associated with the construction works.

Where temporary road closures and diversions occur, direct access across the works site will be retained for pedestrians and cyclists who otherwise would be severely affected by the scheme. This can be achieved through a number of measures such as on request pedestrian traffic lights where required.

Where road closures are required, in order to reduce community severance the contractor will be required to provide advance public notification of pending road closures.

6.5.2 Operational Phase Mitigation Measures Community Impacts

The proposed development will have many significant positive impacts in terms of its effect on the local and wider community. There are no major remedial and mitigation measures required to minimise community severance as all practical provision has been made in the design of the scheme through route selection and maintenance of the existing road network with minimal diversion and disruption.

Along the Killaloe Bypass, the Shannon Bridge Crossing and a section of the upgraded R494, a footpath and street lighting will be provided. Cycle tracks will be provided throughout the length of the scheme and in the case of the R494 Improvement the cycle facilities will be combined with facilities to accommodate pedestrians. Public lighting will also be provided in the vicinity of the R494 / R496 (Roolagh) junction. This measure will improve pedestrian safety and provide opportunity for new walking and cycling circuits of the town and its environs.

6.6 Predicted Impact of the Proposal on the Community

This section discusses the predicted impacts of the proposed Scheme on the community with mitigation measures in place. This is done for both the construction phase and the operational phase.

6.6.1 Predicted Construction Phase Impacts for Community

Minor delays due to traffic management and diversions will arise for the local community during the construction phase, but these will be minimised through provisions in the construction contract. There are likely to be noise and dust related impacts associated with the construction works; however these will be kept to a minimum and are further discussed in **Section 7.3 and 7.4 of Chapter 7**.

Increased job opportunities will arise during the construction phase, which will have a short term positive impact for the working community, including local service providers, who may experience increased trade from workers during the construction phase.

6.6.2 Predicted Operational Phase Impacts for Community

The proposed Scheme has been designed to minimise disruption to local communities in terms of nuisance and potential severance. Any potential adverse impact to individual properties as a result of necessary revised access arrangements will be generally outweighed by proximity to a significantly improved regional route. The existing Killaloe Bridge and approaches will become safer as a result of the scheme and there will be more efficient operating conditions through diversion of through traffic. In particular there will be significant reductions in journey times and traffic safety benefit from the scheme. In general the community in Killaloe / Ballina and its hinterlands will benefit from greatly improved ease and safety of movement as a result of the scheme.

It is considered that the proposed scheme will have a positive overall residual impact for the residential, working and visiting sectors of the community.

Chapter 7

The Natural Environment

Chapter 7 The Natural Environment

7.1 Introduction

The issues that are addressed in this chapter of the Environmental Impact Statement are as follows:

7.2 Flora and Fauna

7.3 Noise & Vibration

7.4 Air Quality and Climate

7.5 Hydrology and Hydrogeology

7.6 Soils & Geology

7.2 Flora and Fauna

7.2.1 Introduction

This report provides an assessment of the likely impacts of the proposed development of the Killaloe Bypass Shannon Bridge Crossing and R494 Improvement on the ecological environment (i.e. flora, fauna and habitats).

This report has been prepared in compliance with the Environmental Protection Agency's *Guidelines on the Information to be Contained in Environmental Impact Statements* (EPA, 2002) as well as the National Roads Authority Environmental and Planning Construction Guidelines including:

- *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (2008),
- *Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes* (2006),
- *Guidelines for the Treatment of Bats during the Construction of National Road Schemes* (2006),
- *Guidelines for Treatment of Otters prior to the Construction of National Road Schemes* (2008),
- *Guidelines for the Treatment of Badgers Prior to the Construction of a National Road Scheme, Guidelines for the Crossing of Watercourses during the Construction of National Road Schemes* (2008),
- *Guidelines for Assessment of Ecological Impacts on National Road Schemes* (Rev 2, June 2009),
- *Ecological Surveying Techniques for Protected Flora and Fauna during Planning of National Road Schemes* (2004).

7.2.2 Survey Methodology

Desk Study

A desk study was undertaken to determine the proximity of the route to designated areas for conservation utilising the National Parks and Wildlife Service (NPWS) website database. Site synopses were reviewed to identify qualifying interests. The NPWS database was also consulted regarding the occurrence of protected species of flora and fauna in the vicinity of the proposed route. Consultations were carried out with the NPWS and Inland Fisheries Ireland (Shannon Region) requesting information on protected species and habitats within the study area as well as comment on the proposed project in relation to survey, assessment and specific mitigation requirements.

A review of aerial photography (2004) over the entire route was undertaken to prepare a preliminary habitat map along the route and to identify potentially ecologically important habitats. The review also aimed to determine the proximity of the proposed route to ecologically important sites in the general vicinity that may be subject to indirect impacts through severance of connecting corridors, pollution run-off during construction, etc. Existing sources of information and records on ecological interests were sourced and reviewed. This included an earlier aquatic (dive) survey undertaken in 2008 looking specifically at the aquatic environment in the vicinity of the proposed Shannon Bridge Crossing.

Field Survey

Following on from the desk study, a series of site surveys were undertaken over the summer of 2009 to survey and map the habitats along the proposed route using the Heritage Council Classification (Fossitt, 2000) and using techniques as prescribed in *Ecological Survey Techniques for Protected Flora and Fauna* (NRA, 2008). While this did not entail compiling detailed species lists for each habitat type encountered, the suite of species characteristic to each habitat were recorded and checks were made for rare or unusual species, including any species noted in the NPWS database or listed as qualifying interest for the Lower River Shannon SAC.

A further survey was undertaken in December 2011 to determine whether any of the ecological sites had been subject to significant change over the intervening period between initial survey and publication of the EIS.

A specific snorkel survey was carried out in the canal over a 150m zone centred on the proposed bridge to specifically check for the presence of the Flora Protection Order (1999) listed species opposite-leaved pondweed (*Groenlandia densa*).

An aquatic ecological assessment was previously undertaken by EirEco Environmental Consultants on behalf of Roughan O'Donovan Consulting Engineers for a proposed bridge crossing of the River Shannon at Killaloe in 2008. The survey targeted specifically the presence or suitability of the river in the vicinity of the proposed bridge as spawning habitat for the internationally rare pollan (*Coregonus autumnalis*). The survey was undertaken in August 2008 using SCUBA. A team of three divers undertook the survey fulfilling the roles of scientific diver, standby diver and dive supervisor / boat cox'n. A series of transects were established at points 50m upstream of the proposed crossing point, along the crossing point, and at distances 50m, 100m and 150m downstream. Two divers then undertook a survey along each transect by following the weighted line. A series of data was recorded on a diver's slate including substrate, depth, macrophyte and algal growth, and notes on any of the target species or other species of note. The presence of potentially suitable spawning habitat for pollan was recorded. Areas of gravels were mapped, the characteristics of the gravels described (including size, depth, algal cover, etc) and photographed. A series of photographs were taken along each transect using a Sea and Sea Richo camera (DX-1G) with a Marine housing Pro50 with external fibre optic armed strobe. Throughout the survey, evidence of freshwater crayfish was looked for in clumps of vegetation, amongst rocks and after the dive survey, amongst the drift line along the shore.

Birds were assessed during the course of the main habitat surveys. A dedicated large mammal survey was carried out during the months of November and December using techniques as prescribed in *Ecological Survey Techniques for Protected Flora and Fauna* (NRA, 2008). This entailed searching for and identification of signs, tracks and droppings of the various mammal (otter, badger, pine marten, Irish stoat, Irish hare, red squirrel, hedgehog and pygmy shrew along with non-native species such as fallow deer, American mink, grey squirrel and rabbit) species in a bank of 300m either side of the road corridor. Badger setts, trails and foraging areas were looked for along the route and within the survey area. Aquatic habitats crossed or in the vicinity of the route were surveyed for the presence of and suitability for otter, including holts and other signs of activity such as couches, trails and slides. The result of this survey is used to inform the location and detailed design of mitigation measures including mammal passage facilities and guide fencing.

Bat Survey

A four season bat survey was carried out throughout 2009. In advance of the survey a review of known bat roosts and bat activity within 10km of the proposed route was conducted using the Bat Conservation Ireland database. Other bat specialists including members of Bat Conservation Ireland and the local Conservation Ranger with the National Parks and Wildlife Service were contacted regarding any surveys or detector work that they had carried out in the area.

The survey began with the winter survey, on the 25th and 26th March 2009. During this time the majority of the route was walked, with some lands not covered due to difficulties with gaining permission for access. Where access was not provided the land was viewed with binoculars from both ends to provide an indication of the habitat type along with assessment of OSI aerial photography. All mature trees were assessed for their potential to support roosting bats. An assessment of bridges in close proximity to the proposed route was also conducted, where bridges were inspected for the presence of hibernating bats and their potential to support roosting bats. Due to poor weather conditions and low temperatures the spring survey was postponed until the end of May 2009 (26th, 27th and 28th) as bat activity levels had remained low in the spring with many bats remaining in hibernation. The summer survey was conducted on the 24th, 25th, 26th, 27th and 28th August 2009, which is within the period of high activity for bats. Mating behaviour of bats was detected on the 26th, 27th and 28th September 2009 during the autumn survey.

Reporting

The evaluation of the ecological environment and the criteria used to assess the significance of impacts are derived from the *Guidelines for Assessment of Ecological Impacts on National Road Schemes* (NRA, Rev. 2, 2009). Reporting is in compliance with *Environmental Impact Assessment of National Road Schemes – A Practical Guide* (NRA, Rev1, 2008).

Mitigation proposals are based on the pertinent National Roads Authority construction guidance documents pertaining to the natural environment.

7.2.3 Receiving Environment

General Description of the Study Area

The scheme involves the upgrade of the existing R494 from the R445 east of Birdhill to the junction with the R496 at Ballina. The route will deviate off the existing road to cross the Kilmastulla River approximately 20m upstream (east) of the existing bridge and a section of new road will be required to tie-in to the north and south. Much of this R494 is lined with tree and hedgerows, with some more extensive blocks of woodland in the north towards Ballina. The road crosses a minor stream immediately north of the R445 junction, the Kilmastulla River, the Kilmaglasderry River and a second minor stream along this section.

The proposed crossing of the River Shannon is located immediately west of the intersection between the R494 and R496 where it will cross a small field with a fringe of mature trees backed by scrub-woodland along the banks of the Shannon. The river at this point is approximately 146m in width with a depth ranging between 3 and 7m. The flow is predominantly swift glide though along the eastern bank there are areas of slack flow with accumulated soft sediments. The western bank is formed by a linear tree-lined island, which separates the river from a canal bypassing the existing bridge further upstream. West of the canal the river bank is lined with mature beech trees along an elevated strip, backed by an area of wet alder-willow woodland.

Thereafter, the proposed route skirts to the west of the built environment of Killaloe crossing a mixture of improved and unimproved pasture divided by hedgerows and treelines, some small areas of mixed woodland and scrub, and to the north at Ballyvally a strip of mature deciduous woodland. It joins the R463 at Kincora near the entrance to the Ballyvally Estate where the road is flanked by mixed woodland and mature trees. Three minor streams are crossed along this stretch of the proposed route.

Designated Areas and Protected Species

Designated Areas

The river downstream of the Killaloe Bridge forms part of the Lower River Shannon SAC (site code no. 002165) which extends to include the entire Shannon Estuary as far as Kerry and Loop Head. The Lower River Shannon SAC is selected for a large number of habitats and species listed under the EU Habitats Directive including lagoons, alluvial wet woodlands, floating river vegetation, Molinia meadows, estuaries, tidal mudflats, Atlantic salt meadows, Mediterranean salt meadows, Salicornia mudflats, sand banks, perennial vegetation of stony banks, sea cliffs, reefs and large shallow inlets and bays - all habitats listed on Annex I of the E.U. Habitats Directive (refer to **Figure 7.2.1** Conservation Designation, Volume 2). The site is also selected for the following species listed on Annex II of the same directive – Bottle-nosed Dolphin, Sea Lamprey, River Lamprey, Brook Lamprey, Freshwater Pearl Mussel, Atlantic salmon and Otter.

Lough Derg is a proposed Natural Heritage Area (pNHA) (Site code No. 000011) and a designated Special Protection Area (site code no. 4058), the boundaries of which commence upstream of the existing Killaloe Bridge. The site is of significant ecological interest as it supports a number of habitats listed on Annex I of the EU Habitats Directive, four of which are priority habitats – alluvial woodland, yew woodland, Cladium fen and petrifying springs. These priority habitats are found mainly at the north and north east of the lake though alluvial woodland has a wider distribution around the lake. Other annexed habitats present include alkaline fen and Juniper scrub formations on heath and calcareous grasslands. The site has been designated as an SPA as it supports important numbers of wintering wildfowl including Greenland white-fronted geese (*Anser albifrons flavirostris*), common terns (*Sterna hirundo*) and cormorants (*Phalacrocorax carbo*). Both the Greenland white-fronted geese and terns are listed under Annex I of the Birds Directive.

Protected Flora

The Flora Protection Order (1999) listed opposite-leaved pondweed (*Groenlandia densa*) is recorded from the Killaloe canal on the north side of the River Shannon (grid ref R701728) (NPWS database). A specific snorkel survey was undertaken in the canal over a 150m zone centred on the proposed bridge to check for the plant. The survey failed to find any evidence of the plant. The stretch of canal in the vicinity is quite heavily shaded and appears unsuited for opposite-leaved pondweed.

No other protected species of plant have been recorded from the 10km squares in which the proposed road is located.

Protected Fauna

The River Shannon supports populations of salmon (*Salmo salar*), sea lamprey (*Petromyzon marinus*), river lamprey (*Lampetra fluviatilis*) and brook lamprey (*L. planeri),* all of which are listed in Annex II of the EU Habitats Directive and have been recorded from Lough Derg. The existence of a landlocked River Lamprey population within the lake is suspected; normally this species spends its adult life in estuarine waters before migrating upstream to spawn. The stretch of river within the vicinity of the proposed bridge does not provide suitable spawning conditions for salmon or lamprey species despite the presence of suitable substrate due to the depth and flow regime. Lamprey ammocoetes may however utilize the soft sediments along the eastern shore.

The internationally rare pollan (*Coregonus autumnalis*) is listed on Annex V of the EU Habitats Directive (92/43/EEC) and is listed in the Irish Red Data Book as Endangered. The European population is confined to four large lakes in Ireland Lough Neagh, Lower Lough Erne, Lough Ree and Lough Derg. Gravel beds along the western third of the river within the vicinity of the proposed bridge location may support spawning by pollan.

Salmon also occur in the Kilmastulla River and potential spawning conditions exist from approx 100m downstream of the existing R494 bridge. The Kilmastulla may also support lamprey species.

The otter (*Lutra lutra*), protected under Annex II of the EU Habitats Directive, and kingfisher (*Alcedo athis*), listed under Annex I EU Birds Directive are both common and widespread along the River Shannon in the vicinity of the proposed crossing. Both species occur on the Kilmastulla River and a breeding kingfisher hole occurs a short distance downstream of the existing bridge on the R494 (c. 150m). An adult bird was observed in flight at this point in September 2009. Regular movement of both species is likely along the Kilmaglassderry Stream though no evidence of either was recorded during the field survey. The Kilmaglassderry supports a stock of brown trout along with other fish species which would entice both species for foraging. There are no records of freshwater crayfish (*Austropotamobius pallipes*) from the area.

Bats

The proposed route is within the known range of the lesser horseshoe bat – this species is restricted in its distribution to the west of Ireland and is found in Counties Mayo, Galway, Clare, Limerick, Kerry and Cork. This species is given additional protection under Annex II of the EU Habitats which requires member states to designate Special Areas of Conservation for the species.

No records of any lesser horseshoe bat roosts are located within 10km of Killaloe town. The closest known lesser horseshoe roost is at Sixmilebridge some 23km to the south-west of Killaloe.

The rare Nathusius' pipistrelle (*Pipistrellus nathusii*) has at present not been recorded from Co. Clare (Bat Conservation Ireland database) but was recorded from Co. Tipperary during bat surveys conducted for the N7 Nenagh to Limerick road scheme.

All Irish species of bats are strictly protected.

Surveys of bats roosting/mating areas recorded within 1km of the route

Table 7.2.1 outlines all potential and confirmed bat roosts and mating areas recorded within 1km of the route.

Table 7.2.1 Potential and confirmed bat roosts/mating areas recorded within 1km of the route (See Figures 7.2.6 and 7.2.7)

Chainage	Description and location	Distance from the CPO	Bat species recorded in area	Potential/confirmed bat roosts	Importance for bats
0+000 K	Gate lodge, Ballyvally Estate	c.50m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential roost in gate lodge, mating roost in close vicinity	High - confirmed roost
0+200 K	Private residence, Ballyvally Estate	c.180m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Possible Plecotus auritus*	Confirmed roost – likely to be maternity roost for pipistrelles, mating roost	High - confirmed roost
0+275 K	Mature treeline between property and Ballyvally	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Mating roost, potential tree roost	High – mating area
0+275 K	Private residence	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Confirmed soprano pipistrelle maternity roost, mating roost for common and soprano pipistrelles	High - confirmed roost
0+280 K	Private residence	50m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Confirmed roost of a unidentified Pipistrellus sp.	High – confirmed roost
0+400 K	Woodpiles at rear of private residence	10m	*Unidentified species*	Hibernation roost	High – hibernation roost
1+100 K	Local road at Knockyclovaun	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Mating activity	High – mating roost
1+100 K	Private residence	50m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Likely soprano pipistrelle roost	Unconfirmed roost
1+100 K	Shed/Garage	Online	*Pipistrellus pygmaeus*	Confirmed soprano pipistrelle roost	High - confirmed roost
1+105 K	Treeline	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential tree roost	High – good levels of activity in the area, near confirmed roost
2+000 K	Local road	Online	*Pipistrellus pipistrellus*	Mating roost	Medium
0+130 S	Treeline of mature beech at R 700 720	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential tree roost	High – good roosting potential
0+100 – 0+420 S	Area of mixed broadleaved woodland with treeline of old mature trees	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Plecotus auritus* *Nyctalus leisleri*	Potential tree roosts	High – good roosting potential

Chainage	Description and location	Distance from the CPO	Bat species recorded in area	Potential/confirmed bat roosts	Importance for bats
0+475 S	Private residence	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Myotis daubentonii* *Myotis nattereri* *Myotis mystacinus/brandtii* *Plecotus auritus*	Confirmed brown long-eared and soprano pipistrelle roost, mating roost, good diversity of species recorded	High – confirmed roost for two species
0+400 S	Private residence, Clarisford Palace	160m	*Plecotus auritus*	Confirmed minor roost	High – confirmed roost
0+600 S	Treeline in private residence	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Myotis daubentonii*	Potential tree roost	High – close to know roost
0+840 S	Treeline near proposed crossing on island	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Myotis daubentonii*	Potential tree roost	High – adjoining good foraging habitat
0+620 S	Grounds of private property	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Mating roost	High – good diversity of bats present
0+500 R	Mature tree	Close to CPO	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential tree roost	Moderate
0+750 R	Mature beech, sycamore and Scot's pine treeline	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Mating roost	High – confirmed mating roost
0+750 R	Mature beech, sycamore and Scot's pine treeline	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential tree roost	High – potential tree roost
2+400 R	Agricultural outbuilding	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Minor pipistrelle roost	High – confirmed roost
2+600 R	Stone culvert below R494	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential hibernation roost	High
2+600 R	Cool Bridge	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Potential hibernation roost	High
3+050 R	Dooly's Bridge	Online	*Pipistrellus pipistrellus*	Potential minor roost	Low

<u>Survey of areas of importance for commuting routes and feeding areas</u>

Other areas that were surveyed included all the crossing points of the proposed route with the existing network of roads and watercourses between the southern end of the proposed bypass at Birdhill and at the northern end of the proposed bypass at Ballyvally.

The key locations of importance for bats for foraging and commuting along the route are depicted on **Figures 7.2.6 and 7.2.7** and include watercourses, treelines, scrub, wet grassland, immature woodland and mixed broadleaved woodland.

Confirmed bat species present

The survey of the various locations along the proposed route and in the surrounding area reveals that a minimum of seven species of bat were recorded in the general area of the route between the townlands of Ballyvally and Gortybrigane near the N7 intersection.

These include: common pipistrelle (*Pipistrellus pipistrellus*), soprano pipistrelle (*Pipistrellus pygmaeus*), Leisler's (*Nyctalus leisleri*), Daubenton's (*Myotis daubentonii*), Natterer's (*Myotis nattereri*), Whiskered/Brandt's (*Myotis mystacinus/ brandtii),* and brown long eared bat (*Plecotus auritus*). A *Myotis* species was detected several times but could not be determined to species level and may be Natterer's, Whiskered or Brandt's.

Table 7.2.2 Areas of importance as commuting routes and feeding areas for bats within 1km of the route (See Figures 7.2.6 and 7.2.7).

Ref. No.	Chainage	Location	Distance from the CPO	Bat species recorded in area	Importance for bats
1	0+000 k	R463 main road below Ballyvally Estate	c.50m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Myotis mystacinus/brandtii*	Frequent foraging along the R463. Potential roost in gate lodge, mating roost in close vicinity
6	0+200 K	Private residence, Ballyvally Estate	c.180m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Confirmed roost – likely to be maternity roost for pipistrelles, mating roost
4	0+275 K	Private residence	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Foraging and commuting activity from and returning to roost
16a	1+100 K	Local road at Knockyclovaun	Online	*Pipistrellus pygmaeus* *Pipistrellus pipistrellus*	Medium – good levels of foraging activity
18	1+500 K	Local road at Shantraud	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	High – good foraging area and commuting route
19	2+000 K	R463 at Shantraud	Online	*Pipistrellus pipistrellus*	Medium – good levels of foraging activity
30	0+400 K	Private residence, Clarisford Palace	160m	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri* *Plecotus auritus*	High – rich foraging and commuting area for good diversity of bat species, confirmed roost nearby
28	0+300 S	Wooded area near Clarisford Palace	Online	*Plecotus auritus* *Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	High – rich foraging area for good diversity of species

Ref. No.	Chainage	Location	Distance from the CPO	Bat species recorded in area	Importance for bats
29	0+475 S	Private residence	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Plecotus auritus* *Nyctalus leisleri* *Myotis daubentonii* *Myotis nattereri* *Myotis mystacinus/brandtii*	High – rich diversity of species, excellent foraging habitat
33	0+800 S – 0+900 S	River Shannon crossing point – Ballina side	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Myotis daubentonii*	High – only three species recorded here but likely to be used by others
37	0+500 R south to 0+800 R	R 494 Ballina – Birdhill road	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus* *Nyctalus leisleri*	Locally important corridor for foraging bats, potential tree roosts in the vicinity
38	1+100 R	Side road to R494 Ballina – Birdhill road	Offline	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Commuting route for 2 pipistrelle species along watercourse
39	2+300 R south to 2+750 R	R 494 Ballina – Birdhill road near Cool Bridge	Online	*Pipistrellus pipistrellus* *Pipistrellus pygmaeus*	Locally important corridor for foraging bats from roost to Kilmastulla River at Cool Bridge

Habitats

The distributions of habitats along the proposed road are described below and shown in **Figures 7.2.2** to **7.2.5.**

Grasslands

Grassland areas impacted by the proposed scheme are confined mainly to the west of the Shannon crossing as the section along the R494 will entail widening of the existing carriageway and thus primarily impact upon fringing hedgerows and treelines. An exception occurs in the vicinity of the Kilmastulla River where a narrow fringe of wet grassland (GS4) occurs on the south of the river at Cool Bridge (chainage 2+640 R – 2+690 R). Part of this grassland is within the Lower River Shannon SAC (a strip of approx 15m south of the River). The species composition is dominated by flag iris *(Iris pseudacorus*) and creeping bent (*Agrostis stolonifera*). The grassland grades to dry meadow (GS2) further south with tussocky species such as cocksfoot (*Dactylis glomerata*) and oat-grass (*Arrenatherum elatius*).

The majority of grasslands west of the Shannon are improved agricultural pasture (GA1) which are typically species poor and of limited ecological value. The diversity of species reflects typically the wetness of the soil and the level of management applied, with some areas supporting ruderal species such as thistles (*Cirsium* spp.), docks (*Rumex* spp.) and nettles (*Urtica dioica*) or indicators of wetness such as rushes (*Juncus* spp.) and buttercup (*Ranunculus repens*).

An area of wet grassland (GS4) occurs between chainage 0+130 S – 0+300 S to the north of Clarisford House. The species composition is limited with evidence of past reseeding suggested by the presence of perennial ryegrass (*Lolium perenne*) and red clover (*Trifolium repens*). The sward is dominated however by rushes (*Juncus* spp.), creeping buttercup (*Ranunculus repens*), spearwort (*R. flammula*), trefoil (*Lotus uliginosus*) and *Calliergon* moss.

Further west of the R463 an area of abandoned grassland occurs from chainage 1+870 K - 2+020 K. This grades from being wet grassland in the east to humid acid grassland (GS3) in the more elevated west. The species composition in the wetter element includes rushes (*Juncus inflexus, J. buffonis*), meadowsweet (*Filipendula ulmaria*), horsetail (*Equisetum sp*.), mint (*Mentha aquatica*), purple loosestrife (*Lythrum salicaria*), spearwort and trefoil. In the more elevated drier area coarser grasses become dominant including cocksfoot (*Dactylis glomerata*), creeping bent (*Agrostis stolonifera*) and false oat-grass (*Arrenatherum elatius*) along with sorrel (*Rumex acetosella*) and tormentil (*Potentilla erecta*). The area has extensive establishing scrub with bracken (*Pteridium aquilinum*) and briar (*Rubus fruticosus* aggr.) in the drier areas and briar and willow in the wetter.

A patch of wet grassland (GS4) is present at chainage chainage1+680 K to 1+750 K at the eastern edge of a field of improved agricultural grassland.

A small field of dry neutral grassland (GS1) occurs on the north of the scheme at Knockyclovaun (chainage 0+380- 0+420 K). The field is on elevated sloping ground to the south of the woodland strip surrounding the Ballyvally Estate and appears not to have been grazed in recent years. The sward is dominated by bents (*Agrostis* spp.) and fescues (*Festuca* spp.) with some Yorkshire fog (*Holcus lanatus*). Broad-leaved herbs include plantains (*Plantago lanceolata*), birdsfoot trefoil (*Lotus corniculatus*), knapweed (*Centaurea nigra*) and clovers (*Trifolium* spp.). Briars and bracken are establishing and spreading from the surrounding hedgerows. East of this on the opposite side of the dwelling at chainage 0+370 K is a small paddock of neglected dry neutral grassland with abundant ragwort (*Senecio jacobea*), thistles (*Cirsium arvense)* and dock (*Rumex* spp.) along with extensive thickets of Japanese knotweed (*Reynoutria japonica*).

Amenity grassland occurs at a small park on the river-side at chainage 0+180 R - 0+250 R. There are scattered ornamental trees in the park along with a small thicket of Japanese knotweed. Amenity grassland is widespread within all fringing domestic properties along the entire route, typically in association with ornamental trees and shrubs (WD5/WS3)

Hedgerows, Treelines and Scattered Trees and Parkland

The majority of field boundaries throughout the scheme are comprised of either hedgerows or treelines (WL1 & WL2). The hedgerows in general are unmanaged, though in the central area of grasslands to the west of Killaloe many are trimmed. Species composition typically consists of hawthorn (*Crataegus monogyna*), blackthorn (*Prunus spinosa*) and ash (*Fraxinus excelsior*) with extensive briar, ivy (*Hedra helix*) and ferns (*Dryopteris* spp., *Phyllitis scolopendrium*) in the understorey. Willow (*Salix* spp.) are a common associate in damper areas and elder (*Sambucus niger*) in the drier areas. Occasional mature or semi-mature ash and occasionally oak (*Quercus* spp.) occur within hedgerows. The invasive alien species montbretia (*Crocosmia auria X potsii*) is frequent in hedgerows along roadsides. In some areas hedgerows are formed of linear scrub comprised of briar, bracken and ruderals such as nettle, willow herb (*Epilobium hirsutum*).

Treelines along the route vary considerably in species composition, height and associated understorey. Along the R494 mature and semi-mature ash are frequent in the southern half often occurring in association with hawthorn and willow. North of the Kilmaglassderry Stream, beech (*Fagus sylvatica*) becomes frequent in treelines along with occasional sycamore (*Acer pseudoplatanus*) and oak. Conifers including Lawson cypress (*Chamaecyparis lawsoniana*) and firs (*Abies* spp.) are also occasional especially in the vicinity of houses, along with other ornamental species (WD5/WS3). Between chainage 0+330 R and 1+100 R the western side of the road is extensively lined with mature trees including beech, ash, sycamore and occasional oak. Between chainage chainage 0+330 R and 0+650 R these are within the grounds of private dwellings along the river front and effectively form a belt of mixed woodland. At chainage 0+650 R to 0+750 R mature trees flank both sides of the road.

Immediately east of the Shannon crossing a treeline of mature oak and ash occur fringing an area of woodland along the river bank. On the west of the river and adjacent canal, a line of mature beech runs parallel to the river on slightly elevated land (possibly dredged spoil from the canal). Another significant treeline primarily comprised of mature beech occurs along the minor stream at chainage 0+140 S. Further west, a mixed treeline occurs in association with the minor stream (extending from chainage 1+760 K to 2+020 K), most of which lies immediately north of the proposed route. Oak is dominant with an understorey of hazel (*Corylous avellana*) and holly (*Ilex aquifolium*).

On the western banks of the River Shannon there are scattered deciduous trees (WD5) on the island between the river and the canal. The trees include occasional oak (*Quercus* spp.), chestnut (*Aesculus hippocastanum*), beech (*Fagus sylvatica*), alder (*Alnus glutinosa*) and willow (*Salix* spp). At the midpoint of the crossing the river bank rises vertically to a height of approximately 3m with a sycamore and three mature beech trees over-hanging the river. The ground flora is dominated by bracken with abundant creeping bent, vetch (*Viccia* sp.), wild strawberry (*Fragaria vesca*), with occasional ferns (*Dryopteris* sp.). There are patches of expanding scrub (WS1) with blackthorn, briar, hazel and hawthorn.

There are scattered trees along the L3078 road in the vicinity of the proposed route crossing and tie-in including two large mature oak at chainage 1+100 K and semi-mature beech, sycamore and fir trees in the vicinity of the crossing.

The R463 in the vicinity of the northern tie-in of the proposed scheme is tree-lined along both sides. There are mature sycamore, ash and Scots pine to the east of the road interspersed with semi-mature ash and occasional spruce. These occur as a fringe to a plantation of young alder. On the west of the road forming the boundary to Ballyvally Estate, there is a strip of young mixed broad-leaved woodland (see below) fringed along the roadside with occasional semi-mature ash, willow, beech and sycamore.

Mixed broad-leaved woodland

The most significant area of mixed broadleaved woodland (WD1) impacted by the proposed route is at Ballyvally Estate at the northern end of the scheme. The woodland forms a linear strip extending from the R463 along the southern boundary of the estate and then swinging in a northerly direction immediately west of the proposed route. The land rises to the west at this point and the proposed route will be in an extensive cut as it crosses the woodland. This will result in an impact over a total length of approximately 210m (chainage 0+160 K to 0+370 K). The woodland may also be impacted at its eastern end adjacent to the R463 where the link from the new intersection will tie-in to the existing road. The woodland is comprised primarily of mature beech in the upper part with a limited ground flora dominated by ivy and carpets of the moss *Eurhynchium praelongum*. Fungi were very noticeable in diversity during a survey of this area in early September. The lower section of woodland has frequent ash in addition to beech with a more diverse associated shrub layer comprised of hazel and holly with abundant regeneration. There is a gap in the canopy of the woodland in the immediate vicinity of the proposed alignment where a powerline runs in a north-east to southwest direction. The vegetation along this line is effectively scrub (WS1) comprised of hawthorn, hazel, young sycamore and dense briar.

A belt of immature woodland (WS2) has been planted along the northern side of the mature woodland at Ballyvally Estate with a mixture of primarily non-native species including pine (*Pinus* sp.), beech, cherry (*Prunus* sp.) and oak (*Quercus* sp.). The trees extend to approximately 5m in height and have a poorly developed understorey of grasses and briar. This immature woodland extends along the R463 as far as the entrance to the Ballyvally Estate where it is interspersed with occasional semi-mature ash.

Further to the south at chainage 0+400 K to 0+450 K a small block of young mixed broadleaved woodland (WD2) occurs comprised of beech, ash and sycamore with bracken and coarse grasses dominant in the understorey. The trees are approximately 10m in height and c15 years in age. East of this block is a garden with scattered fruit trees (WD5) and extensive stands of the invasive alien plant Japanese knotweed (WS3).

A block of conifer woodland (WD4) at Shantraud is comprised of semi-mature, un-thinned spruce (*Picea* sp.) forming a very dense canopy with no understorey vegetation. The plantation occurs adjacent to an old laneway with associated treelines of mature ash and oak forming a linear strip of woodland. There are frequent hawthorn, blackthorn and briar along with occasional young elm (*Ulmus glabra*). The ground flora is diverse though heavily poached by stock during the site visit and includes abundant montbretia (an invasive alien plant).

An area of mixed broadleaved / conifer woodland (WD2) occurs to the north of Clarisford. The block is separated into three distinct types; the southern portion is a semi-mature plantation of ash and larch (*Larix decidua*) extending to approximately 15m height. These trees are close-spaced and the understorey is comprised of briar with frequent ferns and ivy. The central section is a mature stand of mature beech, oak and Scots pine with a shrubby understorey of holly and hawthorn. The ground flora is well developed and includes abundant ferns, ground ivy (*Gleochoma hederacea*) and dog violet (*Viola riviniana*). The northern and largest section is a conifer plantation comprised of fir (*Abies* sp.) which is dense and supports no significant understorey. The woodland is impacted between chainage 0+250 S to 0+400 S.

A belt of woodland on the eastern bank of the River Shannon is a mixture between oak-ash-hazel woodland (WN2) and scrub (WS1). There are scattered mature and semi-mature oak and ash protruding through a dense willow, elder, holly, blackthorn and briar understorey. Some areas are more open with dense briar, nettle and bracken. Ivy, male fern (*Dryopteris felix-mas*) and tutsan (*Hypericum androsaemum*) are dominant in the ground flora.

To the south of the R494 between chainage 0+330 R and 1+100 R there are extensive mature trees fringing primarily the western side of the road (see Treelines above). From chainage 0+630 R to1+100 R mature ash and willow form a fringe to an immature mixed plantation (WD2) to the west of the road. The plantation appears to be on the site of old woodland and is approximately 8m in height and c15 years of age. It consists primarily of Spanish chestnut (*Castanea sativa*) with some beech, birch, oak and spruce. The understorey is a mixture of briar with ferns, horsetail and grasses. Further south between chainage1+200 R and 1+600 R another mixed plantation occurs to the west of the road with a narrow strip of rough grassland and briar scrub running adjacent to the road.

To the south of the railway crossing on the R494 there are two small patches of young, ash dominated woodland (WN2) on either side of the road. These small blocks have abundant briar in the understorey with blackthorn and elder.

Wet woodland

A plantation of alder (*Alnus glutinosa*) occurs to the east of the R463 opposite Ballyvally Estate. The woodland has some natural regeneration of willow and occasional birch (*Betula pubescens*) and appears to be developing towards wet willow-alder-ash woodland (WN6), which would have been the natural woodland type associated with the prevailing conditions and currently existing to the south and further east. The understorey includes abundant briar along with frequent sedges (*Carex* sp.), ferns (*Dryopteris* sp.), opposite-leaved golden saxifrage (*Chrysoplenium oppositifolium*), angelica (*Angelica sylvestris*), horsetail (*Equisetum* sp.), meadowsweet (*Filipendula ulmaria*) and mosses (including *Calliergon cordifolium*).

A block of wet woodland (WN6) comprised of alder with some willow occurs on the western side of the River Shannon (chainage 0+520 S to 0+620 S). This is not within the SAC and does not conform to the Annex I Habitat type Alluvial forests with *Alnus glutinosa* and *Fraxinus excelsior*. The woodland along the line of the proposed road is heavily infested with cherry laurel (*Prunus laurocerasus*) extending to c12m in height and resultantly has virtually no understorey vegetation. The woodland is separated from the canal by an elevated ridge which supports a tree-line of mature beech, with a small number of isolated alder and willow occurring along the canal bank in association with occasional sycamore and pheasant berry (*Leycesteria formosa*). The woodland extends to the south of the proposed road line where it is not infested by cherry laurel and supports a rich and typical ground flora for wet woodland including sedges, lady fern (*Dryopteris felix-femina*), creeping buttercup (*Ranunculus repens*), marsh bedstraw (*Galium palustre*), forget-me-not (*Myosotis* sp.), etc.

On the eastern side of the Shannon between chainage 0+250 S and 0+330 S an area of woodland occurs on sloping ground between the R494 and the river. The woodland is ash dominated with frequent alder and willow (WN6) in the lower and wetter part of the woodland with a fern dominated understorey.

Wet woodland (WN6) also occurs in a narrow fringe along either side of the Kilmastulla River (chainage 2+600 R- 2+630 R).

Scrub

A small area of gorse (*Ulex europaeus*) scrub (WS1) occurs at chainage 0+370 K on the Killaloe Bypass. Thickets of the invasive alien plant Japanese knotweed also occur in the vicinity (non-native scrub -WS3). An area of developing willow, birch and gorse scrub occurs at the eastern part of a disused factory compound off the R463 road at Clarisford. The compound adjoins a tree-line and minor stream to the east which is flanked by a linear belt of gorse, elder, blackthorn and briar scrub. Ornamental shrubs (WS3) occur at chainage 0+100 R to 0+200 R and are associated with most gardens impacted.

Reed and Large sedge swamp

The banks of the River Shannon in the vicinity of the proposed bridge are steep and have limited marginal aquatic vegetation. There are a linear strip of woodland and scrub on the eastern shore and scattered deciduous trees on the island between the river and the canal along the western shore (see Treelines and Woodland descriptions above). Occasional stands of reedmace (*Typha latifolia*) and branched bur-reed (*Sparganium erectum*) occur along the eastern shore with Canadian pondweed (*Elodea canadensis*), yellow water-lily (*Nuphar lutea*), and small amounts of willow moss (*Fontinalis antipyretica*). Filamentous green alga is abundant and in areas of slack flow (in particular along the eastern shore) forms massive mats.

Artificial ponds

An artificial pond occurs in the private garden at chainage 0+560 S on the west of the River Shannon. The pond is shallow and is dominated by the invasive alien aquatic plant curly pondweed (*Lagorosiphon major*) along with horsetail (*Equisetum* sp.), duckweed (*Lemna minor*) and small amounts of emergent reedmace (*Typha latifolia*) and reed canary grass (*Phalaris arundinacea*).

A small artificial pond also occurs in a property at chainage 0+390 K immediately south of Ballyvally Estate. This pond also supports a dense population of curly pondweed.

Invasive Alien Species

A number of invasive alien species of plant and animal are present along the proposed route. Dominant amongst these is Japanese knotweed (*Reynoutria japonica*), which is present in large thickets at numerous locations throughout the Killaloe and Ballina area (See **Figure 7.2.2** to **7.2.5** Habitat Maps). This plant is readily spread as fragments and has proved very problematic to control.

Montbretia (*Crocosmia auria X potsii*) is present at a number of locations primarily along road edges. While not as problematic as Japanese knotweed the plant will still be prevented from further spread associated with the road development.

Curly pondweed (*Lagorosiphon major*) is present at two artificial ponds (chainage 0+390 K and chainage 0+560 S). This plant has become a major problem in Lough Corrib due to prolific growth and though it is apparently not present in the Shannon system there is considerable risk of it establishing. A number of other invasive plants are recorded from Lough Derg notably American pondweed (*Elodea nuttallii*), water violet (*Hottonia palustris*), water soldier (*Stratiotes aloides*) and least duckweed *(Lemna minuta*).

Zebra mussel (*Dreissena polymorpha*) is established in Lough Derg and occur in high densities in the River Shannon in the vicinity of the proposed crossing point. Appropriate measures will be required to avoid the accidental transfer of mussels from the construction site to other waterways on machinery, boats, etc. Lough Derg also supports a number of other invasive alien species including the Caspian shrimp (*Hemimysis anomala*).

Mammals (exc. Bats)

Otter

Otter (*Lutra lutra*) are afforded protection under the EU Habitats Directive where they are listed in Annex II. The River Shannon and Lough Derg are ideally suited to otter on account of the good water quality, abundant prey, suitable bank-side cover and generally low levels of human disturbance. Evidence of otter was noted during the site survey on the River Shannon and on the Kilmastulla River. Otter typically utilize cavities in banks, among rocks or tree roots as holt sites and may have many holts within their territory.

On the island separating the Shannon and canal along its western shore, there is a cavity in the river bank which suitable as a holt. There were no spraints evident in the area during the survey but the potential of utilisation is high due to its isolation and proximity to the river.

An above ground lie-up (couch) is present approximately 42m upstream of the existing R494 Bridge over the Kilmastulla River. The site is regularly used and fresh spraint was present. There is evidence of otter crossing the existing road at the bridge, presumably during periods of flood when strong flow prevents them from moving upstream under the bridge.

Spraints were also recorded on the Kilmaglasderry River under a bridge immediately downstream of the confluence with its minor tributary. No suitable locations for a holt or couch were noted in the vicinity of the proposed R494 improvement.

There is likely to be movement of otter along all watercourses in the study area including drainage ditches and this will need to be accommodated for in all bridge and culvert design.

Badger

There is abundant badger (*Meles meles*) activity in the woodland at Ballyvally Estate and three active setts were located to the north of the proposed route in the vicinity of chainage 0+400 K. Theses setts contain only one or two entrances and appear to be Annex setts due to their close proximity. A main sett was not located but may lie in dense scrub to the north. An active outlier sett is also located in the lower part of the woodland with tracks crossing the route at a number of points between chainage 0+300 and 0+400 K connecting to the other setts. Tracks and diggings were also recorded to the east of the woodland between chainage 0+400 and 0+500 K and the entire area is likely to lie within a single territory that is bisected by the road.

Evidence of badger was recorded on both sides of the proposed route in the vicinity of chainage 1+700 to 1+950 k. An outlier sett with no evidence of recent activity was recorded approximately 100m west of the road at chainage 1+900 k. No other setts were found but the stretch of road appears to bisect the territory of a single group at the point.

Abundant badger digging was noted in woodland and adjacent rough grassland in the vicinity of chainage 0+300 S. The woodland in this area is primarily semi-mature conifer plantation with some remnant mature mixed woodland on the southern section. No evidence of sett was located to the east of the road and it is assumed that a sett is within the wooded grounds of Clarisford House. The territory may therefore only extend marginally to the north of the road at this point but appears to extend eastwards as far as the river as diggings were recorded from a lawn as chainage 0+500 S and from the river bank at chainage 0+610 S.

Diggings were also noted near chainage 1+120 R along the banks of the Kilmaglasderry River and further south at chainage 1+300 on the edge of immature woodland on the west of the R494. There was no evidence of regular passage across the road in this area but it cannot be ruled out. No sett was found in the area though access to the Garrynatineel Estate was limited and it is probable that the territory is centred on the estate.

Badger diggings were present in the pasture adjacent to the Kilmastulla River upstream of the R494 and there is evidence of some movement through a dry culvert immediately north of the Kilmastulla Bridge at chainage 2+630. The river is likely to form a boundary to this group's territory as it has too powerful a flow for badgers to ford. There may however be some movement along the bridge. No setts were found in this area though the habitat to the west of the river appears unsuited and it is probable that the territory is primarily to the east of the R494.

Other Mammals

Pine marten (*Martes martes*) appear to be widespread in the area and have been reported from woodland and gardens along the western bank of the River Shannon and from the Ballyvally Estate. They could be expected to occur in other suitable habitat (woodland, scrub and interconnecting treelines and hedgerows) on both sides of the River Shannon. Pine marten are primarily solitary and territorial mammals occupying home ranges of up to 80ha in optimal habitat. They may have several dens within their territory utilising a variety of niches such as hollow trees, squirrel dreys, cavities in rocks, out-buildings and occasionally occupied dwellings. No potential denning sites were found along the line or in the immediate vicinity of the proposed route.

Evidence of Red Squirrel (S*ciurus vulgaris)* was recorded in the woodland at Ballyvally Estate (chainage 0+350 to 0+450 k). This area of mixed mature woodland and adjacent scrub provides suitable habitat and there is good continuity to woodland along the Shannon on the east of the R463. While no evidence was noted at other locations along the proposed route they are likely to occur in areas of woodland in the vicinity of Clarisford House (chainage 0+130 to 0+600 S). To the east of the Shannon, they may also occur along the stretch of the R494 between chainage 0+050 – 1+600 R) where there is a mixture of woodland to the west of the road with frequent mature treelines in between.

Fallow Deer (*Dama dama*) appear to be widespread in the general Killaloe area. Evidence of activity was identified in the woodland around Ballyvally Estate (chainage 0+350 to 0+450 K). Deer slots were also noted in the woodland were also noted in the woodland and adjacent habitats at chainage1+800 to 1+900 K. There were abundant signs of activity on the island between the River Shannon and the Canal chainage 0+630 S), this area appears to be used as daytime tie-up or refuge for deer with animals moving out to forage on the mainland to the west during the night. No deer activity was noted to the east of the Shannon.

Signs of fox (*Vulpes vulpes*), rabbit (*Oryctolagus cuniculus*) and brown rat (*Rattus norvegicus*) were recorded during the site survey at a number of locations and these species are widespread. Additional species likely to occur include hedgehog (*Erinaceus europaeus*), Irish stoat (*Mustela erminea*), Irish hare (*Lepus timidus hibernicus*) and wood mouse (*Apodemus sylvaticus*).

Bird Species

The River Shannon and associated canal in the vicinity of the proposed crossing would be expected to support a breeding population of common waterfowl including mute swan, moorhen, mallard as well as passerines such as reed bunting, sedge warbler and long-tailed tit. Kingfisher, an Annex I listed species under the EU Birds Directive, was observed roosting under the mature trees on the western side of the River Shannon and the steep earthen bank at this point may offer potentially suitable nesting conditions. A nesting burrow as also identified approximately 150m downstream of the existing bridge on the R494 along the Kilmastulla River and an adult bird was observed in flight at this point in September 2009. Regular movement of the kingfisher is likely along the Kilmaglasderry River though no evidence of birds were recorded during the field survey.

Lough Derg is a Special Protection Area under the EU Birds Directive (site code no. 4058), the boundaries of which commence upstream of the existing Killaloe Bridge. The site has been designated as an SPA as it supports important numbers of wintering wildfowl including Greenland white-fronted geese (*Anser albifrons flavirostris*), common terns (*Sterna hirundo*) and cormorants (*Phalacrocorax carbo*). Both the Greenland white-fronted geese and terns are listed under Annex I of the Birds Directive. None of these species would be expected to forage in the vicinity of the proposed crossing of the River Shannon with the exception of cormorant.

A variety of other breeding species associated with the range of habitats present (i.e. grasslands, hedgerows, treelines, woodland and scrub) would be expected to occur including various tits, finches, thrushes and corvids. Raptors including sparrowhawk, kestrel and both long-eared and barn owl would also be expected to be present and potential nesting conditions for most of these species exist in mature trees and woodlands along the proposed route. Barn owl however, typically utilise old buildings as nest sites and no suitable structures exist along the route. Ground nesting species skylark and meadow pipit would be expected to nest in some of the grassland areas.

Snipe and woodcock would be expected to utilise wet or rough grassland and woodland habitats respectively during the wintering months. Other wintering waders including lapwing and golden plover may periodically utilise areas of grassland along the route for foraging.

Aquatic Environment

A total of seven watercourses are crossed by the proposed scheme as detailed in **Table 7.2.3** below. The most significant of these is the River Shannon, an internationally important watercourse and a designated Special Area of Conservation (SAC). A canal runs along the western side of the Shannon leading to a lock by-passing the existing Killaloe Bridge. The Kilmastulla River is part of the River Shannon SAC. All the other watercourses crossed by the scheme are first or second order tributaries of the River Shannon.

Table 7.2.3 Watercourses crossed by the Killaloe Bypass Scheme

Chainage	Watercourse	Townland	Evaluation
0+000 K & 0+300 K	Un-named stream	Kincora	C
1+740 K & 0+140 S	Un-named stream	Shantraun	C
0+080 S to 0+790 S	River Shannon	Clarisford	A
0+650 S	Canal (Part of River Shannon)	Clarisford	A
0+990 R	Kilmaglasderry tributary	Kilmaglasderry	C
1+140 R	Kilmaglasderry River	Kilmaglasderry	C
2+630 R	Kilmastulla River	Coolnadornory	A
3+280 R	Un-named stream	Coolnadornory	C

River Shannon

An aquatic ecological assessment was undertaken for the proposed bridge crossing of the River Shannon in August 2008. The survey targeted specifically the presence or suitability of the river in the vicinity of the proposed bridge as spawning habitat for the internationally rare pollan (*Coregonus autumnalis*). As the River Shannon is a candidate Special Area of Conservation at the proposed crossing point, the survey also addressed the presence of or suitability for species or habitats listed as qualifying interests for the site including salmon, sea, river and brook lamprey, freshwater crayfish and otter. The following results are derived from this study.

Flow regime and substrate

The flow regime in the vicinity of the proposed crossing point is comparatively uniform with strong glide conditions along the western half of the river. The western bank descends steeply from the tree-lined shore over boulder and cobble initially, then over exposed bedrock from approximately 2m to 5m in depth after which the gradient slackens over a boulder, cobble and gravel matrix. At the base of this slope in a depth of 6-7 m of water, a swathe of gravel from 2-8m in width runs almost the entire length of the survey area (200m) as identified during the River Shannon Crossing Study. Along the centre of the river the substrate is comprised of a mixture of boulder and cobble with small pockets of gravel and sand. All hard substrates within the river are blanketed with the alien invasive zebra mussel (*Dreissena* *polymorpha*) which in places form extensive reefs. Towards the eastern half of the river, the flow reduces, especially downstream of the proposed bridge line and east of the old island. The slack flow has allowed accumulation of soft silts with extensive macrophyte and algae growth.

Spawning Potential for Pollan

The flow regime and gravel substrate along the western third of the river provide potentially suitable spawning conditions for the nationally rare pollan (see **Plate 7.2.1**) which shows the approximate location of potentially suitable gravels). The gravels occur in a narrow band parallel to the river bank over a distance of at least 100m at a depth of between 5m and 7m. Pockets of gravels also occur along the eastern side and upstream of the band, typically on the downstream of boulders. While it is uncertain as to whether spawning actually occurs at this location, considerable numbers of pollan have been taken in the past in the eel fyke nets at Killaloe during the spawning season, suggesting that some spawning may occur in the area.

Pollan spawn in December on rocky or shallow gravely areas of lakebed though within Lough Derg there has been no confirmed identification of spawning areas to date. The pollan is one a handful of freshwater fishes native to Ireland. Pollan have been regularly taken at the eel fishery at Killaloe though their numbers have declined dramatically in recent years. Their limited distribution in Ireland suggests that they may have been the first fish species to colonise freshwater in Ireland at the end of the last Ice-Age (~10,000 years ago). Today Pollan are restricted to two lakes on the Shannon, Lough Ree and Lough Derg. They also occur in Lower Lough Erne. Although it is anadromus throughout most of its northern range, the Irish population are all non-migratory and purely freshwater. The decline in the pollan stock is probably directly related to the introduced roach rather than eutrophication, as Lough Neagh is more eutrophic than Lough Erne and although Upper Lough Erne is cleaner that Lower Lough Erne, pollan are now absent from it. The spread of the alien invasive zebra mussel is also recognized as a factor in their decline in both the Shannon and Erne systems. Within Lough Derg, all three factors have combined to place the pollan population in jeopardy of imminent extinction. The priority proposed action of the “Irish Pollan County Clare Species Action Plan” is to “*Identify and map spawning beds in Lough Derg. There should be no dredging in potential spawning areas (river or lake) or development of marinas, jetties or other navigation infrastructure until the spawning areas have been formally identified and mapped*.”.

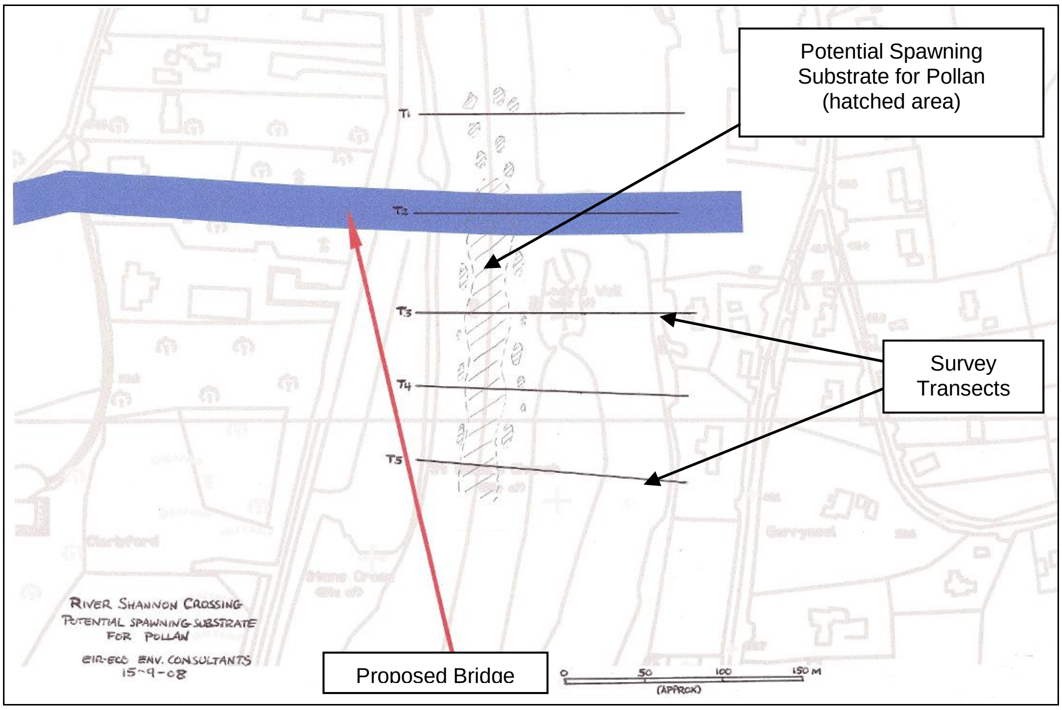

Plate 7.2.1 Location of potential spawning gravels for pollan (hatched area) in vicinity of proposed bridge.

Fisheries Value

The River Shannon system supports an internationally important population of the Annex II listed salmon (*Salmo salar*). The river has a large run of grilse (single winter fish) along with significant numbers of spring salmon (multiple winter fish). The habitat in the vicinity of the proposed crossing point is not suited to spawning by salmon.

All three species of lamprey listed under Annex II of the EU Habitats Directive have been recorded from Lough Derg. The existence of a population of landlocked River Lamprey (*Lampetra fluviatilis*) within the lake is suspected; normally this species spends its adult life in estuarine waters before migrating upstream to spawn. Brook Lamprey (*L. planeri*) is known to be common in the lower Shannon catchment, as it indeed appears to be throughout the country. All three species of lamprey spawn in gravely substrates (size dependant) and the larval stage burrow into soft sediments in which they spend a number of years. The areas of soft sediment along the eastern bank of the river in the vicinity of the proposed bridge may support lamprey ammocoetes. The habitat in the vicinity of the proposed crossing point however, is not suited to spawning by lamprey.

Angling takes place along the entire Shannon system for both game and coarse fish. In addition, there is a commercial eel fishery located at the existing Killaloe Bridge, which is active during the main downstream migration of silver eels in early spring. The river also has a good run of sea trout (*Salmo trutta*) along with healthy resident populations of brown trout and a large variety of coarse fish species.

<u>Other Watercourses</u>

The Kilmastulla River is a first order tributary of the River Shannon and part of the Lower River Shannon SAC. The river support spawning salmon and trout and potentially suitable spawning habitat occurs approximately 100m downstream of Cool Bridge on the R494. The river is also likely to support populations of brook lamprey.

A small stream that flows under the R494 immediately north of the R445 interchange (chainage 3+280 R) is a tributary of the Kilmastulla River. It is up to 2m in width and has a riffle flow over gravels immediately upstream and downstream of the R494, which appear suited to spawning by both trout and brook lamprey.

The Kilmaglasderry River is another first order tributary of the River Shannon and flows under the R494 at chainage 1+140 R. The river is approximately 3m in width and has good riffle habitat downstream of the crossing that may support spawning trout and brook lamprey. A minor tributary of the river is also crossed at chainage 0+990 R. This small slack-flowing stream is less than 1m in width at the R494 and flows through woodland downstream of the road until its confluence with the Kilmaglasderry. While it appears unsuited to spawning it may however provide nursery habitat for juvenile trout and lamprey ammocoetes, the latter especially in the vicinity of the confluence where there are deep silt beds.

The proposed road crosses a minor stream on the west of the River Shannon at Shantraud in two separate locations. The stream is crossed in its upper reaches at chainage 1+765 K on the edge of a conifer plantation where it is less than 1m in width. It is crossed again at chainage 0+140 S where it runs adjacent to a mature treeline with associated scrub and has increased to c2m in width. There is stock access along the stream at this point and resultant siltation in the otherwise gravely substrate. The stream has limited fisheries potential though it may support minnow, brook trout and possibly brook lamprey. The presence of fish may occasionally attract kingfisher and possibly otter to forage along it though it appears unsuited to regular use.

A second minor stream flows through the mixed woodland north of the proposed road alignment at Ballyvally Estate and then runs along its northern edge before crossing the R463 into a plantation of semi-mature alder (*Alnus glutinosa*) woodland on the east side of the road. This stream is crossed by the intersection with the R463 at chainage 0+000 K and higher up at chainage 0+300 K. This stream has no fisheries value and appears unsuited for any protected aquatic species.

Evaluation

The principle feature of ecological value along the entire scheme is the River Shannon and associated habitats including the canal to the west, which are part of the Lower River Shannon SAC. This feature is of international importance. The Kilmastulla River is also within the Lower River Shannon SAC and is similarly rated of international importance while its tributary at chainage 3+280 R is rated of county importance as it may support spawning by trout and lamprey, and occasionally otter and kingfisher. The Kilmaglasderry and tributary are also rated of county importance as they support trout and may support otter movement as well as kingfisher. The other watercourses within the scheme are all rated of higher local importance and are all tributaries of the River Shannon.

The woodland habitats along the proposed route vary in composition and character. The woodland in the vicinity of the Ballyvally estate is rated of county importance as is the woodland flanking the River Shannon crossing but outside of the SAC boundary. Areas of wet woodland habitat in the line of the route are also rated of county importance. These occur on the western side of the River Shannon (chainage 0+520 S to 0+620 S); east of the R463 opposite Ballyvally Estate and on the eastern side of the Shannon between chainage 0+250 S and 0+330 S. The wet woodland along either side of the Kilmastulla River (chainage 2+600 R- 2+630 R) is rated of International Importance as it is within the Lower River Shannon SAC.

Woodland at Clarisford (chainage 0+250 S - 0+420 S) is a mixture of young plantation with old mixed woodland and contains a considerable number of mature trees with a good associated ground flora. Similarly at Garrynatineel (chainage 0+900 R – 1+100 R) there is an immature plantation on the site of old woodland with a fringe of mature trees. Both these sites are rated of higher local importance.

The hedgerows and treelines along the proposed route are generally of high local value where they are unmanaged and mature on account of their diversity and function as corridors of movement. Grasslands along the route are generally of moderate value where they have not been heavily managed due to their floristic value and as habitat for a variety of mammals, birds and invertebrates. The artificial ponds at chainage 0+500 K and chainage 0+380 K are rated of low value on account of their population of curly pond weed.

Table 7.2.4 presents a list of the habitats impacted and their location, a brief description and their evaluation. The evaluation system utilises that of the NRA guidance equating A to sites of international importance, B to sites of national importance, etc.

Table 7.2.4 Evaluation of Habitats along the Proposed Scheme (see also Figures 7.2.2 to 7.2.5)

Mixed Broadleaved Woodland			
Code	***Chainage***	***Description***	***Evaluation****
WD1	0+100-0+350 K	A significant woodland forming a linear strip extending from the R463 along the southern boundary of the estate and then swinging in a northerly direction immediately west of the proposed route.	C
WS2	0+050-330 K	A belt of immature woodland, planted along the northern side of the mature woodland.	D
WD2	0+430-0+460 K	A small block of young mixed broadleaved woodland.	D
WD5	0+420 K	A garden with scattered fruit trees.	E
WD4	1+800 K	A block of conifer woodland at Shantraud.	E
WD2	0+250-0+420 K	An area of mixed broadleaved / conifer woodland occurs to the north of Clarisford.	C/D
WN2/ WS1	0+320-0+560 R	A belt of woodland on the eastern bank of the River Shannon is a mixture between oak-ash-hazel woodland and scrub.	C
WN2	0+630-0+900 R	Mature ash and willow form a fringe to an immature mixed plantation.	D
WD2	0+900-1+100 R	This plantation appears to be on the site of old woodland and is approximately 8m in height and c15 years of age.	C/D
WD2	1+200-0+600 R	A mixed plantation occurs to the west of the road with a narrow strip of rough grassland and briar scrub running adjacent to the road.	D

Mixed Broadleaved Woodland			
Code	Chainage	Description	Evaluation*
WN2	3+000-0+150 R	Two small patches of young, ash dominated woodland on either side of the road.	D
Wet Woodland			
Code	**Chainage**	**Description**	***Evaluation***
WN6	0+000-0+100 K	This woodland has some natural regeneration of willow and occasional birch and appears to be developing towards wet willow-alder-ash woodland.	C
WN6	0+430-0+600 S	A block of wet woodland comprised of alder with some willow occurs on the western side of the River Shannon.	C
WN6	0+250-0+320 R	This woodland is ash dominated with frequent alder and willow in the lower and wetter part of the woodland with a fern dominated understorey.	C
WN6	2+600-0+630 R	Woodland either side of the Kilmastulla River (Within the Lower River Shannon SAC).	A
Scrub			
Code	**Chainage**	**Description**	***Evaluation***
WS1	0+350 K	An isolated block of scrub grows along the powerline.	C
WS3	0+400 K	Thickets of the invasive alien plant Japanese knotweed.	E
WS1	0+080-0+120 S	An area of developing willow, birch and gorse scrub occurs at the eastern part of a disused factory compound off the R463 road at Clarisford.	D
WS1	0+620-0+650 S	Mosaic of blackthorn, hawthorn, hazel and briar scrub with dense bracken on island between Shannon and canal	C/B
WS3	0+100-0+200 R	Ornamental shrubs in gardens.	E
Hedgerows, Treelines and Scattered Trees and Parkland			
Code	**Chainage**	**Description**	***Evaluation***
WL1	1+340-0+500 K	Series of trimmed hedgerows.	D
WL1	0+140-0+620 R	Hedgerows are formed of linear scrub comprised of briar, bracken and ruderals such as nettle, willow herb	D
WL1	1+800-0+900 R	Unmanaged hedgerow	D
WL1	2+180-0+300 R	Unmanaged hedgerow	D
WL1	3+180-0+310	Unmanaged hedgerow	D
WL2	0+300 K	There are mature and semi-mature trees to the east of the road (sycamore, ash and Scots pine, ash and occasional spruce). These occur as a fringe to a plantation of young alder. On the west of the road forming the boundary to Ballyvally Estate, there is a strip of young mixed broad-leaved woodland (see below) with occasional semi-mature trees (ash, willow, beech and sycamore)	D

Hedgerows, Treelines and Scattered Trees and Parkland			
Code	**Chainage**	**Description**	Evaluation
WL2	1+350- 0+500 K	There are scattered trees along the L3078 road in the vicinity of the proposed route crossing and tie-in including two large mature oak, semi-mature beech, sycamore and fir's	D
WL2	1+840-2028 K	A mixed treeline occurs in association with the minor stream most of which lies north of the proposed route. Oak is dominant.	D
WL2	0+140 S	A significant treeline primarily comprised of mature beech occurs along the minor stream.	D
WL2	SBC 600-650 S	Scattered trees on island between Shannon and canal (occasional oak, chestnut, beech, alder and willow)	D
WL2	0+810 S	A treeline of mature oak and ash occur fringing an area of woodland along the river	D
WL2	0+330-1+100R	The western side of the R494 is lined with mature trees (beech, ash, sycamore and occasional oak). Between chainage 330-650 these are within the grounds of private dwellings along the river front and effectively form a belt of mixed woodland.	D
WL2	1+100 R	Treeline running alongside stream, beech is frequent with occasional sycamore and oak.	D
WL2	2+180-0+300 R	Treeline alongside road	D
WL2	2+540-0+650 R	Treeline alongside road.	D
Grasslands			
Code	**Chainage**	**Description**	***Evaluation***
GA2	0+180-0+260 R	Small field of amenity grassland.	E
GA1	0+180-0+250 K	Scattered ornamental trees in the park along with a small thicket of Japanese knotweed. Amenity grassland is widespread within all fringing domestic properties along the entire route, typically in association with ornamental trees and shrubs (WD5/WS3)	D
GS1	0+380-0+420 K	A small field on elevated sloping ground to the south of the woodland strip surrounding the Ballyvally Estate and appears not to have been grazed in recent years.	D
GS4	1+680-0+750 K	Patch of wet grassland at the edge of improved agricultural grassland.	D
GS3/HD1	1+890-0+950 K	This grades from being wet grassland in the east to humid acid grassland in the more elevated west. Continuum with site below.	D
GS4	1+ 870-2+020 K	This grades from being wet grassland in the east to humid acid grassland in the more elevated west. Continuum with site above.	D
GS4	0+130-0+300 S	The species composition is limited with evidence of past reseeding suggested by the presence of perennial ryegrass and red clover	D

Grasslands			
Code	**Chainage**	**Description**	**Evaluation**
GS2	2+620-0+700 R	Dry meadow with tussocky species such as cocksfoot and oat-grass	D
GS4	2+630-0+750 R	A narrow fringe of wet grassland occurs on the south of the river at Cool Bridge. Part of this grassland is within the Lower River Shannon SAC (a strip of approx 15m south of the River).	C/A
GA1	Throughout route	Improved agricultural grassland.	E
Dense Bracken			
Code	**Chainage**	**Description**	***Evaluation***
HD1	0+620-0+1640 S	The island is composed of a mixture of dense bracken and scrub.	C
Reed & Large Sedge Swamp			
Code	**Chainage**	**Description**	***Evaluation***
FS1	0+ 600-0+800 S	The eastern banks of the River Shannon in the vicinity of the proposed bridge have a narrow fringe of reed swamp.	B
Artificial ponds			
Code	**Chainage**	**Description**	***Evaluation***
FL8	0+380 K	A small artificial pond in a property at immediately south of Ballyvally Estate. This pond also supports a dense population of curly pondweed.	E
FL8	0+500 S	The pond is shallow and is dominated by the invasive alien aquatic plant curly pondweed	E
Watercourses			
Code	**Chainage**	**Description**	***Evaluation***
FW4	KBP Roundabout	Drainage ditch through woodland.	D
FW4	0+340-0+350 K	Drainage ditch through mature woodland.	D
FW4	1+750 K	Stream running between wet grassland and conifer plantation	D
FW1	1+880-2+020 K	Stream running along edge of wet grassland, treeline occurring as well.	D
FW2	0+080-0+790 S	River Shannon	A
FW3	0+650 S	Canal (Within the Lower River Shannon SAC)	A
FW2	0+130 S	Stream running across proposed route. Treeline along bank.	D
FW	0+990 & 1+140 R	Kilmaglasderry River & tributary passing under the road, joining and flowing in to the River Shannon. Treeline along stream further north.	C
FW1/2	2+620 R	Kilmastulla River (Within the Lower River Shannon SAC)	A
FW	3+280 R	Small stream north of route.	D

** A = International importance; B = National Importance; C = County Importance; D = Higher Local Importance; E = Lower Local Importance.*

7.2.4 Impact of Proposed Development

Impacts on Designated Areas and Protected Species

An Appropriate Assessment (Natura Impact Assessment) has been carried out in accordance with Article 6.3 of the EU Habitats Directive to assess the impact of the proposed route on the Natura 2000 network. In addition an Appropriate Assessment has been prepared as part of the Strategic Environmental Assessment for the Killaloe Bypass 2009 Amendment to the East Clare Local Area Plan. The proposed Scheme includes a vehicular bridge over the River Shannon near Killaloe which will pose a minor risk of pollution associated with the construction and operational phases resulting in impacts on the SAC downstream and on pollan spawning gravels in the vicinity of the bridge. This risk will be minimised by the adoption of appropriate design standards and good practice and procedures during construction. The bridge will result in the loss of the existing bankside vegetation in the vicinity, which includes mature deciduous trees and a narrow band of fringing tall herb swamp.

A potential otter holt is located at the point of the crossing on the western bank of the River Shannon under overhanging mature trees. Derogation has been sought from the NPWS for the exclusion of the holt outside of the breeding season.

The crossing of the Kilmastulla River will also pose risks of pollution to the SAC both during construction and operation. The shorter span however will enable a clear span bridge that will enable the retention of some bank side habitat which will facilitate ecological connectivity along the river corridor by birds and mammals.

With the successful implementation of the detailed mitigation measures there will be no impact on the qualifying interests or integrity of the Lower River Shannon SAC.

Impact on bats

Bats are potentially impacted by road schemes through the direct loss of roosts and feeding and commuting routes. Road construction will have a negative impact on bats through the loss of feeding habitat, roost sites, and flight paths or commuting routes. Large areas of potential feeding habitat such as woodland, hedgerow and treeline will be lost.

Four buildings containing roosts of soprano pipistrelle, an unidentified pipistrelle species and brown long-eared bat will be demolished. Removal of mature trees along the route may also destroy small existing and potential bat roost sites. Flight paths between foraging and roosting sites will be lost or interrupted through the removal of hedgerows, treelines and woodland. Bats tend not to fly over areas of open ground so the construction of roads can act as a barrier to their movement. Lighting associated with roads and interchanges may also constitute a negative impact for some bat species. The main impacts will be in, or close to areas of suitable habitat, that were previously unlit.

Overall, the impacts of the proposed Killaloe Bypass on bats would be considered to be major to moderate negative given the loss of four confirmed bat roosts and removal of vegetation and woodland at both the proposed Shannon Bridge Crossing and at the northern end of the Killaloe Bypass in Ballyvally. However, given the extent of hedgerow and scrub in the wider vicinity, impacts arising from the loss of roosting and foraging habitat, if offset with suitable mitigation measures, may be reduced to minor negative.

Loss of roost sites

Bats are often faithful to a particular roost site from year to year. Buildings occupied by bats are typically maternity roosts where females congregate to give birth. The loss of such sites can have serious implications for a colony as there may be no other suitable sites in the area. The loss of roosts is believed to be one of the factors contributing to declines in bat populations throughout Europe. Bats potentially use a variety of buildings, bridges, culverts and trees along the Killaloe Bypass as roost sites.

All the buildings that are due to be demolished along the Killaloe Bypass contain some evidence of being used by bats however it has not been possible to accurately determine the significance of the roosts present in most cases or a complete and accurate tally of the number of bats utilising each building due to constraints in gaining access to each property.

Based on the evidence recorded and observed two of the buildings scheduled for demolition (the private residence at chainage 0+275 K and the private residence at chainage 0+475 S are considered to be maternity roosts for both soprano pipistrelle, and soprano pipistrelle and brown long-eared bats respectively.

The other two buildings along the route (the shed/garage at chainage 1+100 K and the agricultural shed at chainage 2+400 R are both described as minor roosts and are both used by pipistrelle bats (likely to be soprano pipistrelle).

The stone culvert north of Cool Bridge at chainage 2+600 R was deemed to have very high potential as a hibernation roost. This bridge will not be impacted by the proposed Scheme.

Impacts on Habitats

The main direct impact on habitats arising from the proposed development relates to loss of semi-mature and mature trees along the route, in particular at Ballyvally Estate where due to the topography, road construction will require a large cutting centred on the belt of woodland. Sections of mature woodland will be impacted in the townland of Clarisford and to the east of the River Shannon. Along the R494 woodland will be impacted along the road though as most of this section of the proposed route entails widening along the existing footprint, the impacts will be limited to the woodland edge and may be reduced by minor local realignments. Wet woodland fringing the western bank of the River Shannon will be dissected. This habitat is not continuous as it has been previously fragmented by private gardens and marina developments but it still retains overall ecological continuity. The fragmentation effect will also be prevalent on the eastern banks of the Shannon.

Impacts on Fauna

Otter

The otter is listed under Annex II of the EU Habitats Directive and a qualifying interest for the Lower River Shannon SAC. The potential holt at the Shannon Bridge crossing point will be lost. The couch (above ground lie-up) on the Kilmastulla River will be impacted by the proposed new crossing of the river and will require exclusion under conditions outlined in the Derogation license from the National Parks and Wildlife Service . The loss of these features will reduce the availability of suitable holt and couch sites in the vicinity and alterative structures will need to be provided. An interruption to the movement of otter along all watercourses presents a risk of mortality though traffic collision should animal movement fail to be accommodated in the bridge and culvert design. An increase in mortality rates could result in localised extinction of the species.

In addition to the risk of direct mortality through traffic collision, there is a minor risk of indirect impacts on otter through a reduction in prey availability resulting from a decline in water quality through pollution or siltation during the construction or operation phase of the proposed development.

Other Mammals

The proposed development will result in potential fragmentation of habitats on either side of the road and the restriction of movement by mammals by associated fencing and median barriers. This will give rise to a significant risk of mortality through traffic collision where mammals gain access to and attempt to cross the road. This may lead to localized extinction of larger mammals such as badgers, hares and hedgehogs over time, or result in a decline in population. There will be disturbance and displacement of the fallow deer using the island between the Shannon and adjacent canal especially during the construction phase. Deer activity is also likely to be affected by the proposed road during operation. There will be a minor reduction in the foraging area for various small mammals likely to occur along the line of the proposed road, though overall such loss is considered minor and could be offset by appropriate landscaping along the road.

Birds

Site clearance works associated with the development will be undertaken outside of the breeding bird season from March 1st to August 31st (in accordance with the Wildlife (Amendment) Act (2000)).There are unlikely to be impacts associated with the proposed development on birds, as the habitats lost as a result of the development are common and widespread.

Kingfisher may be exposed to the risk of traffic collision should their movement not be accommodated in the culvert design on watercourse.

7.2.5 Mitigation Measures

In addition to the mitigation measures arising from ecological assessment of the proposed scheme, this section has incorporated those measures identified as part of the Strategic Environmental Assessment and Appropriate Assessment for the East Clare Local Area Plan amendment 2009 (Western Bypass of Killaloe).

Designated Areas

The potential for direct impacts on the Lower River Shannon SAC during the construction of the Shannon and Kilmastulla River Crossings will be avoided, reduced and remedied by a suite of measures as detailed below:

Mitigation within the SAC:

- There will be no works permitted outside the identified land take area within the SAC;
- Design and construction method statements will be submitted to IFI and NPWS for approval prior to commencement of construction;
- Where site investigation (including archaeological works) is required in the vicinity of or adjacent to the SAC and outside of the lands made available, these works will be supervised by an appropriately qualified ecologist and mitigation measures will apply as outlined in this section;

- In the vicinity of the SAC the site boundary will be defined at the outset of construction using rigid timber or equivalent robust fencing. Within the site boundary fence, earth bunds will be constructed to contain surface water run-off and channel it to a silt trap before discharge. This will entail measures to ensure that suspended solids in any runoff (either direct or via small watercourses or field drains) into the River Shannon from the construction area, machinery access routes or any other source does not exceed 25mg/l. Among other measures this will require isolating the area where works are carried out from the river and pumping all runoff to sediment removal facilities;
- Prior to construction commencing, a detailed survey of the river bank in the vicinity of the proposed works will be undertaken to determine the status of the identified otter holt and couch and to check for any further potential features. Appropriate mitigation will be put in place under licence from the NPWS for encountered holts or couches. Artificial holts will be provided in the vicinity of both the Shannon and Kilmastulla crossings at locations and to specifications agreed with the NPWS;
- The location of instream piers have been selected to minimise damage or disturbance to pollan spawning habitat in the vicinity of the bridge;
- Bridge and approach road design shall incorporate best environmental practice and design in the control of road run-off and accidental spillage. Run-off shall be channelled through a spill-containment facility and hydrocarbon interceptor prior to discharge to the river;
- A sustainable drainage system will be installed on the new road which will prevent significant pollution to surface receiving waters. The system installed will have a proven capability of achieving and sustaining at least the following percentage pollution reduction in runoff:

Total Suspended Solids	85%
Heavy Metals	50 – 80%
Chemical Oxygen Demand	50%
Hydrocarbons	90%

- An emergency-operating plan shall be established to deal with incidents or accidents during construction that may give rise to pollution within the Lower River Shannon SAC. This will include means of containment in the event of accidental spillage of hydrocarbons or other pollutants (including oil booms and soakage pads);
- The design of lighting for the bridge will take into consideration the requirement to avoid unnecessary light spill into the river and the adjacent river banks in order to minimize disturbance to fish, mammals and bats in the area.

Bats

Mitigation measures for the loss of roosts

- Mitigation measures to offset the loss of roosts are detailed below and follow the NRA Guidelines for the Treatment of Bats during the Construction of National Road Schemes and NRA Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes (National Roads Authority 2006).

A) Trees

- All retained trees will be subject to assessment for potential bat roosts prior to the commencement of road construction and both these (and those trees retained within the CPO) will be subject to appropriate felling measures as detailed in NRA Guidelines for the Treatment of Bats during the Construction of National Road Schemes (National Roads Authority 2006) once the construction of the scheme commences.

Avoidance

- The scheme has been designed to avoid the treeline of mature beech, sycamore and Scot's pine at chainage 0+750 R on the Ballina/Birdhill Road and will be fenced off during construction.

Protective measures

- Where possible, trees that are located very close to the CPO will be retained and afforded protective measures. Protective fencing will be erected outside the drip-line of the canopy of any retained trees in order to prevent damage by machinery, compaction of soil, etc. in accordance with BS 5837: 1991.

Provision of bat Boxes

Prior to the removal of any trees that have potential to support roosting bats a bat box scheme will be erected in close proximity to those trees scheduled for removal. These works will be done a minimum of 6 months in advance of planned tree felling to allow bats to become accustomed to new roosting opportunities in the area. A variety of box types will be provided and the types to be used and their locations for erection will be decided by a licensed bat specialist and erected under their supervision.

Timing of tree felling

- All trees which are to be felled will be felled during the autumn months of September or October. In this way felling can be timed to coincide with the least vulnerable parts of the bats' lifecycle - namely over winter hibernation and summer breeding and avoid the bird breeding season.
- The felling of all trees, which have been identified as potential bat roosts must be supervised by a bat specialist holding a bat handling licence issued by the National parks and Wildlife Service, (Department of Arts, Heritage and the Gaeltacht). If bats are encountered they will be removed by the licence holder to a bat box, to be sited on a nearby tree and the NPWS notified.
- Identified trees must be felled carefully. Specific advice in relation to individual trees will be given on site by a bat specialist. Gradual dismantling of very mature trees that are likely to be hollow may be necessary to ensure the safety of any bats which may be roosting within significant sized boughs or in the trunk.
- Otherwise tree felling will be undertaken using heavy plant machinery. Normally trees are simply pushed over, though there may be a need to excavate and sever roots in some cases. In order to ensure that any roosting bats present are given some warning the tree will be pushed lightly several times prior to felling. The fall of the tree can be slowed by placing the bucket of the machine on the root ball thereby slowing the fall of the tree. The tree will be inspected by a bat specialist, and left intact on the ground for 24 hours to allow any bats within them to escape prior to processing.
- Similarly all ivy covered trees (which are unmarked) along the route will be felled and left intact for 24 hours so that any roosting bats that may be present may have a chance to awaken and escape.

B) <u>Loss of roosts in structures or buildings</u>

- The private residence at chainage 0+275 K and the private residence at chainage 0+475 S are considered to be maternity roosts for both soprano pipistrelle and soprano pipistrelle and brown long-eared bats respectively.
- The other two buildings along the route (the shed/garage at chainage 1+100 K and the agricultural shed at chainage 2+400 R are both described as minor roosts and are both used by pipistrelle bats (likely to be soprano pipistrelle). The demolition of all of these buildings therefore requires a bat derogation licence from the National Parks and Wildlife Service.
- The stone culvert north of Cool Bridge at chainage 2+600 R was deemed to have very high potential as a hibernation roost and should this culvert require any strengthening works this will be done under the supervision of a licensed bat specialist who will identify any deep crevices which will be retained for use by bats.

<u>Erection of bat boxes</u>

- In order to provide alternative roosting locations for bats a bat box scheme will be erected in close proximity to the locations of those buildings, which have been confirmed as bat roosts. These works will be carried out a minimum of 6 months in advance of planned building demolition to allow bats to become accustomed to new roosting opportunities in the area. A variety of boxes will be provided and the types to be used and their locations for erection will be decided by a licensed bat specialist and erected under their supervision.

<u>Demolition of buildings</u>

- The demolition of each of the buildings in question will be scheduled for the winter months as bat numbers are known to be lower in buildings at that time.
- All buildings will be surveyed again immediately prior to demolition by a suitably qualified bat specialist to determine which, if any, contain bats.
- If no bats are found the building may be safely demolished immediately on from the assessment. Demolition will be done with the expectation that bats may be found following the procedures recommended in the NRA Guidelines for the treatment of Bats during the Construction of National road Schemes. The roof of such structures will be carefully removed by hand to protect any animals which may be beneath slates. Half the roof will be removed then the work will cease for 24 hours to allow any bats to leave before removing the remaining roof. If discovered, bats will be retained in a box until dusk and released on site.

C) <u>Bridges and culverts</u>

- Where re-pointing or pressure grouting of existing bridges/culverts, which have potential for roosting bats, is to be undertaken in the future, this will only proceed after an inspection of the structure for bat presence. Some crevices beneath bridges/culverts will be left open for bat use as deemed appropriate.

Table 7.2.5 Proposed mitigation measures for potential and confirmed bat roosts within 1km of the route

Map Ref. No.	Chainage	Description	Distance from roost or potential roost to the CPO	Potential/confirmed bat roosts	Proposed Mitigation Measures
2	0+000 K	Gate lodge, Ballyvally Estate	c.50m	Potential roost in gate lodge, mating roost in close vicinity	None required - offline
5	0+200 K	Private residence, Ballyvally Estate	c.180m	Confirmed roost – likely to be maternity roost for pipistrelles, mating roost	None required - offline
7	0+325 K	Area of mature woodland – ash, larch, beech	Online	Potential tree roosts, mating area	**A**
9	0+275 K	Mature treeline between property and Ballyvally	Online	Mating roost, potential tree roost	**A**
11	0+275 K	Private residence	Online	Confirmed soprano pipistrelle maternity roost, mating roost for common and soprano pipistrelles and Leisler's	**B**
10	0+280 K	Private residence	50m	Confirmed roost of a unidentified *Pipistrellus* sp.	None required - offline
12	0+400 K	Woodpiles at rear of private residence	10m	Hibernation roost	None required - offline
13	0+900 K	Mature oak with large crevice/split, broken boughs	Online	Potential tree roost	**A**
14	1+100 K	Local road at Knockyclovaun	Online	Mating activity	**A**
15	1+100 K	Private residence	50m	Likely soprano pipistrelle roost	None required - offline
16	1+100 K	Shed/Garage	Online	Confirmed soprano pipistrelle roost	**B**
17	1+105 K	Treeline of three semi-mature beech– S side of road	Online	Potential tree roost	**A**
20	2+000 K	Local road	Online	Mating roost	**A**
21	0+130 S	Treeline of mature beech	Online	Potential tree roost	**A**
22	0+100 S – 0+420 S	Area of mixed broadleaved woodland with treeline of old mature trees	Online	Potential tree roosts	**A**

Map Ref. No.	Chainage	Description	Distance from roost or potential roost to the CPO	Potential/confirmed bat roosts	Proposed Mitigation Measures
23	0+400 S	Private residence, Clarisford Palace	160m	Confirmed minor roost – brown long-eared bat	None required - offline
25	0+475 S	Private residence	Online	Confirmed brown long-eared and soprano pipistrelle roost, mating roost, good diversity of species recorded	**B** **C**
26	0+600 S	Treeline of mature beech	Online	Potential tree roosts	**A** **C**
28a	0+660 S	Mature sycamore and beech on island	Online	Potential tree roosts	**A** **C**
32	0+820 S	Mature oak and ash in treeline	Online	Potential tree roosts	**A** **C**
34	0+500 R	Mature ash with good ivy cover	Online	Potential tree roosts	**A**
36	0+750 R	Treeline mature beech, sycamore, Scot's pine at Gortna House	Online	Mating roost	**A**
40	2+400 R	Agricultural outbuilding	Online	Minor pipistrelle roost	**B**
41	2+600 R	Stone culvert below R494	Online	Potential hibernation roost	**C**
42	2+600 R	Cool Bridge	Online	Potential hibernation roost	**B,C**
43	3+050 R	Dooly's Bridge	Online	Potential minor roost	**C**

Mitigation measures and recommendations for the loss of commuting roosts and feeding areas

- The loss of feeding areas and severance of commuting routes can be mitigated by several measures, which are detailed below and presented in the NRA Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes (National Roads Authority 2006).
- Specific measures for each site identified as a feeding area/commuting route are detailed in **Table 7.2.6**.
- Enhancement areas will be replanted with native species to re-create habitats lost as a result of the road development. These areas will also serve as feeding areas for bats. The areas will arise from lands made redundant e.g. road pavements no longer required and which can be planted over, small areas of severed land.

D) Reconnection of severed linear habitats

- Severed linear features such as hedgerows and treelines will be reconnected using semi-mature trees under planted with hedgerow species to compensate for the loss of treelines and hedgerows that are used by bats as commuting routes. These measures will also compensate for habitat loss and provide continuity in the landscape. Areas requiring such planting are detailed in **Tables 7.2.5 and 7.2.6**.The exact locations and specifications of such planting to ensure the safe passage of commuting bats over the road will be designed by a bat specialist in conjunction with the landscaping contractor at the planting/design stage. Native species will be used as they support more insect life than non-native varieties.
- Where farm/property access tracks are created a hedgerow will be created on both sides of the track to create a corridor effect which will be of benefit to both foraging and commuting bats.
- An advanced planting contract will commence as soon as possible in terms of the re-creation of linear features along the margins of the CPO fence line. This will ensure that the hedgerow develops as quickly as possible and will reduce the impacts of fragmentation of habitats for both bats and other wildlife by reconnecting severed linear habitats as per the EIS. Following this planting the boundary of this planted area closest to the CPO may require protective fencing to prevent damage to planted vegetation once road construction commences. The creation of enhancement areas which will also serve as foraging areas for bats will be completed once the general landscaping contract commences.

E) Watercourses

- Watercourses present along the route corridor will be enhanced by the planting of native shrubs along one or both banks. The planting of shrubs in such areas provide shelter in which insect numbers can accumulate and also provide a corridor along which bats can commute. These measures will also enhance these areas for wildlife in general. Native species of shrub such as holly, hazel and hawthorn will be used to provide a vegetation belt along watercourses to act as a shelter belt for foraging bats.

F) Lighting

- In general, bright lighting creates a barrier to commuting bats so lighting will be minimised along the proposed route. This will be done by either reducing the height of lamp standards, or by using cowled lights to limit the light spread to the area required for illumination.

- This is especially important for the proposed River Shannon crossing. Trees and wooded areas will be retained as close as possible to the crossing point, to maintain a corridor effect and encourage bats to pass under the bridge/culvert and utilise feeding habitat on both sides. Similarly it is important that the retained sections of the shelterbelt of woodland at Ballyvally and the areas of woodland at the new tie in with the R463 remain unlit.

It is a typical condition of bat derogation licences that these mitigation measures will be monitored by a licensed bat specialist for up to two years following the destruction of roosts in order to ensure that they are functioning appropriately. Where a bat box is not being used by bats it will be relocated in order to ensure bats may utilise them more efficiently as per NRA guidelines.

Table 7.2.6 Proposed mitigation measures for areas of importance as commuting routes or feeding areas for bats within 1 km of the route

Map Ref. No.	Chainage	Description and Location	Distance from the CPO	Importance for bats	Proposed Mitigation Measures
1 & 6	0+000 K	Ballyvally Estate	c.50m	Frequent foraging along the R463. Potential roost in gate lodge, mating roost in close vicinity. Four bat species recorded in area.	**D** **C** between chainage 0+000 and 0+300 **G**
4	0+275 K	Private residence	Online	Foraging and commuting activity from and returning to confirmed roost. Three bat species recorded. Other roosts in close proximity.	**D** **E** between chainage 0+300 and retained hedgerows at 0+750
	0+750 K – 1+130 K	Area of improved grassland and hedgerows	Online	Likely to be used by pipistrelles	**D** **E** between chainage 0+750 and 1+130
16a	1+100 K	Local road at Knockyclovaun	Online	Medium – good levels of foraging activity for two species	**D** **E** between newly created access roads to carriageway and existing roadside hedges
	1+100 K – 1+500 K	Area of improved grassland and hedgerows	Online	Likely to be used by pipistrelles	**D** **E** between chainage 1+100 and 1+500
18	1+500 K	Local road at Shantraud	Online	High – good foraging area and commuting route from nearby roost, two pipistrelle species recorded	**D** **E** between newly created access roads to carriageway and existing roadside hedges
	1+500 K – 2+080 K	Area of improved grassland and hedgerows, conifer plantation and treelines	Online	Likely to be used by pipistrelles	**D** **E** between chainage 1+500 and 2+080 and between newly created access roads to carriageway and existing roadside hedges

Map Ref. No.	Chainage	Description and Location	Distance from the CPO	Importance for bats	Proposed Mitigation Measures
19	2+000 K	R463 at Shantraud	Online	Medium – good levels of foraging activity of common pipistrelle	**D** **E** between newly created access roads to carriageway from roundabout and existing roadside hedges
19, 28, 28a, 29 & 30	0+000 S – 0+650 S	R463, improved grassland, treelines, hedgerows, mixed broadleaf woodland, private residences, pond, lowland depositing rivers	Online	High - rich foraging and commuting area for good diversity of bat species (seven species recorded), confirmed roost nearby and online	**D** **E** between chainage 0+000 and 0+900 **F** **G**
33	0+000 Rsouth to 3+300 R	R 494 Ballina – Birdhill road, treelines, hedgerows, watercourses, improved agricultural grassland	Online	Locally important corridor for foraging bats, confirmed roost, potential tree roosts and hibernation roosts in the vicinity	**D** **E** between chainage 0+000 and 3+300 **F** **G**
38	1+100 R	Side road to R494 Ballina – Birdhill road	Offline	Commuting route for 2 pipistrelle species along watercourse	**D** **E** **F** **G**
39	2+300 R south to 2+750 R	R 494 Ballina – Birdhill road near Cool Bridge	Online	Locally important corridor for foraging bats from roost to Kilmastulla River at Cool Bridge	**D** **E** **F** **G**

Habitats

Mitigation measures to avoid and reduce impacts on habitats along the proposed route are presented below. These measures may relate also to mitigating against impacts for fauna and vice versa.

Terrestrial habitats

- To avoid impacting on bird nesting sites, the vegetation within the defined working area will be cut back outside the peak bird nesting season of mid-February to August prior to the onset of works. The extent of bankside disturbance shall be kept to the minimum required for completion of the contract.
- Control of the movement of construction plant within the site, to ensure that the minimum area of ground would be disturbed outside the footprint of the works.
- Within the scheme, the number of trees to be removed will be minimised and all trees to be retained will be afforded protection in accordance with the NRA Guidelines on the Protection of Trees on National Road Schemes (NRA 2006). The erection of all protective fencing will be undertaken prior to the commencement of any site works.
- The loss of habitats of along the route will be mitigated for by the landscape design associated with the proposed road improvements. The landscape design will use primarily native species and aim to recreate mixed species hedgerows and grasslands to compensate for the loss of these habitat types and will be undertaken in accordance with the NRA Guide to Landscape Treatments on National Road Schemes (NRA, 2006).

Landscaping:

- The impact of habitat loss and fragmentation on the movement of fauna is also addressed by the design of landscaping for the scheme in tandem with the provision of passage facilities and guide fencing for various mammalian species.
- Landscaping and design shall focus on the establishment of naturally occurring habitat types using predominantly native species to re-establish the linear corridor of vegetation along the river bank in accordance with *A Guide to Landscape Treatments for National Road Schemes in Ireland (*NRA, 2006).

Invasive Alien Species:

- All soil imported for landscaping purposes will be screened and verified as free of noxious weeds and invasive non-native species such as Japanese Knotweed, Himalayan balsam and giant hogweed. Due care will applied to ensure invasive alien species of plant and animal are not inadvertently spread during the landscaping works.
- In accordance with the NRA *Guidelines on The Management of Noxious Weeds and non-native plant Species on National Road Schemes* (2010) a pre-construction survey will be undertaken to map all locations of invasive alien species within or adjacent to the CPO. A specific management plan will be prepared detailing the various species distribution along the scheme, the treatment required during site clearance works, how to dispose of all material arising and an assessment of the risk of re-infestation from surrounding land.
- Monitoring of the effectiveness of control measures will be undertaken post construction in accordance with the NRA guidelines (ibid).

Mammals

Specific measures are proposed for dealing with mammals below that tie in with generic measures prescribed above.

Otter:

- Mitigation for otter will require the provision of safe passage along all watercourses. This will be achieved by the incorporation of suitable mammal passage facilities within all culverts in conjunction with otter-proof fencing along the road network to prevent animals from accessing the carriageway. The specification for otter passage and fencing design will be in accordance with the *Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes* (NRA, 2007). The maintenance of water quality within the scheme is covered under mitigation for aquatic habitats. The movement of fish will be maintained on all watercourses by ensuring a minimum depth of water and flow velocity in all bridge and culvert designs (in accordance with *Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes* (NRA, 2006) in order to retain their suitability for otter.
- The potential otter holt on the island at chainage 0+640 S and the couch on the Kilmastulla River at chainage 2+620 will be examined pre-construction for signs of activity and if active, will be excluded during the appropriate season under derogation from the NPWS. Consultation with the NPWS will be required to define the exclusion process.
- Artificial holts will be provided in the vicinity of both the Shannon and Kilmastulla crossings in locations and according to designs agreed with the NPWS.

Badger:

- While the provision of otter passage within all river crossing designs will also serve for other mammal species including badger, specific badger underpasses in accordance with *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (NRA, 2005) will be provided for in the vicinity of all locations where badger activity was recorded during the detailed winter mammal survey as detailed in Table 7.2.7. These locations are based on the current design and may be altered following development of the detailed design. Badger-proof fencing will be provided for a distance of 500m to either side of the underpasses in accordance with the NRA Guidelines and along the whole of the Killaloe Bypass. The feasibility of an underpass in the vicinity of Ballyvally Estate is however questionable as the road will be in deep cut though the wooded section where badger activity is concentrated.

Table7.2.7 Locations for Badger underpasses or passage facilities along proposed route

Chainage	***Description***
O+050 K	At eastern end of Ballyvally Estate.
0+700 K	At end of cut after Ballyvally Estate
1+760 K	In association with minor watercourse culvert at woodland edge.
0+140 S	In association with minor watercourse culvert at edge treeline.
0+600 S / 0+800 S	Along river and canal banks on both sides of River Shannon.
1+140 R	In association with watercourse culvert.
2+600 R	To north of Kilmastulla River at location existing dry culvert.

Fallow Deer:

- The prevention of fallow deer crossing the proposed road will require appropriate fencing and signage throughout the Killaloe Bypass section of the scheme.

Other mammals:

- Other species of mammal will benefit from the mitigation provided for otter and badger above in addition to the measures detailed under landscaping. Red squirrel is however, unlikely to benefit from such features and fragmentation of populations may occur.

Birds:

- Clearance of vegetation along the proposed route will take place outside of the breeding bird season (1st March to 31st August) in accordance with the Wildlife (Amendment) Act (2000). To compensate for the loss of habitat for bird species, landscaping proposals will primarily entail the use of native trees and shrubs. In addition, the use of pesticides and herbicides will be minimized to avoid reductions in insect populations and potential impacts on bird fertility.

Aquatic Habitats:

- All design, construction and operation shall be carried out in accordance with *Guidelines for the Crossing of Watercourse During the Construction of National Road Schemes* (NRA, 2006)
- The storage of oils, hydraulic fluids, etc will be undertaken in accordance with current best practice for oil storage (Enterprise Ireland, BPGCS005).
- The pouring of concrete, sealing of joints, application of water-proofing paint or protective systems, curing agents, etc will be completed in the dry to avoid pollution of the freshwater environment.
- All machinery operating in-stream will be steam-cleaned in advance of works and routinely checked to ensure no leakage of oils or lubricants occurs. All fuelling of machinery will be undertaken on dry land.
- Instream works (including erection and dismantling of temporary bridges, pile driving, etc., will be undertaken during the period 1st May to 30th September. This avoids the pollan spawning season (December to January inclusive) as well as that for salmonids. This will reduce the risk of accidental damage or siltation of spawning beds.
- A Class 2 Bypass Petrol/Oil Interceptor is to be provided at each outfall.
- Road runoff is to go through a stilling process to allow suspended solids to settle out (this may be in open ditches, ponds, hydrodynamic separators, etc.
- All pollution control facilities and attenuation areas shall be fitted with a penstock or similar restriction at the outfall to the receiving channel to contain pollutants in the event of an accidental spillage.
- Dredged spoil if arising, will be disposed of under appropriate licence or permissions to an authorised spoil depository location.
- The risk of accidental transfer of the non-native invasive species will require adherence to current best practice protocol for avoiding the spread or transfer of all invasive animals and plants including zebra mussel (Dreissena polymorpha). These measures will be enforced during construction to ensure accidental spread does not occur on machinery or materials from / to the site.

The developers will also adopt any modified or updated approaches to invasive alien species control.

- Preservation of stream flows for movement of fish by ensuring a minimum depth of water will be maintained in the streams.
- Prior to any instream works being undertaken, the stretches of watercourse to be impacted will be surveyed for protected aquatic species (lamprey ammocoetes and freshwater crayfish) and appropriate salvage measures employed (under licence from the NPWS).
- A continuous bund will be built 10m from the stream and its inflow to control suspended soils laden runoff from construction.
- Sediment collection mats will be placed in streams outflow in order to reduce the potential for discharge of silt laden runoff water to the streams.
- Work near surface water features will be carried out during drier months where possible.

7.2.6 Residual Impacts

With mitigation measures in place, the impact of the proposed scheme on the ecological environment along the proposed route will be locally significant at specific locations, namely the River Shannon and associated habitats, Kilmastulla River and at Ballyvally Estate woodland. With mitigation, the ecological integrity of the Lower River Shannon SAC will not be adversely affected.

Due to the extensive cut proposed in the vicinity of the Ballyvally Estate woodland, it is unlikely that badger passage will be accommodated at this location and thus fragmentation of the group’s territory is likely to occur. Similarly, the red squirrel population in this area is likely to be fragmented. Over time as the landscaping at these locations matures, the impact will be lessened. Elsewhere along the proposed route the impacts will be minor.

Given that suitable mitigation measures are applied in terms of the provision of alternative roosts for bats and timing of demolition the overall long term impact of the proposed loss of these roosts on the local bat population is deemed to be moderate. It is considered that, if appropriate mitigation measures are taken, bats of each species observed on site should persist in the area and a significant impact is not considered for bat populations.

7.3 Noise & Vibration

7.3.1 Introduction

This chapter deals with an assessment of the potential noise and vibration impacts associated with the proposed Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme.

Design Goal for Specifying Mitigation Measures

For new roads in Ireland, it is standard practice to adopt the traffic noise design goal contained within the NRA document (Guidelines for the Treatment of Noise and Vibration in National Road Schemes). This document specifies that the Authority (i.e. NRA) considers it appropriate to set the design goal for Ireland as follows:

- day-evening-night 60dB L_{den} (free field residential façade criterion)

Noise mitigation measures are deemed necessary whenever all of the following three conditions are satisfied:

(a) the combined expected maximum traffic noise level, i.e. the relevant noise level, from the proposed road scheme together with other traffic in the vicinity is greater than the design goal;

(b) the relevant noise level is at least 1dB more than the expected traffic noise level without the proposed road scheme in place, and;

(c) the contribution to the increase in the relevant noise level from the proposed road scheme is at least 1dB.

These conditions will ensure that mitigation measures arising out of this process are based upon the degree of impact of the scheme under consideration.

This Design Goal is applicable to new road schemes only. In EIS terms, this means that they are to be applied to existing receptors in respect of both the year of opening and the design year. In this case, the opening year of 2012 and a design year of 2027 have been assessed.

It is stated that the Authority acknowledges 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.

7.3.2 Methodology

In order to assess the noise impact of any proposed road scheme, the following methodology is normally adopted.

The first stage is to assess and quantify the existing noise environment in the vicinity of sensitive receptors that may be affected by the proposed development. In the case of a road scheme, the selected noise-sensitive locations are likely to be those in closest proximity to the proposed road. Both the construction and operational phases of the scheme should be reviewed when selecting appropriate measurement locations.

Where possible, the noise levels resulting from both the construction and operational phases are then calculated using established prediction techniques. The noise levels associated with the operational phase of the proposed development are predicted in accordance with guidance set out in Calculation of Road Traffic Noise (CRTN), giving results in the form of $L_{A10(18hour)}$ values. These are then converted to L_{den} values in accordance with the procedures detailed in the NRA guidance. The derived values for L_{den} should be rounded to the nearest whole number, with 0.5 being rounded up.

The predicted values are then assessed against the three conditions set out in **Section 7.3.1** in order to assess the need for mitigation measures.

Description of Existing Conditions

A series of environmental noise surveys was conducted in order to quantify the existing noise environment in the vicinity of noise-sensitive locations that may be affected by the proposed road development.

Table 7.3.1 Details of Survey Locations

Location	Description of Survey Location	Grid Reference	
		E	N
S01	On the grounds of Ballyvally House	169,113	173,942
S02	To the east of the R463, in the vicinity of a hotel	169,411	173,556
S03	Back garden of a residential dwelling	169,848	173,175
S04	Back garden of a residential dwelling along the R466	170,481	173,158
S05	Common area within a residential estate along the R463	169,447	172,957
S06	Along local road to the south of Killaloe	169,549	172,505
S07	Approximately 8m back from the R463	170,033	172,220
S08	In vicinity of bridge on the Ballina side	170,326	172,168
S09	Front garden of residential dwelling at junction of R494 and R496	170,835	172,095
S10	Along R494 in the vicinity of a residential dwelling	170,729	171,511
S11	Front garden of residential dwelling along the R494	170,825	170,451
S12	Along the R494 in the vicinity of a number of commercial premises	170,987	169,258

Survey Periods

Attended measurement survey periods were as follows:

- S01 to S06 on 30th June 2009, 10:00hrs to 17:00hrs, and;
- S07 to S12 on 25th August 2009, 10:00hrs to 16:00hrs.

Unattended 24-hour monitoring was conducted at the following locations:

- S03 between 17:00hrs on 29th June to 17:00hrs on 30th June 2009, and;
- S09 between 16:00hrs on 24th August and 16:00hrs on 25th August 2009.

7.3.3 Results

The survey results are presented in terms of the following three parameters.

L_{Aeq} is the A-weighted equivalent continuous steady sound level during the sample period and effectively represents an average value.

L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period; generally used to quantify background noise.

L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period; this parameter gives an indication of the upper limit of fluctuating noise such as that from road traffic.

The results for all twelve locations, along with the derived L_{den} values, are presented below:

Table 7.3.2 Shortened Measurement Results and LA10 (18hour) Values

Survey Location Reference	Time	Measured Noise Levels (dB re.2x10^{-5}Pa)			Derived dB L_{den}
		L_{Aeq}	L_{A10}	L_{A90}	
S01	10:00 - 10:15	42	45	37	47
	11:07 - 11:22	43	45	37	
	12:13 - 12:28	45	44	37	
S02	10:22 - 10:37	51	54	38	56
	11:28 - 11:43	51	55	40	
	12:35 - 12:50	52	56	37	
S03	10:41 - 10:56	41	44	35	47
	11:48 - 12:05	45	47	36	
	12:56 - 13:11	41	43	37	
S04	14:01 - 14:16	49	53	35	55
	15:03 - 15:18	54	54	37	
	16:01 - 16:16	51	55	36	
S05	14:20 - 14:35	50	55	38	57
	15:21 - 15:36	51	56	39	
	16:20 - 16:35	52	56	37	
S06	14:39 - 14:54	45	44	36	46
	15:39 - 15:54	43	42	37	
	16:39 - 16:54	48	44	38	
S07	10:03 - 10:18	52	54	34	56
	11:04 - 11:19	51	54	35	
	12:08 - 12:23	54	55	39	
S08	10:24 - 10:39	54	56	47	59
	11:24 - 11:39	57	60	49	
	12:30 - 12:45	55	58	48	
S09	10:43 - 10:58	54	58	43	58
	11:44 - 11:59	54	58	43	
	12:50 - 13:05	53	57	43	
S10	13:10 - 13:25	64	69	41	69
	14:03 - 14:18	63	69	40	
	15:00 - 15:15	65	70	42	

Survey Location Reference	**Time**	**Measured Noise Levels (dB re.2x10^{-5}Pa)**			**Derived dB L_{den}**
		L_{Aeq}	**L_{A10}**	**L_{A90}**	
S11	13:27 - 13:42	58	63	42	64
	14:20 - 14:35	60	64	43	
	15:18 - 15:33	58	64	37	
S12	13:44 - 13:59	64	70	46	69
	14:38 - 14:53	65	71	47	
	15:35 - 15:50	65	71	43	

Table 7.3.2 24-Hour Monitoring Results at Survey Location S03 (24hr)

Time Period	**Measured Noise Levels (dB re.2x10^{-5}Pa)**		
	L_{Aeq}	**L_{A10}**	**L_{A90}**
17:00	39	41	30
18:00	41	42	32
19:00	42	44	35
20:00	40	43	33
21:00	36	39	30
22:00	33	36	28
23:00	34	36	28
00:00	31	32	24
01:00	29	32	25
02:00	28	30	23
03:00	29	30	24
04:00	43	45	25
05:00	42	43	33
06:00	45	46	33
07:00	43	45	36
08:00	43	46	36
09:00	41	44	36
10:00	42	44	36
11:00	44	46	36
12:00	42	44	36
13:00	43	46	38
14:00	43	47	37
15:00	43	46	36
16:00	44	47	38
Measured value of L_{den}		46	

Table 7.3.4 24-Hour Monitoring Results at Survey Location S09 (24hr)

Time Period	Measured Noise Levels (dB re.2x10^{-5}Pa)		
	L_{Aeq}	L_{A10}	L_{A90}
16:00	56	59	48
17:00	57	60	50
18:00	72	76	55
19:00	56	60	47
20:00	54	58	45
21:00	52	57	40
22:00	50	55	34
23:00	47	52	30
00:00	45	47	29
01:00	39	37	27
02:00	41	39	27
03:00	41	36	27
04:00	40	35	27
05:00	43	43	27
06:00	50	55	30
07:00	55	59	40
08:00	55	59	42
09:00	54	58	42
10:00	55	58	41
11:00	54	58	42
12:00	55	59	45
13:00	55	58	45
14:00	56	59	47
15:00	55	59	44
Measured value of L_{den}		60	

Location S01

Noise levels at this location were dominated by distant traffic. Noise levels were in the range 42dB to 45dB L_{Aeq} and 44 to 45dB LA10. The derived L_{den} at this location is 47dB.

Location S02

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 51dB to 52dB L_{Aeq} and 54 to 56dB LA10. The derived L_{den} at this location is 56dB.

Location S03

Noise levels at this location were dominated by distant traffic. Noise levels were in the range 41dB to 45dB L_{Aeq} and 43 to 47dB LA10. The derived L_{den} at this location is 47dB.

This was also the location of an unattended 24-hour measurement. The measured L_{den} at this location was 46dB.

Location S04

Noise levels at this location were dominated by occasional local vehicle movements and distant road traffic. Noise levels were in the range of 49 to 54dB L_{Aeq} and 53 to 55dB LA10. The derived L_{den} at this location is 55dB.

Location S05

Noise levels at this location were dominated by local vehicle movements. Noise levels were in the range 50dB to 52dB L_{Aeq} and 55 to 56dB LA10. The derived L_{den} at this location is 57dB.

Location S06

Noise levels at this location were dominated by distant traffic. Noise levels were in the range 43dB to 48dB L_{Aeq} and 42 to 44dB LA10. The derived L_{den} at this location is 46dB.

Location S07

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 51dB to 54dB L_{Aeq} and 54 to 55dB LA10. The derived L_{den} at this location is 56dB.

Location S08

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 54dB to 57dB L_{Aeq} and 56 to 60dB LA10. The derived L_{den} at this location is 59dB.

Location S09

Noise levels at this location were dominated by local road traffic. Noise levels were in the range 53dB to 54dB L_{Aeq} and 57 to 58dB LA10. The derived L_{den} at this location is 58dB.

This was also the location of an unattended 24-hour measurement. The measured L_{den} at this location was 60dB

Location S10

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 63dB to 65dB L_{Aeq} and 69 to 70dB LA10. The derived L_{den} at this location is 69dB.

Location S11

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 58dB to 60dB L_{Aeq} and 63 to 64dB LA10. The derived L_{den} at this location is 64dB.

Location S12

Noise levels at this location were dominated by passing road traffic. Noise levels were in the range 64dB to 65dB L_{Aeq} and 70 to 71dB LA10. The derived L_{den} at this location is 69dB.

7.3.4 Assessment of Operational Noise

Traffic Noise Predictions for 2012 and 2027

Four scenarios have been considered as follows:

- Opening Year 2012 – Do Minimum (i.e. proposed development does not take place);
- Opening Year 2012 – Do Something (i.e. incorporates proposed development and incorporates the use of a low noise surface The low noise surface should have a minimum reduction in noise levels of 3.5dB when compared to hot-rolled asphalt, this reduction has been included in both do Something scenarios);
- Design Year 2027 – Do Minimum;
- Design Year 2027 – Do Something.

The results of the traffic noise predictions are presented in **Table 7.3.5**.

Table 7.3.5 Predicted Noise Levels for Years 2012 and 2027 for Do Minimum and Do Something Scenarios

Receiver Location Reference	Opening Year 2012		Mitigation Required?	Design Year 2027		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den}	L_{den}		L_{den}	L_{den}	
R001	55	56	No	58	58	No
R001a	67	58	No	69	60	No
R002	59	60	No	62	62	No
R003	47	46	No	49	49	No
R004	46	46	No	49	48	No
R005	63	56	No	66	59	No
R006	65	58	No	68	61	No
R007	67	60	No	70	62	No
R008	60	54	No	63	56	No
R009	42	42	No	44	44	No
R010	42	51	No	45	53	No
R011	50	51	No	53	54	No
R012	45	54	No	48	56	No
R013	52	54	No	54	57	No
R014	51	51	No	54	55	No
R015	60	60	No	62	62	No
R016	50	58	No	52	60	No
R017	54	54	No	56	57	No
R018	58	53	No	61	58	No
R019	59	57	No	62	59	No
R020	62	59	No	65	61	No
R021	64	60	No	67	62	No
R022	59	59	No	61	61	No
R023	62	63	No*	65	65	No

Receiver Location Reference	Opening Year 2012		Mitigation Required?	Design Year 2027		Mitigation Required?
	Predicted Noise Level			Predicted Noise Level		
	Do Minimum	Do Something		Do Minimum	Do Something	
	L_{den}	L_{den}		L_{den}	L_{den}	
R024	51	57	No	54	60	No
R025	68	64	No	71	67	No
R026	48	58	No	50	60	No
R027	48	54	No	50	56	No
R028	67	68	No*	69	69	No
R029	68	64	No	70	67	No
R030	63	63	No	66	65	No
R031	59	60	No	61	62*	No
R032	51	52	No	54	54	No
R033	70	70	No	72	72	No
R034	60	57	No	62	60	No
R035	57	56	No	60	59	No
R036	57	57	No	60	60	No
R037	61	61	No	63	63	No
R038	62	60	No	64	64	No
R039	51	52	No	53	55	No
R040	66	62	No	69	67	No
R041	62	60	No	64	62	No
R042	62	62	No	64	63	No
R043	60	57	No	63	58	No
R044	64	59	No	66	61	No
R045	62	57	No	64	59	No
R046	68	64	No	70	66	No
R047	61	59	No	63	60	No
R048	56	53	No	58	55	No
R049	62	59	No	64	61	No
R050	61	58	No	63	60	No
R051	62	60	No	65	62	No
R052	70	67	No	72	68	No
R053	65	63	No	68	65	No
R054	68	62	No	71	64	No
R055	70	59	No	72	61	No
R056	63	56	No	65	58	No
R057	64	57	No	66	58	No
R058	64	55	No	67	56	No
R059	63	60	No	65	61	No
R060	61	57	No	63	58	No

Note * Contains a contribution of less than 1dB from the new scheme, therefore Condition (c) of the Design Goal (refer to Section 7.3.1) is not satisfied and mitigation measures are not required.

Year 2012

The combined expected maximum traffic noise level from the proposed road scheme together with other traffic in the vicinity (i.e. Do Something scenario) is greater than 60dB L_{den} at thirteen locations: R023, R025, R028, R029, R030, R033, R037, R040, R042, R046, R052, R053 and R054.

The Do Something noise level at all of these locations is less than or equal to the Do Nothing level or is dominated by contributions from the existing road network. Mitigation measures are therefore not required at these locations.

Year 2027

The combined expected maximum traffic noise level from the proposed road scheme together with other traffic in the vicinity (i.e. Do Something scenario) is greater than 60dB L_{den} at twenty eight locations: R002, R006, R007, R015, R020, R021, R022, R023, R025, R028, R029, R030, R031, R033, R037, R038, R040, R041, R042, R044, R046, R049, R051, R052, R053, R054, R055 and R059.

The Do Something noise level at all of these locations is less than or equal to the Do Nothing level or is dominated by contributions from the existing road network. Mitigation measures are therefore not required at these locations.

7.3.5 Description of Mitigation Measures

The predicted noise levels outlined do not satisfy the criteria in **Section 7.3.1**, therefore no further mitigation over and above the low noise surface along the length of the entire route is required.

7.3.6 Construction Impacts and Mitigation Measures

Standards and Guidelines

As per NRA guidance noise levels associated with construction may be calculated in accordance with methodology set out in BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise*. This standard sets out sound power levels for plant items normally encountered on construction sites, which in turn enables the prediction of noise levels at selected locations. However, it is often not possible to conduct detailed prediction calculations for the construction phase of a project in support of the EIS. This is due to the fact that the programme for construction works has not been established in detail. Under such circumstances, best practice involves the consideration of appropriate mitigation measures.

The NRA guidance document specifies noise levels that it typically deems acceptable in terms of construction noise. These limits are set out in **Table 7.3.6.** Note that these values are indicative only; it may be appropriate to apply more stringent limits in areas where pre-existing noise levels are low.

Table 7.3.6 Maximum Permissible Noise Levels at the Façade of Nearby Dwellings during Construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturday 08:00 to 16:30hrs	65	75
Sundays and Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other that required for emergency works, will normally require the explicit permission of the relevant local authority.

Assessment of Construction Noise

A variety of items of plant will be in use, such as excavators, lifting equipment, dumper trucks, compressors and generators. It is also possible that rock breaking may be required on occasions and there will be vehicular movements to and from the site that will make use of existing roads.

Due to the nature of the activities undertaken on a large construction site, there is potential for generation of significant levels of noise. The flow of vehicular traffic to and from a construction site is also a potential source of relatively high noise levels.

Due to the fact that the construction programme has been established in outline form only, it is not possible to calculate the actual magnitude of noise emissions to the local environment. However, the following paragraphs present calculations of indicative noise levels for typical noise sources associated with road construction.

BS 5228: 2009: *Code of practice for noise and vibration control on construction and open sites – Part 1: Noise* sets out typical noise levels for items of construction plant. **Table 7.3.7** lists the expected noise level at various distances from the roadway.

Table 7.3.7 Indicative noise levels from construction plant items at various distances from the road

Item of Plant (BS5228 Ref.)	Highest predicted noise level at stated distance from edge of works (dB $L_{Aeq(1hr)}$)				
	10m	20m	40m	60m	100m
Pneumatic breaker (C.8.12)	72	66	60	56	52
Wheeled loader (C.3.51)*	68	62	56	52	48
Tracked excavator (C.3.43)*	69	63	57	53	49
Dozer (C.3.30)*	70	64	58	54	50
Dump truck (C.3.60)*	66	60	54	50	46
Vibratory roller (C.3.116)	72	66	60	56	52
Asphalt Spread (C.8.24)	76	70	64	60	56
Diesel Hoist (C.7.98)	70	64	58	54	50
Compressor (C.7.27)	67	61	55	51	47
Generator (C.7.49)	71	65	59	55	51
Road Roller (C.3.114)	74	68	62	58	54
HGV Movements (20 per hour)	59	56	53	52	49

Note * Assume noise control measures as outlined in Table B1 of BS 5228 – 1 (i.e. fit acoustic exhaust).

The noise levels presented are within the limit values shown in **Table 7.3.6** for weekday daytime periods at distances of 20m or greater from the works. The following section describes typical measures to minimise the potential for noise disturbance to the surrounding area.

Mitigation Measures

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS 5228: Part 1 and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001.

During the course of the construction programme, supervision of the works will include ensuring compliance with the limits detailed in **Table 7.3.6**.

Working Hours

Normal working times will be 07:00 to 19:00hrs Monday to Saturday. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached.

Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority. Night is defined as 19:00 to 07:00hrs.

When overtime and shift work is permitted, the hauling of spoil and delivery of materials outside normal working hours is prohibited and the noise limits outlined in **Table 7.3.6** will apply.

Emergency Work

The emergency work referred to above may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.

7.3.7 Residual Impacts

Construction Phase

During the construction phase of the project there will be some small impact on nearby residential properties due to noise emissions from site traffic and other activities. The application of binding noise limits and hours of operation, along with implementation of appropriate noise control measures, will ensure that noise impact is kept to a minimum.

Operational Phase

None of the locations assessed in this document meet all of the three conditions that must be satisfied before noise mitigation measures are deemed necessary. The predicted noise levels at all locations assessed comply with the adopted criterion.

7.3.8 Vibration

This section deals with the potential for vibration during both construction and operational phases of the proposed development. The NRA Guidelines provide guidance in relation to vibration from the construction and operational phases of road schemes and this is referenced in this section.

Description of Existing Environment

A survey of vibration along the proposed route corridor was not undertaken, as levels associated with existing roads would not be expected to be of a magnitude sufficient to cause disturbance to people or structural damage to property. Furthermore, vibration was not perceptible at any of the noise survey locations.

Potential Impacts – Operational Phase

As a vehicle travels along a road, vibration can be generated in the road and subsequently propagate towards nearby buildings. Such vibration is generated by the interaction of a vehicle's wheels and the road surface and by direct transmission through the air of energy waves. Some of these waves arise as a function of the size, shape and speed of the vehicle, and others from pressure fluctuations due to engine, exhaust and other noises generated by the vehicle.

It has been found that ground vibrations produced by road traffic are unlikely to cause perceptible structural vibration in properties located near to well-maintained and smooth road surfaces. Problems attributable to road traffic vibration can therefore be largely avoided by maintenance of the road surface.

Potential Impacts – Construction Phase

The potential for vibration at neighbouring sensitive locations during construction is typically limited to demolition, excavation works, rock-breaking operations and lorry movements on uneven road surfaces. The more significant of these is the vibration from excavation and rock-breaking operations; the method of which will be selected and controlled to ensure there is no likelihood of structural or even cosmetic damage to existing neighbouring dwellings.

Mitigation Measures and Residual Impacts

The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities will be limited to the values set out in **Table 7.3.8**.

Table 7.3.8 Maximum Allowable Vibration Velocity

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Measures shall be taken to minimize vibration due to plant and machinery on the site and no machine which uses the dropping of heavy weights for the purpose of demolition shall be permitted.

Ground vibration from additional traffic due to the development under consideration would be expected to be orders of magnitude less than that required to cause cosmetic or structural damage to buildings or lead to disturbance of occupiers, hence mitigation measures are not required in respect of the operational phase.

It may be concluded that the proposed road scheme is not expected to give rise to vibration that is either significantly intrusive or capable of giving rise to structural or even cosmetic damage.

7.3.9 Conclusion

The noise environment in the vicinity of the proposed scheme has been characterised by a set of traffic noise surveys. The existing noise levels are typical of a semi-rural area in the vicinity of a major road.

Noise levels with the scheme and a suitable low noise surface in place have been predicted to be within the design goals as set down in the NRA Guidelines at all receiver locations assessed; therefore no further remedial measures are required.

Indicative noise levels during the construction phase of the scheme have been predicted. It has been shown that is possible to comply with the construction noise limits in the Guidelines.

7.4 Air Quality & Climate

7.4.1 Introduction

Ambient Air Quality Standards

In order to reduce the risk to health from poor air quality, national and European statutory bodies have set limit values in ambient air for a range of air pollutants. These limit values or "Air Quality Standards" are health or environmental-based levels for which additional factors may be considered. For example, natural background levels, environmental conditions and socio-economic factors may all play a part in the limit value which is set.

Air quality significance criteria are assessed on the basis of compliance with the appropriate standards or limit values. The applicable standards in Ireland include the Air Quality Standards Regulations 2002, which incorporate European Commission Directives 1999/30/EC and 2000/69/EC, which have set limit values for the pollutants SO_2, NO_2, PM_{10}, benzene and CO. The most recent European Commission Directive on ambient air quality was published on the 11/06/08. Council Directive 2008/50/EC combines the previous Air Quality Framework Directive (96/62/EC) and its subsequent daughter directives (including 1999/30/EC and 2000/69/EC). Provisions were also made for the inclusion of new ambient limit values relating to PM2.5 (see **Table 7.4.1**).

Climate Agreements

Ireland ratified the United Nations Framework Convention on Climate Change (UNFCCC) in April 1994 and the Kyoto Protocol in principle in 1997 and formally in May 2002. For the purposes of the EU burden sharing agreement under Article 4 of the Kyoto Protocol, in June 1998, Ireland agreed to limit the net growth of the six GHGs under the Kyoto Protocol to 13% above the 1990 level over the period 2008 to 2012. The UNFCCC is continuing detailed negotiations in relation to GHGs reductions and in relation to technical issues such as Emissions Trading and burden sharing. The most recent Conference of the Parties (COP14) to the agreement was convened in Poznan, Poland in December 2008.

Gothenburg Protocol

In 1999, Ireland signed the Gothenburg Protocol to the 1979 UN Convention on Long Range Transboundary Air Pollution. The objective of the Protocol is to control and reduce emissions of Sulphur Dioxide (SO_2), Nitrogen Oxides (NO_X), Volatile Organic Compounds (VOCs) and Ammonia (NH_3). To achieve the targets Ireland since 2010, have to meet national emission ceilings of 42kt for SO_2 (67% below 2001 levels), 65kt for NO_X (52% reduction), 55kt for VOCs (37% reduction) and 116kt for NH_3 (6% reduction). EU Directive 2001/81/EC, the National Emissions Ceiling Directive, prescribes the same emission limits. Emissions of SO_2 and NH_3 from the road traffic sector are insignificant accounting for less than 1.5% of total emissions in Ireland in 2001. Road traffic emissions of Nitrogen Oxides (NO_X) and Volatile Organic Compounds (VOCs) are important accounting for 37% and 38% respectively of total emissions of these pollutants in Ireland in 2001. A National Programme for the progressive reduction of emissions of the four transboundary pollutants is in place since April 2005.

7.4.2 Methodology Used for Assessment of Impacts

Local Air Quality Assessment

The air quality assessment has been carried out following procedures described in the publications by the EPA and using the methodology outlined in the guidance documents published by the UK DEFRA. The assessment of air quality was carried out using a phased approach as recommended by the UK DEFRA. The phased approach recommends that the complexity of an air quality assessment be consistent with the risk of failing to achieve the air quality standards. In the current assessment, an initial scoping of possible key pollutants was carried out and the likely location of air pollution “hot-spots” identified. An examination of recent EPA and Local Authority data in Ireland, has indicated that SO_2 and smoke and CO are unlikely to be exceeded at locations such as the current one and thus these pollutants do not require detailed monitoring or assessment to be carried out. However, the analysis did indicate potential problems in regards to nitrogen dioxide (NO_2) and PM_{10} at busy junctions in urban centres. Benzene, although previously reported at quite high levels in urban centres, has recently been measured at several city centre locations to be well below the EU limit value. Historically, CO levels in urban areas were a cause for concern. However, CO concentrations have decreased significantly over the past number of years and are now measured to be well below the limits even in urban centres.

The current assessment thus focused firstly on identifying the existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, benzene and CO in the region of the proposed road development, both currently (by carrying out a baseline survey and by analysis of suitable EPA monitoring data), and with the proposed development in place (through modelling). Thereafter, the impact of the development on air quality at the neighbouring sensitive receptors was determined relative to the existing baseline for the opening (2012) and design years (2027). The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (Version 1.03c, July 2007) and following guidance issued by the NRA, UK DEFRA and the EPA. The inputs to the air dispersion model consist of information on road layouts, receptor locations, annual average daily traffic movements (AADT), annual average traffic speeds and background concentrations. Using this input data the model predicts ambient ground level concentrations at the worst-case sensitive receptor using generic meteorological data. This worst-case concentration is then added to the existing background concentration to give the worst-case predicted ambient concentration. The worst-case predicted ambient concentration is then compared with the relevant ambient air quality standard to assess the compliance of the proposed road development with these ambient air quality standards.

Although no relative impact, as a percentage of the limit value, is enshrined in EU or Irish Legislation, the NRA guidelines detail a methodology for determining air quality impact significance criteria for road schemes. The degree of impact is determined based on both the absolute and relative impact of the development. The NRA significance criteria have been adopted for the current development. The significance criteria are based on PM_{10} and NO_2 as these pollutants are most likely to exceed the limit values. However the criteria have also been applied to the predicted 8-hour CO, annual benzene and annual $PM_{2.5}$ concentrations for the purposes of this assessment.

Regional Impact Assessment (Including Climate)

The impact of the proposed road development at a national / international level has been determined using the procedures given by the NRA and the methodology provided in Annex 2 in the UK DMRB. The assessment focused on determining the resulting change in emissions of CO, particulates (PM_{10}), hydrocarbons (VOCs), nitrogen oxides (NO_x) and carbon dioxide (CO_2). The Annex provides a method for the prediction of the regional impact of emissions of these pollutants from road schemes. The inputs to the air dispersion model consist of information on road link lengths, annual average daily traffic movements (AADT) and annual average traffic speeds.

7.4.3 Description of the Existing Environment

Meteorological Data

A key factor in assessing temporal and spatial variations in air quality is the prevailing meteorological conditions. Depending on wind speed and direction, individual receptors may experience very significant variations in pollutant levels under the same source strength (i.e. traffic levels). Wind is of key importance in dispersing air pollutants and for ground level sources, such as traffic emissions, pollutant concentrations are generally inversely related to wind speed. Thus, concentrations of pollutants derived from traffic sources will generally be greatest under very calm conditions and low wind speeds when the movement of air is restricted. In relation to PM_{10}, the situation is more complex due to the range of sources of this pollutant. Smaller particles (less than $PM_{2.5}$) from traffic sources will be dispersed more rapidly at higher wind speeds. However, fugitive emissions of coarse particles ($PM_{2.5}$ - PM_{10}) will actually increase at higher wind speeds. Thus, measured levels of PM_{10} will be a non-linear function of wind speed.

The nearest representative weather station collating detailed weather records is Shannon Airport meteorological station, which is located approximately 33 km west of the proposed road. For data collated during five representative years (1998-2002), the predominant wind ranges from southwest to west in direction, with an average wind speed of approximately 4-6 m/s.

Trends In Air Quality

Air quality is variable and subject to both significant spatial and temporal variation. In relation to spatial variations in air quality, concentrations generally fall significantly with distance from major road sources. Thus, residential exposure in urban and suburban areas will be determined by the location of sensitive receptors relative to major roads sources in the area. Temporally, air quality can vary significantly by orders of magnitude due to changes in traffic volumes, meteorological conditions and wind direction.

In assessing baseline air quality, two tools are generally used: ambient air monitoring and air dispersion modelling. In order to adequately characterise the current baseline environment through monitoring, comprehensive measurements would be required at a number of key receptors for PM_{10}, NO_2 and benzene. In addition, two of the key pollutants identified in the scoping study (PM_{10} and NO_2) have limit values which require assessment over time periods varying from one hour to one year. Thus, continuous monitoring over at least a one-year period at a number of locations would be necessary in order to fully determine compliance for these pollutants. Although this study would provide information on current air quality it would not be able to provide predictive information on baseline conditions, which are the conditions which prevail just prior to opening in the absence of the development. Hence the impacts of the development were fully assessed by air dispersion modelling which is the most practical tool for this purpose. The baseline environment has also been assessed using modelling, since the use of the same predictive technique for both the “do minimum" and "do something" scenario will minimise errors and allow an accurate determination of the relative impact of the development.

Baseline Air Quality Monitoring

Baseline monitoring was carried out close to the route of the R463, the R494 and near the proposed route of the Killaloe Bypass. The survey was indicative only and cannot be used to gauge compliance with either the short-term or annual limit values for the reasons outlined above. The survey does however allow an indicative assessment of the influence of local road sources relative to the prevailing background level of these pollutants in the area. The monitoring methodology and results are described below.

NO_2

NO_2 monitoring, using nitrogen dioxide passive diffusion tubes, was conducted over a one-month period at seven locations. The results allow an indicative comparison with the annual average limit value and an assessment of the spatial variation of NO_2 away from existing road sources.

The passive diffusion tube survey was designed to assess urban background and roadside levels close to the proposed road alignment. The monitoring results show that one month average concentrations along the proposed Killaloe Bypass route ranged from 5 - 10 μg/m^3, while the average concentration measured along the R494 was 16 μg/m^3. The concentration measured in Killaloe town was 7 μg/m^3. Thus average NO_2 concentrations measured over the one month period were all well below the national and EU annual limit value of 40 μg/m^3, reaching at most 58% of this limit.

Benzene

Benzene was monitored, using passive diffusion tubes over a one month period at three locations close to the proposed road alignment. The passive diffusion tube survey was designed to assess urban background and roadside levels along the route of the proposed road. Average benzene concentrations over the one month monitoring period measured less than 0.5 μg/m^3. Thus the average concentrations measured reached at most 10% of the national and EU limit value of 5 μg/m^3.

EPA Monitoring Data and Background Concentrations

Air quality monitoring programs have been undertaken in recent years by the EPA and Local Authorities. The most recent annual report on air quality in Ireland is the "*Air Quality Monitoring Report 2007*". The EPA website details the range and scope of monitoring undertaken throughout Ireland and provides both monitoring data and the results of previous air quality assessments.

In terms of air monitoring and assessment, Killaloe is categorised as Zone D. The long-term monitoring data has been used to determine background concentrations for the key pollutants in the region of the proposed development. The background concentration accounts for all non-traffic derived emissions (e.g. natural sources, industry, home heating etc.).

NO_2 monitoring was carried out at five Zone D locations in 2007, Navan, Ferbane, Cork Harbour, Glashsaboy and Kilkitt. The NO_2 annual averages for the sites ranged from 2 μg/m^3 in Kilkitt to 16 μg/m^3 in Navan. NO_2 monitoring was carried out at three Zone C locations in 2007, Limerick Park Road, Ennis and Waterford. The NO_2 annual averages for these three sites were 15, 14 and 18 μg/m^3, respectively.

Hence long-term average concentrations measured at these locations were significantly lower than the annual average limit value of 40 µg/m^3. Based on the above information, a conservative estimate of the background NO_2 concentration for Killaloe in 2007 is 15 µg/m^3.

The results of CO monitoring carried out in Navan in 2007 (Zone D) showed no exceedences of the 8-hour limit value, with an average level of 0.5 mg/m^3. Data for the Zone C station in Waterford in 2007 indicated a long-term average of 0.5 mg/m^3 respectively(19). Based on the above information, a conservative estimate of the background CO concentration for Killaloe in 2007 is 0.5 mg/m^3.

With regard to benzene, monitoring was carried out at Waterford in 2007, with an annual average of 0.8 µg/m^3 respectively. The results of monitoring carried out in the Zone C locations of Ennis and Bray in 2006 indicated long-term averages of 0.6 and 0.3 µg/m^3 respectively. Based on the above information, a conservative estimate of the background benzene concentration for Killaloe in 2007 is 0.6 µg/m^3.

Long-term PM_{10} measurements carried out at seven Zone D locations in 2007, gave average levels ranging from 10 µg/m^3 in Kilkitt to 23µg/m^3 in Navan. Data from the Phoenix Park in Dublin also provides a good indication of urban background levels, with an annual average in 2007 of 12 µg/m$^{3.}$ Based on this information, a conservative estimate of the background PM_{10} concentration for Killaloe in 2007 of 16 µg/m^3 has been used.

The results of $PM_{2.5}$ monitoring at Station Road in Cork City in 2007 indicated an average $PM_{2.5}/PM_{10}$ ratio of 0.53. Based on this information, a conservative ratio of 0.6 was used to generate a background $PM_{2.5}$ concentration in 2007 of 9.6 µg/m^3.

Background concentrations for 2012 and 2027 were calculated from the 2007 background concentrations using the Netcen background calculator, which uses year on year reduction factors provided by DEFRA.

In summary, existing baseline levels of NO_2, PM_{10}, $PM_{2.5}$, CO and benzene based on extensive long-term data from the EPA are expected to be below ambient air quality limit values in the vicinity of the proposed road scheme.

7.4.4 Predicted Impacts of the Scheme

Construction Phase: Air Quality

The greatest potential impact on air quality during the construction phase is from construction dust emissions and the potential for nuisance dust. In order to minimise dust emissions during construction, a series of mitigation measures have been prepared in the form of a dust minimisation plan. Provided the dust minimisation measures outlined in the plan (see **Appendix 7.4.1**) are adhered to, the air quality impacts during the construction phase will be not be significant.

Construction Phase: Climate

Due to the size and nature of the construction activities, CO_2 and N_2O emissions during construction will have a negligible impact on climate.

Operational Phase: Local Air Quality Assessment

Detailed traffic flow information was obtained from the traffic consultant for the project and has been used to model pollutant levels under various traffic scenarios and under sufficient spatial resolution to assess whether any significant air quality impact on sensitive receptors may occur.

Cumulative effects have been assessed, as recommended in the EU Directive on EIA (Council Directive 97/11/EC) and using the methodology of the UK DEFRA. Firstly, background concentrations have been included in the modelling study, for both “do minimum” and “do something” scenarios. These background concentrations are year-specific and account for non-localised sources of the pollutants of concern. Appropriate background levels were selected based on the available monitoring data provided by the EPA.

Once appropriate background concentrations were established, the existing situation, including background levels, was assessed in the absence of the development for the opening and design years (2012 and 2027). The assessment methodology involved air dispersion modelling using the UK DMRB Screening Model (Version 1.03c) and the NO_x to NO_2 Conversion Spreadsheet (Version 1.1 (Released December 2008)) and follows guidance issued by the UK DEFRA. Ambient concentrations of CO, benzene, NO_2, PM_{10} and $PM_{2.5}$ for the opening (2012) and design year (2027) were predicted at the nearest sensitive receptors to the road development. “Do minimum” and “do something” modelling was carried out at the building façade of the worst-case receptors for both years. This assessment allows the significance of the development, with respect to both relative and absolute impact, to be determined.

Operational Phase: Local Air Quality - Receptor Locations

Twenty-four receptor locations were modelled in the region of the Killaloe Bypass, Shannon River Crossing and R494. The receptors modelled represent the worst-case locations along individual sections of the proposed road development and were chosen due to their close proximity to the major roads within the study area. Annual average traffic speeds are required as an input to the DMRB screening model. Results are reported for typical traffic speeds. The discussion below provides modelling results for CO, benzene, PM_{10}, $PM_{2.5}$ and NO_2 based on typical speeds.

“Do Minimum” Modelling Assessment

PM_{10}, CO and Benzene

The results of the “do minimum” modelling assessment for PM_{10}, CO and benzene in the opening and design years are shown in **Tables 7.4.2 and 7.4.3**. Concentrations are well within the limit values under all scenarios at all worst-case receptors. Levels of all three pollutants range from 10 - 41% of the respective limit values in 2012.

The temporal trend in these pollutants can be established by an examination of levels in 2012 and 2027 (see **Tables 7.4.2 and 7.4.3**). Future trends for the “do minimum” scenario indicate similar levels of PM_{10}, CO and benzene. “Do minimum” levels of all three pollutants range from 11% of the limit value for benzene to 40% of the annual limit value for PM_{10} in 2027.

NO_2

The results of the baseline modelling assessment for annual average NO_2 concentrations in the opening and design years are shown in **Tables 7.4.2 and Table 7.4.3.** The modelling assessment for NO_2 indicates that baseline levels peak at 43% of the limit value in 2012 and at 45% of the limit value in 2027.

The EU limit value for the maximum one-hour standard for NO_2 is based on a one-hour mean not to be exceeded more than 18 times a year (99.8th%ile). The maximum 1-hour limit value (as a 99.8th%ile) in either 2012 or 2027 is predicted to peak at 45% of this limit value.

$PM_{2.5}$

The results of the "do minimum" modelling assessment for $PM_{2.5}$ in the opening and design years are shown in **Tables 7.4.2 and 7.4.3**. The $PM_{2.5}$ concentration peaks at 10.1 μg/m^3 as an annual average in 2012. This level is below the limit value which is in place since 2010.

The temporal trend in $PM_{2.5}$ can be established by an examination of levels in 2012 and 2027 (see **Tables 7.4.2 and 7.4.3**). "Do minimum" levels of $PM_{2.5}$ will also peak at 10.1 μg/m^3 at the worst-case receptor in 2027 which is below the annual limit value in place since 2010.

Modelled Impact of the Development Once Operational ("Do Something")

$PM_{10,}$ CO and Benzene

The results of the modelled impact of the road development for PM_{10}, CO and benzene in the opening year are shown in **Tables 7.4.4 – 7.4.5.** The cumulative impact of both "do minimum" traffic levels and additional traffic due to the road development are presented. Concentrations are below the ambient standards under all scenarios. Levels of all three pollutants range from 11% of the annual limit value for benzene and 40% of the annual limit value for PM_{10} in 2027.

The impact of the development can be assessed relative to "do minimum" levels in the worst case year which is the design year. Relative to baseline levels, some small increases and decreases in pollutant levels at the worst-case receptors are predicted as a result of the proposed road development.

With regard to CO, all twenty-four receptors will experience an increase or decrease in levels of less than 2% of the limit value in the design year. The greatest impact on CO concentrations will be an increase of 0.7% of the limit value, while the greatest improvement will be a decrease of 1.6% of the limit value.

With regard to benzene, all twenty-four receptors will experience an increase or decrease in levels of less than 1% of the limit value in the design year. The greatest impact on benzene concentrations will be an increase of 0.3% of the limit value, while the greatest improvement will be a decrease of 0.8% of the limit value.

With regard to $PM_{10,}$ all twenty-four receptors assessed will experience an increase or decrease in levels of less than 2% of the limit value in the design year. The greatest impact on PM_{10} concentrations will be an increase of 0.9% of the limit value, while the greatest improvement will be a decrease of 1.4% of the limit value.

Thus, using the assessment criteria for NO_2 and PM_{10} and applying these criteria to CO and benzene as well as PM_{10}, the impact of the road development in terms of $PM_{10,}$ CO and benzene is negligible at all twenty-four worst-case receptors assessed.

NO_2

The results of NO_2 dispersion modelling of the proposed road development in the opening year (2012) are shown in **Tables 7.4.4 – 7.4.5**. The annual average concentration is within the annual limit value for all scenarios. Future trends, with the road development in place, indicate similar annual levels of NO_2. Levels of NO_2 range from 32 - 43% of the annual limit value in 2012 and 2027.

Maximum one-hour NO_2 levels with the development in place will be significantly below the limit value, with levels at the worst-case receptor reaching 43% of the limit value in 2012 and 2027.

The impact of the development on maximum one-hour NO_2 levels can be assessed relative to "do minimum" levels in the design year (see **Tables 7.4.2 – 7.4.3**). Relative to baseline levels, some increases and decreases in pollutant levels are predicted as a result of the proposed road development.

Twenty-one of the twenty-four receptors assessed will experience an increase or decrease in levels of less than 5% of the limit value. Three receptors will experience a decrease greater than 5% of the limit value. The greatest impact on NO_2 concentrations will be an increase of 4.7% of the limit value, while the greatest improvement will be a decrease of 6.4% of the limit value.

Thus, using the assessment criteria, the impact of the road development in terms of NO_2 is negligible at twenty-one worst-case receptors assessed and slight beneficial at three of the receptors assessed.

$PM_{2.5}$

The results of the impact assessment of the proposed road development for $PM_{2.5}$ in the opening year (2012) and design year (2027) are shown in **Tables 7.4.4 – 7.4.5**. The $PM_{2.5}$ concentration peaks at 10.1 μg/m^3 as an annual average in 2012. This level is below the annual limit value which was set in 2010. "Do something" levels of $PM_{2.5}$ will decrease slightly peaking at 10.0 μg/m^3 at the worst-case receptor in 2027 which is again below the annual limit value which was put in place since 2010.

The impact of the development on annual average $PM_{2.5}$ levels can be assessed relative to "do minimum" levels in the design year (see **Table 7.4.2 – 7.4.3**). Relative to baseline levels, some small increases and decreases in $PM_{2.5}$ levels at the worst-case receptors are predicted as a result of the proposed road development.

Twenty-two of the twenty-four receptors assessed will experience an increase or decrease in levels of less than 2% of the limit value. Two receptors will experience a decrease greater than 2% of the limit value. The greatest impact on $PM_{2.5}$ concentrations will be an increase of 1.5% of the limit value, while the greatest improvement will be a decrease of 2.3% of the limit value.

Thus, using the assessment criteria for PM_{10}, and applying these criteria to $PM_{2.5}$, the impact of the road development in terms of $PM_{2.5}$ is negligible at 22 of the worst-case receptors assessed and is slight beneficial at two of the receptors assessed.

Worst-case Traffic Speed Scenario

An assessment of the effect of changing the traffic speed (for the entire assessment year) from typical to worst-case peak hour speeds has also been carried out for all pollutants (see **Table 7.4.6**). Dispersion modelling was carried out at Receptors 15 and 17 as these represent the highest predicted pollutant levels or impacts for the typical speed scenario.

The results indicate that the levels of CO, benzene, PM_{10}, $PM_{2.5}$ and NO_2 are increased at the worst-case traffic speed. Nevertheless, pollutant levels are still below the relevant limit values with the proposed road development in place, ranging from 11 - 49% of the limit values in 2012 and 2027.

Air Quality Impacts on Sensitive Ecosystems

The EC Directive 92/43/EEC on the Conservation of Natural Habitats and of Wild Fauna and Flora (the "Habitats Directive") requires an Appropriate Assessment to be carried out where there is likely to be a significant impact upon a European protected site. 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 NRA guidelines state that as the potential impact of a scheme is limited to a local level, detailed consideration need only be given to roads where there is a significant change to traffic flows (>5%) and the designated site lies within 200m of the road centre line.

The impact of NO_x (i.e. NO and NO_2) emissions resulting from the proposed road at the Lower River Shannon SAC was assessed. Dispersion modelling and prediction was carried out at typical traffic speeds. Ambient NO_x concentrations predicted for the design year along a transect of up to 200m within the Lower River Shannon cSAC are given in **Table 7.4.7**. The road contribution to dry deposition along the transect is also given and was calculated using the methodology of the NRA.

The predicted annual average NO_x level at the Lower River Shannon cSAC is below the limit value of 30 μg/m^3 for the "do minimum" scenario in 2027, reaching 72% of this limit value. Levels with the proposed development in place are predicted to increase to 73% of the limit value. The impact of the proposed road leads to an increase in NO_x concentrations of >2 μg/m^3 within the Lower River Shannon cSAC at distances greater than 10m from the proposed bridge centreline.

The road contribution to the NO_2 dry deposition rate along the 200m transect within the cSAC is also detailed in **Table 7.4.7**. The maximum NO_2 dry deposition rate is 0.15 Kg(N)/ha/yr in 2027. This reaches only 3% of the critical load for inland and surface water habitats of 5-10 Kg(N)/ha/yr.

Regional Air Quality Assessment

The regional impact of the proposed road on emissions of NO_x and VOCs has been assessed using the procedures of the NRA and the UK DEFRA using the DMRB screening model (V1.03c, July 2007). The results (see **Table 7.4.8**) indicate that the impact of the proposed road on Ireland's obligations under the Gothenburg Protocol is negligible in the design year 2027. The predicted impact of the proposed road is to increase NO_x levels by 0.0018% of the NO_x emissions ceiling in 2012 and by 0.0009% in 2027. The proposed road scheme is predicted to increase VOC levels in the opening year by 0.0001% and to decrease VOC levels in the design year by 0.0003% of the VOC emissions ceiling complied with since 2010 .

Climate

The impact of the proposed road on emissions of CO_2 were also assessed using the DMRB screening model. The results show that the impact of the proposed road will be to increase CO_2 emissions by 0.0005% of Ireland's Kyoto target in 2012 and by 0.0001% in 2027. Thus, the impact of the proposed road development on national greenhouse gas emissions will be insignificant in terms of Ireland's obligations under the Kyoto Protocol.

7.4.5 Measures to Mitigate Significant Impacts

Construction Phase: Air Quality

A dust minimisation plan has been formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions (see **Appendix 7.4.1**).

Construction Phase: Climate

No mitigation measures are necessary.

Operational Phase: Air Quality

Mitigation measures in relation to traffic-derived pollutants have focused generally on improvements in both engine technology and fuel quality. EU legislation, based on the EU sponsored Auto-Oil programmes, has imposed stringent emission standards for key pollutants (REGULATION (EC) No 715/2007) for passenger cars to be complied with in 2009 (Euro 5) and 2014 (Euro 6). With regard to heavy duty vehicles, EU Directive 2005/78/EC defines the emission standard currently in force, Euro IV, as well as the next stage (Euro V) which will enter into force in October 2009. In addition, it defines a non-binding standard called Enhanced Environmentally-friendly Vehicle (EEV). In relation to fuel quality, SI No. 407 of 1999 and SI No. 72 of 2000 have introduced significant reductions in both sulphur and benzene content of fuels.

In relation to design and operational aspects of road schemes, emissions of pollutants from road traffic can be controlled most effectively by either diverting traffic away from heavily congested areas or ensuring free flowing traffic through good traffic management plans and the use of automatic traffic control systems. Improvements in air quality are likely over the next few years as a result of the on-going comprehensive vehicle inspection and maintenance program, fiscal measures to encourage the use of alternatively fuelled vehicles and the introduction of cleaner fuels.

Operational Phase: Climate

CO_2 emissions for the average new car fleet will be reduced to 120 g/km by 2012 through EU legislation on improvements in vehicle motor technology and by an increased use of biofuels. This measure will reduce CO_2 emissions from new cars by an average of 25% in the period from 1995 to 2008/2009 whilst 15% of the necessary effort towards the overall climate change target of the EU will be met by this measure alone.

Additional measures included in the National Climate Change Strategy include: (1) VRT and Motor Tax rebalancing to favour the purchases more fuel-efficient vehicles with lower CO_2 emissions; (2) continuing the Mineral Oils Tax Relief (MOTR) II Scheme and introduction of a biofuels obligation scheme; (3) implementation of a national efficient driving awareness campaign, to promote smooth and safe driving at lower engine revolutions; and (4) enhancing the existing mandatory vehicle labelling system to provide more information on CO_2 emission levels and on fuel economy.

7.4.6 Residual Impacts

The results of the air dispersion modelling study show that the residual impacts of the proposed road development on air quality and climate will be insignificant.

Table 7.4.1 EU Air Quality Standards (based on EU Council Directive 2008/50/EC)

Pollutant	Regulation Note 1	Limit Type	Margin of Tolerance	Value
Nitrogen Dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 18 times/year	40% until 2003 reducing linearly to 0% in 2010	200 μg/m^3 NO_2
		Annual limit for protection of human health	40% until 2003 reducing linearly to 0% in 2010	40 μg/m^3 NO_2
		Annual limit for protection of vegetation	None	30 μg/m^3 NO + NO_2
Lead	2008/50/EC	Annual limit for protection of human health	100% Note 2	0.5 μg/m^3
Sulphur dioxide	2008/50/EC	Hourly limit for protection of human health - not to be exceeded more than 24 times/year	150 μg/m^3	350 μg/m^3
		Daily limit for protection of human health - not to be exceeded more than 3 times/year	None	125 μg/m^3
		Annual & Winter limit for the protection of ecosystems	None	20 μg/m^3
Particulate Matter (as PM_{10})	2008/50/EC	24-hour limit for protection of human health - not to be exceeded more than 35 times/year	50%	50 μg/m^3 PM_{10}
		Annual limit for protection of human health	20%	40 μg/m^3 PM_{10}
$PM_{2.5}$ (Stage 1)	2008/50/EC	Annual limit for protection of human health	20% from June 2008. Decreasing linearly to 0% by 2015	25 μg/m^3 $PM_{2.5}$
$PM_{2.5}$ (Stage 2)	-	Annual limit for protection of human health	None	20 μg/m^3 $PM_{2.5}$
Benzene	2008/50/EC	Annual limit for protection of human health	100% until 2006 reducing linearly to 0% in 2010	5 μg/m^3
Carbon Monoxide	2008/50/EC	8-hour limit (on a rolling basis) for protection of human health	60%	10 mg/m^3 (8.6 ppm)

Note 1 EU 2008/50/EC – Clean Air For Europe (CAFÉ) Directive replaces the previous Air Framework Directive (1996/30/EC) and daughter directives 1999/30/EC and 2000/69/EC

Note 2 EU 2008/50/EC states - '*Limit value to be met only by 1 January 2010 in the immediate vicinity of the specific industrial sources situated on sites contaminated by decades of industrial activities. In such cases the limit value is 1.0 μg/m^3. The area in which higher limit values apply must not extend further than 1000 m from such specific sources*'

Table 7.4.2 Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme (Screening Assessment Year 2012 Do Minimum)

Townland	Receptors OS Co-ordinates	NO_2 Annual ($\mu g/m^3$)	NO_2 Max. 1-Hr ($\mu g/m^3$)	PM_{10} Annual ($\mu g/m^3$)	PM_{10} Max. 24-Hr ($\mu g/m^3$)	Benzene Annual Mean ($\mu g/m^3$)	CO Max. 8-Hr (mg/m^3)	$PM_{2.5}$ Annual ($\mu g/m^3$)
Ballyvally	169285 173912	15.0	75.1	15.7	0	0.6	2.0	9.6
Lakeview 1	169341 173749	14.8	73.9	15.7	0	0.5	1.9	9.5
Lakeview 2	169365 173630	14.8	74.1	15.7	0	0.6	2.0	9.5
Newtown	169302 173080	13.3	66.7	15.4	0	0.5	1.9	9.2
Newtown 2	169445 173260	14.2	71.0	15.6	0	0.5	1.9	9.4
West Of Fairhaven	169388 172876	13.4	66.8	15.4	0	0.5	1.9	9.3
Killaloe Town	170326 172985	14.4	72.1	15.6	0	0.6	1.9	9.5
Abbey Street East	170395 172814	13.9	69.3	15.5	0	0.5	1.9	9.4
Shantraud 1	169662 172548	13.8	69.1	15.5	0	0.5	1.9	9.3
Shantraud 2	169563 172489	13.6	67.9	15.5	0	0.5	1.9	9.3
North of Clarisford	170410 172738	16.3	81.6	16.0	0	0.6	2.0	9.9
Moys (school)	170310 172508	16.2	81.0	16.0	0	0.6	2.0	9.9
Shantraud Woods	169949 172155	15.2	76.0	15.8	0	0.6	2.0	9.6
Shauntraud Woods (South)	169989 172065	13.6	68.0	15.5	0	0.5	1.9	9.3
Moys	170386 172186	13.3	66.6	15.4	0	0.5	1.9	9.2
Roolagh	170787 172200	16.2	80.8	16.0	0	0.6	2.0	9.8
R496 (South)	170794 172078	16.4	81.8	16.1	0	0.6	2.0	9.9
R494 (South) 1	170747 172022	16.1	80.3	15.9	0	0.6	2.0	9.7
R494 (South) 2	170700 171502	15.8	79.2	15.9	0	0.6	2.0	9.7
R494 (Knockadromin)	170927 169729	16.1	80.5	15.9	0	0.6	2.0	9.8
R494 (Lackenavea)	171047 168846	15.1	75.4	15.7	0	0.6	2.0	9.6
Near Killaloe Bridge	170517 173131	16.4	82.2	16.1	0	0.6	2.0	9.9
Cullenagh	170553 173216	17.4	86.9	16.3	0	0.6	2.1	10.1
Ballina	170599 173028	15.8	79.0	15.9	0	0.6	2.0	9.8
Ambient Air Limit Values (Directive 2008/50/EC)		40 $\mu g/m^3$	200 $\mu g/m^3$	40 $\mu g/m^3$	No. days > 50 $\mu g/m^3$	5.0 $\mu g/m^3$	10.0 mg/m^3	25.0 mg/m^3

Table 7.4.3 Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme (Screening Assessment Year 2027 Do Minimum)

Townland	Receptors OS Co-ordinates	NO_2 Annual ($\mu g/m^3$)	NO_2 Max. 1-Hr ($\mu g/m^3$)	PM_{10} Annual ($\mu g/m^3$)	PM_{10} Max. 24-Hr ($\mu g/m^3$)	Benzene Annual Mean ($\mu g/m^3$)	CO Max. 8-Hr (mg/m^3)	$PM_{2.5}$ Annual ($\mu g/m^3$)
Ballyvally	169285 173912	15.0	75.2	15.4	0	0.6	2.0	9.4
Lakeview 1	169341 173749	14.7	73.5	15.3	0	0.6	2.0	9.3
Lakeview 2	169365 173630	14.8	73.8	15.3	0	0.6	2.0	9.3
Newtown	169302 173080	12.8	63.9	14.9	0	0.6	2.0	8.9
Newtown 2	169445 173260	13.9	69.7	15.1	0	0.6	2.0	9.2
West Of Fairhaven	169388 172876	12.8	64.0	14.9	0	0.6	2.0	9.0
Killaloe Town	170326 172985	14.4	71.9	15.3	0	0.6	2.0	9.3
Abbey Street East	170395 172814	17.1	85.7	15.9	0	0.6	2.2	9.9
Shantraud 1	169662 172548	13.4	67.1	15.1	0	0.6	2.0	9.1
Shantraud 2	169563 172489	13.1	65.5	15.0	0	0.6	2.0	9.0
North of Clarisford	170410 172738	16.9	84.3	15.8	0	0.6	2.2	9.9
Moys (school)	170310 172508	16.5	82.7	15.8	0	0.6	2.2	9.8
Shantraud Woods	169949 172155	15.3	76.3	15.4	0	0.6	2.1	9.4
Shauntraud Woods (South)	169989 172065	13.1	65.6	15.0	0	0.6	2.0	9.0
Moys	170386 172186	12.7	63.6	14.9	0	0.6	1.9	8.9
Roolagh	170787 172200	16.7	83.5	15.8	0	0.6	2.2	9.8
R496 (South)	170794 172078	16.8	83.8	15.8	0	0.6	2.2	9.8
R494 (South) 1	170747 172022	16.4	82.1	15.6	0	0.6	2.1	9.7
R494 (South) 2	170700 171502	16.1	80.5	15.6	0	0.6	2.1	9.6
R494 (Knockadromin)	170927 169729	16.5	82.4	15.7	0	0.6	2.1	9.7
R494 (Lackenavea)	171047 168846	15.1	75.6	15.4	0	0.6	2.0	9.4
Near Killaloe Bridge	170517 173131	16.9	84.3	15.8	0	0.6	2.2	9.9
Cullenagh	170553 173216	18.1	90.4	16.1	0	0.6	2.3	10.1
Ballina	170599 173028	16.0	80.1	15.6	0	0.6	2.1	9.7
Ambient Air Limit Values (Directive 2008/50/EC)		40 $\mu g/m^3$	200 $\mu g/m^3$	40 $\mu g/m^3$	No. days > 50 $\mu g/m^3$	5.0 $\mu g/m^3$	10.0 mg/m^3	25.0 mg/m^3

Table 7.4.4 Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme (Screening Assessment Year 2012 Do Something)

Townland	Receptors OS Co-ordinates	NO_2 Annual (µg/m^3)	NO_2 Max. 1-Hr (µg/m^3)	PM_{10} Annual (µg/m^3)	PM_{10} Max. 24-Hr (µg/m^3)	Benzene Annual Mean (µg/m^3)	CO Max. 8-Hr (mg/m^3)	$PM_{2.5}$ Annual (µg/m^3)
Ballyvally	169285 173912	14.3	71.4	15.6	0	0.5	1.9	9.4
Lakeview 1	169341 173749	13.8	69.0	15.5	0	0.5	1.9	9.3
Lakeview 2	169365 173630	13.6	68.2	15.5	0	0.5	1.9	9.3
Newtown	169302 173080	13.4	67.0	15.4	0	0.5	1.9	9.3
Newtown 2	169445 173260	13.5	67.5	15.4	0	0.5	1.9	9.3
West Of Fairhaven	169388 172876	13.4	67.2	15.4	0	0.5	1.9	9.3
Killaloe Town	170326 172985	13.6	67.9	15.5	0	0.5	1.9	9.3
Abbey Street East	170395 172814	14.5	72.3	15.6	0	0.6	2.0	9.5
Shantraud 1	169662 172548	13.5	67.5	15.4	0	0.5	1.9	9.3
Shantraud 2	169563 172489	14.6	73.1	15.6	0	0.5	1.9	9.5
North of Clarisford	170410 172738	14.4	72.2	15.6	0	0.6	2.0	9.5
Moys (school)	170310 172508	14.4	71.9	15.6	0	0.6	1.9	9.5
Shantraud Woods	169949 172155	15.5	77.7	15.8	0	0.6	2.0	9.6
Shauntraud Woods (South)	169989 172065	14.7	73.5	15.7	0	0.5	1.9	9.5
Moys	170386 172186	14.7	73.7	15.7	0	0.5	1.9	9.5
Roolagh	170787 172200	17.0	84.9	16.2	0	0.6	2.1	10.0
R496 (South)	170794 172078	17.3	86.6	16.3	0	0.6	2.1	10.1
R494 (South) 1	170747 172022	16.5	82.6	16.0	0	0.6	2.0	9.8
R494 (South) 2	170700 171502	15.5	77.4	15.8	0	0.6	2.0	9.6
R494 (Knockadromin)	170927 169729	16.2	81.2	16.0	0	0.6	2.0	9.8
R494 (Lackenavea)	171047 168846	15.1	75.5	15.7	0	0.6	2.0	9.6
Near Killaloe Bridge	170517 173131	15.1	75.5	15.8	0	0.6	2.0	9.6
Cullenagh	170553 173216	16.6	83.1	16.1	0	0.6	2.1	9.9
Ballina	170599 173028	16.1	80.3	16.0	0	0.6	2.0	9.8
Ambient Air Limit Values (Directive 2008/50/EC)		40 µg/m^3	200 µg/m^3	40 µg/m^3	No. days > 50 µg/m^3	5.0 µg/m^3	10.0 mg/m^3	25.0 mg/m^3

Table 7.4.5 Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme Year 2027 Do Something)

Townland	Receptors OS Co-ordinates	NO_2 Annual ($\mu g/m^3$)	NO_2 Max. 1-Hr ($\mu g/m^3$)	PM_{10} Annual ($\mu g/m^3$)	PM_{10} Max. 24-Hr ($\mu g/m^3$)	Benzene Annual Mean ($\mu g/m^3$)	CO Max. 8-Hr (mg/m^3)	$PM_{2.5}$ Annual ($\mu g/m^3$)
Ballyvally	169285 173912	13.9	69.7	15.1	0	0.6	2.0	9.2
Lakeview 1	169341 173749	13.4	66.9	15.0	0	0.6	2.0	9.1
Lakeview 2	169365 173630	13.2	65.9	15.0	0	0.6	2.0	9.0
Newtown	169302 173080	12.8	64.2	14.9	0	0.6	2.0	9.0
Newtown 2	169445 173260	13.0	64.9	15.0	0	0.6	2.0	9.0
West Of Fairhaven	169388 172876	12.9	64.5	14.9	0	0.6	2.0	9.0
Killaloe Town	170326 172985	13.1	65.6	15.0	0	0.6	2.0	9.0
Abbey Street East	170395 172814	14.6	73.0	15.3	0	0.6	2.1	9.3
Shantraud 1	169662 172548	13.1	65.6	15.0	0	0.6	2.0	9.0
Shantraud 2	169563 172489	14.4	72.0	15.2	0	0.6	2.0	9.3
North of Clarisford	170410 172738	14.5	72.4	15.3	0	0.6	2.1	9.3
Moys (school)	170310 172508	14.3	71.7	15.3	0	0.6	2.0	9.3
Shantraud Woods	169949 172155	15.8	79.0	15.5	0	0.6	2.1	9.5
Shauntraud Woods (South)	169989 172065	14.5	72.6	15.2	0	0.6	2.0	9.3
Moys	170386 172186	14.6	73.1	15.3	0	0.6	2.0	9.3
Roolagh	170787 172200	17.0	84.9	15.8	0	0.6	2.2	9.9
R496 (South)	170794 172078	17.4	86.9	15.9	0	0.6	2.2	10.0
R494 (South) 1	170747 172022	16.5	82.3	15.6	0	0.6	2.1	9.7
R494 (South) 2	170700 171502	15.2	76.2	15.4	0	0.6	2.1	9.4
R494 (Knockadromin)	170927 169729	16.2	80.8	15.6	0	0.6	2.1	9.6
R494 (Lackenavea)	171047 168846	14.8	74.1	15.3	0	0.6	2.0	9.4
Near Killaloe Bridge	170517 173131	15.1	75.6	15.4	0	0.6	2.1	9.5
Cullenagh	170553 173216	16.7	83.4	15.8	0	0.6	2.2	9.8
Ballina	170599 173028	15.8	78.9	15.6	0	0.6	2.1	9.6
Ambient Air Limit Values (Directive 2008/50/EC)		40 $\mu g/m^3$	200 $\mu g/m^3$	40 $\mu g/m^3$	No. days > 50 $\mu g/m^3$	5.0 $\mu g/m^3$	10.0 mg/m^3	25.0 mg/m^3

Table 7.4.6 DMRB Screening Air Quality Assessment, Proposed Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme. Assessment of Peak Traffic Speed at Worst-Case Receptors.

Receptor Note 1	NO_2 Annual ($\mu g/m^3$)	NO_2 Max. 1-Hr ($\mu g/m^3$)	PM_{10} Annual ($\mu g/m^3$)	PM_{10} Max. 24-Hr (No. days >50$\mu g/m^3$)	$PM_{2.5}$ Annual ($\mu g/m^3$)	Benzene Annual Mean ($\mu g/m^3$)	CO Max. 8-Hr (mg/m^3)
Do Minimum (2012)							
R15	13.3	67	15.4	0	9.2	0.54	1.9
R17	18.3	92	16.6	1	10.5	0.61	2.3
Do Something (2012)							
R15	14.8	74	15.7	0	9.5	0.55	2.0
R17	19.6	98	17.0	1	10.8	0.63	2.4
Do Minimum (2027)							
R15	12.8	64	14.9	0	8.9	0.56	1.9
R17	19.1	95	16.5	1	10.6	0.68	2.6
Do Something (2027)							
R15	14.6	73	15.3	0	9.1	0.58	2.1
R17	19.7	99	16.7	1	10.5	0.69	2.7
Ambient Air Limit Values Note 2	40 $\mu g/m^3$	200 $\mu g/m^3$	40 $\mu g/m^3$	35 days	25 $\mu g/m^3$	5 $\mu g/m^3$	10 mg/m^3

Note 1 For details of receptor locations see Table X.10

Note 2 Limit values as detailed in EU Directive 2008/50/EC.

Table 7.4.7 Air Quality Assessment of Ecosystems, Proposed Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme. Assessment of Impact Along Transect From Proposed Road Through Lower River Shannon SAC.

Dist. To Road (m) Note 1	Year 2012 - NO_x Conc. ($\mu g/m^3$)			NO_2 Dry Deposition Rate Impact (Kg(N) /ha/yr)	Year 2027 - NO_x Conc. ($\mu g/m^3$)			NO_2 Dry Deposition Rate Impact (Kg(N) /ha/yr)
	Do Minimum	Do Something	Impact	2012	Do Minimum	Do Something	Impact	2027
10	20.8	20.4	-0.5	-0.01	21.5	21.8	0.3	0.1
20	19.9	19.5	-0.3	-0.01	20.2	20.4	0.2	0.1
30	19.2	18.9	-0.3	-0.01	19.3	19.5	0.2	0.1
40	18.7	18.5	-0.2	-0.01	18.6	18.8	0.1	0.0
50	18.3	18.1	-0.2	-0.01	18.1	18.2	0.1	0.0
60	18.0	17.9	-0.1	0.00	17.7	17.8	0.1	0.0
70	17.8	17.7	-0.1	0.00	17.4	17.5	0.1	0.0
80	17.6	17.5	-0.1	0.00	17.2	17.2	0.1	0.0
90	17.4	17.4	-0.1	0.00	17.0	17.0	0.0	0.0
100	17.3	17.3	0.0	0.00	16.8	16.9	0.0	0.0
110	17.2	17.2	0.0	0.00	16.7	16.8	0.0	0.0
120	17.2	17.1	0.0	0.00	16.6	16.7	0.0	0.0
130	17.1	17.1	0.0	0.00	16.6	16.6	0.0	0.0
140	17.1	17.0	0.0	0.00	16.5	16.5	0.0	0.0
150	17.0	17.0	0.0	0.00	16.5	16.5	0.0	0.0
160	17.0	17.0	0.0	0.00	16.5	16.5	0.0	0.0
170	17.0	17.0	0.0	0.00	16.5	16.5	0.0	0.0
180	17.0	17.0	0.0	0.00	16.4	16.4	0.0	0.0
190	17.0	17.0	0.0	0.00	16.4	16.4	0.0	0.0
200	17.0	17.0	0.0	0.00	16.4	16.4	0.0	0.0
Standards	30 $\mu g/m^3$	30 $\mu g/m^3$	-	5 - 10 Kg(N)/ha/yr	30 $\mu g/m^3$	30 $\mu g/m^3$	-	5 - 10 Kg(N)/ha/yr

Note 1 Distance from bridge centerline

Table 7.4.8 Regional Air Quality Assessment. Proposed Killaloe Bypass, Shannon Crossing and R494 Road Improvement Scheme.

Year	Scenario	CO (kg/annum)	VOC (kg/annum)	NO_X (kg/annum)	PM_{10} (kg/annum)	CO_2 (tonnes/annum)
2012	Without scheme	11,978	1,661	8,261	237	3,312
	With Scheme	12,061	1,710	9,429	257	3,609
2027	Without scheme	20,490	2,844	11,340	336	5,591
	With Scheme	19,055	2,699	11,957	341	5,629
Increment in 2012 (kg)		83	49	1,168	20	298
Increment in 2027 (kg)		-1,436	-145	617	5	37
Emission Ceiling (kilo-tonnes)			55(1)	65(1)		60,740(2)
Impact of Scheme 2012 (%)			0.0001%	0.0018%		0.0005%
Impact of Scheme 2027 (%)			-0.0003%	0.0009%		0.0001%

Note 1 National Emission Ceiling (EU Directive 2001/81/EC)

Note 2 Ireland's Target Under The Kyoto Protocol

APPENDIX 7.4.1

Dust Minimisation Plan

A dust minimisation plan will be formulated for the construction phase of the project, as construction activities are likely to generate some dust emissions. The potential for dust to be emitted depends on the type of construction activity being carried out in conjunction with environmental factors including levels of rainfall, wind speeds and wind direction. The potential for impact from dust depends on the distance to potentially sensitive locations and whether the wind can carry the dust to these locations. The majority of any dust produced will be deposited close to the potential source and any impacts from dust deposition will typically be within two hundred metres of the construction area.

In order to ensure mitigation of the effects of dust nuisance, a series of measures will be implemented. Site roads shall be regularly cleaned and maintained as appropriate. Hard surface roads shall be swept to remove mud and aggregate materials from their surface while any un-surfaced roads shall be restricted to essential site traffic only. Furthermore, any road that has the potential to give rise to fugitive dust shall be regularly watered, as appropriate, during dry and/or windy conditions.

Vehicles using site roads shall have their speeds restricted where there is a potential for dust generation. Vehicles delivering material with dust potential to an off-site location shall be enclosed or covered with tarpaulin at all times to restrict the escape of dust.

Vehicles exiting the site shall make use of a wheel wash facility, prior to entering onto public roads, to ensure mud and other wastes are not tracked onto public roads. Public roads outside the site shall be regularly inspected for cleanliness, and cleaned as necessary. Before entrance onto public roads, trucks will be adequately inspected to ensure no potential for dust emissions.

Material handling systems and site stockpiling of materials shall be designed and laid out to minimise exposure to wind. Water misting or sprays shall be used as required if particularly dusty activities are necessary during dry or windy periods.

At all times, the procedures put in place will be strictly monitored and assessed. In the event of dust nuisance occurring outside the site boundary, satisfactory procedures will be implemented to rectify the problem.

The dust minimisation plan shall be reviewed at regular intervals during the construction phase to ensure the effectiveness of the procedures in place and to maintain the goal of minimisation of dust through the use of best practice and procedures.

7.5 Hydrology and Hydrogeology

7.5.1 Methodology

Data Compilation & Desk Study

A detailed desk study was carried out for the proposed scheme using data compiled from the following sources:

- Site investigation (including groundwater) data provided by IGSL Limited;
- Consultation with relevant public bodies such as the Geological Survey of Ireland (GSI) Groundwater Section, the Office of Public Works (OPW) Hydrometric Section, the Environmental Protection Agency (EPA) Water Quality Section, National Parks & Wildlife Service (NPWS) and the Shannon Regional Fisheries Board (SRFB, now Inland Fisheries Ireland).

Impact Assessment Methodology

This impact assessment is based on the road design for the Killaloe Bypass, Shannon Bridge Crossing & R494 Improvement. The following impact assessment methodology was undertaken following a desk review of site investigation data carried out as part of this scheme.

- Characterise the site's existing hydrological / hydrogeological regime from the topographical, geological, hydrometric and hydrochemical data acquired;
- Undertake consultation with relevant public bodies such as the Geological Survey of Ireland (GSI) Groundwater Section, the Office of Public Works (OPW) Hydrometric Section, the Environmental Protection Agency (EPA) Water Quality Section, National Parks & Wildlife Service (NPWS) and the Shannon Regional Fisheries Board (SRFB);
- Determine the likelihood of existing baseline environmental trends / changes that are occurring within the study site;
- Determine what catchment(s) / sub-catchment(s) the proposed Killaloe Bypass, Shannon Bridge Crossing & R494 Improvement is located within;
- Consider the likely hydraulic and hydrochemical impacts that may arise from the construction and operation of the proposed road scheme with respect to baseline hydrology and hydrogeology;
- Evaluate the increased risk of contamination to any karst aquifers, if they occur within any sections of the proposed road scheme;
- Evaluate how local side road realignments that are part of the proposed development will impact on baseline hydrology, hydrogeology and water supplies;
- Evaluate whether there is an increased risk of flooding arising from (a) increased surface water runoff from the road hard standing, (b) from the proposed bridge structure crossing the River Shannon, (c) from the proposed bridge structure crossing of the Kilmastulla River, or (d) from the proposed minor stream culvert crossings;
- Identify whether there are likely to be any indirect impacts by changes in hydrology and hydrogeology on terrestrial and aquatic habitats including annexed species that are designated and thus protected under Irish and European law along or proximal to the Killaloe Bypass, Shannon Bridge Crossing or R494 Improvement;
- For each impact identified, classify the impact significance according to the criteria outlined in the NRA '*Guidelines on Procedures for Assessment and*

Treatment of Geology, Hydrology and Hydrogeology for National Road Schemes';

- For each impact identified, identify measures that would prevent, reduce or remediate the identified impact;
- Identify any residual impacts that would remain or arise from the mitigation measures identified.

7.5.2 Scheme Description

The main components of the proposed scheme that are relevant to the scope of this study are:

- Location and depth of cuts along the scheme relative to baseline hydrogeology;
- River and drainage crossings with respect to road runoff discharge, flood risk and water quality.

7.5.3 Road Cuts

Nine road cuts have been identified along the design. The key characteristics and significance of these cuts are tabularised in **Table 7.5.1** below.

Table 7.5.1 Road Cut Details

Cut No.	Road Chainage	Maximum Cut Depth (m)	Maximum Excavation Depth (m) (incl. F&D)$_1$	Significance of Cut$_2$
1	KBP – 0+060-0+640	17.70	19.20	Major
2	KBP – 0+740-1+000	3.40	4.90	Moderate
3	KBP – 1+400-1+500	0.70	2.20	Minor
4	KBP – 1+800-1+920	2.00	3.50	Moderate
5	SBC – 0+360-0+440	1.50	3.00	Minor
6	R494 – 0+000-0+200	1.00	2.50	Minor
7	R494 – 0+320-0+460	0.40	1.90	Minor
8	R494 – 1+320-1+800	0.50	2.00	Minor
9	R494 – 2+140-2+225	0.50	2.00	Minor

1 F&D = Foundation and Drainage impact for road design, estimated at 1.5m below proposed road surface.

2 Significance of Cut: Minor Cut = <2m, Moderate Cut = >2<5m, Major Cut = >5<10m.

7.5.4 Drainage Crossings

Fourteen drainage crossings have been identified as part of the design. The key characteristics and significance of these crossings are tabularised in **Table 7.5.2**.

Table 7.5.2 Drainage Crossings

DX No.	Road Chainage	Description	Significance of Crossing	Reason for Significance Level
1	KBP 0+000	Stream	Moderate	Drains to River Shannon (pNHA)
2*	KBP 1+760	Stream	Moderate	Drains to River Shannon (SAC)
3*	R463 North	Stream	Moderate	Drains to River Shannon (SAC)
4*	SBC 0+020	Stream	Moderate	Drains to River Shannon (SAC)
5	SBC 0+140	Stream	Moderate	Drains to River Shannon (SAC)

DX No.	Road Chainage	Description	Significance of Crossing	Reason for Significance Level
6	SBC 0+620	River Shannon & Shannon Canal	Major	SAC (with pNHA upstream at Lough Derg)
7	R494 0+980	Stream	Moderate	Drains to River Ford
8	R494 1+120	River Ford	Moderate	Drains to River Shannon (SAC)
9	R494 1+170	Man Made Drain	Minor	Local Land Drain
10	R494 1+720	Stream	Moderate	Drains to River Shannon (SAC)
11	R494 1+995	Man Made Drain	Minor	Local Land Drain
12	R494 2+300	Stream	Moderate	Drains to River Shannon (SAC)
13	R494 2+630	Kilmastulla River	Major	Drains to River Shannon (SAC)
14	R494 3+270	Stream	Moderate	Drains to River Shannon (SAC)

*This stream crosses the proposed road alignment at the three locations identified

The drainage crossings set out in **Table 7.5.2** above are mapped on **Figures 7.5.2.1 and 7.5.2.2** '*Hydrology – Surface Catchments, Hydrological Features & Direction of Runoff Flow* included in this assessment. Clearly, the River Shannon crossing is the most significant in both size and potential impact. **Chapter 3** of the EIS describes the proposed Shannon Bridge Crossing as follows:

"The proposed Shannon Bridge Crossing crosses the Shannon where it is 143 metres wide. The land is moderately sloping on the east side, falling a height of 11.5 metres over a distance of 94 metres between the R494 and the bank of the river. On the west side the terrain is gently sloping, falling a height of 6 metres over a distance of 170 metres between the existing residential access road at Moys and the bank of the river. In addition there are the remains of the inundated canal running parallel to the river bank.

The bridge superstructure consists of a slender reinforced concrete deck supported on struts to steel arches under the deck. The superstructure is supported on four reinforced concrete piers in the river channel, and two reinforced concrete abutments at the river banks. The three interior span lengths are 42 metres and the two end spans are 21 metres.

The length of the bridge lends itself to this form of structure in that it results in the span lengths and the number of spans being technically appropriate, and with a span rather than a pier coinciding with midstream".

7.5.5 Water Framework Directive

The Water Framework Directive (WFD) was created in December 2000 and implemented in 2003 with the aim of improving the quality of our water environment. Its purpose is also to integrate existing European directives into the new legislation. To this end, it establishes a legal framework for the protection and management of water resources throughout the EU. The Directive requires each Member State to implement changes to the management of water bodies taking account of all aspects of the Water Cycle. The principal objective of the Directive is "to achieve good status in all waters by 2015 and [to] ensure that status does not deteriorate in any waters."

Under the WFD the bodies of water that need to be protected are:

- All surface waters (lakes, rivers, canals, reservoirs);
- Groundwater;

- Estuarine waters (or Transitional waters);
- Coastal waters (up to 12 nautical miles from our shores).

A total of eight River Basin Districts (RBDs) have been identified on the whole island of Ireland as the "administrative areas" for co-ordinated management of WFD implementation. The relevant administrative area for the Killaloe Bypass, Shannon Bridge Crossing & R494 Improvement Scheme is the Shannon International River Basin District.

This scheme has been developed to comply with the requirements of the Water Framework Directive. In particular, **Section 7.5.8** of this report outlines the mitigation measures proposed to deal with any predicted impacts identified in **Section 7.5.7**.

It is noted in the case of the proposed R494 Improvement section of the scheme, the proposed mitigation measures will in fact help to improve water quality, as existing road run-off from the R494 regional road is not treated to the levels proposed in the above-mentioned **Section 7.5.8**. This meets one of the principal objectives of the WFD, which is to enhance water status where possible.

In the cases of the other two proposed sections of the scheme, namely the Killaloe Bypass section and the Shannon Bridge Crossing section, the proposed mitigation measures will ensure that the existing water status does not deteriorate.

7.5.6 Existing Environment

Surface Water

Catchment

Aside from the River Shannon itself at the proposed bridge crossing location, eleven distinct hydrological sub-catchments are intercepted by the design, the key details of which are outlined in **Table 7.5.3** below. These sub-catchments are mapped on **Figures 7.5.2.1 and 7.5.2.2** '*Hydrology – Surface Catchments, Hydrological Features & Direction of Runoff Flow'.*

Table 7.5.3 Catchments / Sub-catchments

Sub-catchment Name / ID	Road Chainage	Total Area of Sub-catchment (km^2)	Associated River Name
CA1 (Killaloe Bypass)	KBP 0+000	0.6	Stream drains to River Shannon
CA2/CB1a/CB1b (Killaloe Bypass/Shannon Bridge Crossing)	KBP 1+760, R463 North, SBC 0+020	1.2	Stream drains to River Shannon
CB2 (Shannon Bridge Crossing	SBC 0+140	0.8	Stream drains to River Shannon
CC1 (R494 Upgrade)	R494 0+980	3.0	Stream drains to River Ford
CC2 (R494 Upgrade)	R494 0+1120	4.0	River Ford (drains to River Shannon)
CC2A (R494 Upgrade)	R494 1+170	-	Drainage ditch
CC3 (R494 Upgrade)	R494 1+720	1.4	Stream drains to River Shannon
CC3A (R494 Upgrade)	R494 1+995	-	Drainage ditch
CC4 (R494 Upgrade)	R494 2+300	0.8	Stream drains to River Shannon
Kilmastulla (R494 Upgrade)	R494 2+630	96.2	Kilmastulla River (drains to River Shannon)
CC5 (R494 Upgrade)	R494 3+270	2.4	Stream drains to River Shannon

The sub-catchments above are localised watersheds in which surface water flow to local drainage can be delineated for the purpose of evaluating potential impact on local hydrology. All of the sub-catchments identified ultimately drain into the main catchment of the River Shannon, which is estimated at c.10,600km^2 in total area close to this location, at Killaloe.

Drainage

River Shannon: The most significant drainage feature within the study area is that of the River Shannon. The River Shannon is the largest river system in Ireland and is estimated to drain a total area of more than 10,600 km^2 from its source to Killaloe, just upstream of the proposed river crossing. The River Shannon flows in a southerly direction within the study area. The proposed scheme will cross the River Shannon and associated canal, which runs parallel to the river on its western side, between chainage 0+620 approx and chainage 0+820 approx. The canal, which is approximately 10-12m wide at the bridge site, is separated from the river by a strip of land approximately 25m in width at this location.

Examination of the Environmental Protection Agency (EPA) website, which provides a register of hydrometric gauging (flow measuring device and/or rain gauge) stations in Ireland (in 2007) indicates that the nearest hydrometric station to the bridge site is located at Ballina, Co. Tipperary (Station No. 25236). There is also a gauge at Killaloe (Station No. 25074) which is operated by the ESB. The station at Ballina is only a staff gauge whereas the Killaloe gauge is a data logger. The Killaloe gauge reports an Annual Average Rainfall of 1092mm.

The river hydraulics prevailing at the proposed bridge site are rigorously controlled by the ESB by means of Parteen Weir at the head of the Ardnacrusha Headrace canal, some 5km downstream. The water level at the bridge site is virtually the same as in the basin above the weir, which is maintained at a target upper level of 33.56m OD Poolbeg (30.86m OD Malin). However ESB have advised that the target maximum level of 33.56m OD Poolbeg is not always achievable and has been exceeded as records show.

Records indicate that the level at Parteen Weir was 33.98m OD Poolbeg on 24/10/1938 and almost the same at 33.97m OD Poolbeg on 16/12/1994. Prior to the commencement of writing this report, the highest recorded flood level at Killaloe (from ESB records) and post-construction of the Ardnacrusha Hydroelectric Scheme was 34.01m OD Poolbeg on 01/02/1995 at Killaloe Pier Head (report prepared by ESB International in November 2000 titled River Shannon Flood of Winter 1999/2000 report No PA449-R46-006). However in November 2009 this level was exceeded when a peak flood level of 34.31m OD Poolbeg was recorded at Pier Head (as advised by ESB). Indeed ESB have advised that the 33.56m OD Poolbeg target level has been exceeded on many occasions since the Shannon Hydroelectric Scheme came into operation. It is considered that levels can rise quickly in Lough Derg due to sudden rainstorms or snow melt in the Lough Derg catchment. ESB endeavour to maintain a minimum level to facilitate navigation of 32.80m OD Poolbeg, although the statutory low water level is 32.00m OD Poolbeg, which has been recorded on occasion.

Prior to November 2009, the maximum recorded peak flow at the bridge site is 950m^3/s (1960) and based on this flow and the existing cross-section area, the expected maximum average flow velocity across the section will be 1.9m/s at the bridge site. The average of the annual peak flow volumes is 535m^3/s, which would result in a correspondingly lower velocity. The average flow through the bridge site is estimated at 180m^3/s.

It is noted that the Lower River Shannon is designated as a Special Area of Conservation (SAC) at the proposed bridge crossing point and is thus considered to be a significant and sensitive water body. It is also noted that Lough Derg and the River Shannon adjacent to the northern tie-in of the proposed Killaloe Bypass is designated as a proposed National Heritage Area (pNHA). Lough Derg is also listed on the Water Framework Directive Register of Protective Areas as a protected “Recreational Lake”, “Nutrient Sensitive Lake” and a “Drinking Water Lake”.

Kilmastulla River: The Kilmastulla River is a significant drainage feature within the study area. This river flows in a westerly direction and drains into the River Shannon approximately 2.5km downstream of the proposed Shannon Bridge Crossing, which is designated as a SAC as described above. The Kilmastulla River rises to the north of the Silvermines Mountains and has a catchment area of approximately 96km^2 at its crossing point of the R494 at chainage 2+360. Due to the raising of water levels in the River Shannon to facilitate the Ardnacrusha Hydroelectric Scheme, and in particular because of the construction of the weir at Parteen and its associated embankments, the outfall of the Kilmastulla River to the River Shannon has been diverted.

Streams crossing the R494 Upgrade: Five streams (including the River Ford) and two man-made drains cross the proposed R494 Upgrade in addition to the Kilmastulla River discussed above. These streams all flow in a westerly or southwesterly direction and discharge to the River Shannon downstream of the proposed Shannon Bridge Crossing. Similar to the Kilmastulla River, the streams to the south of this river have outfalls to the River Shannon which have been altered as a result of the Ardnacrusha Hydroelectric Scheme.

Stream crossing the Shannon Bridge Crossing: This stream flows in a southerly direction and discharges to the River Shannon downstream of the proposed Shannon Bridge Crossing.

Streams crossing the Killaloe Bypass: Two streams cross the proposed Killaloe Bypass. The first stream flows in an easterly direction and discharges to the River Shannon upstream of the proposed Shannon Bridge Crossing and also upstream of the existing bridge in Killaloe. This section of the River Shannon is a pNHA and is also listed on the Water Framework Directive Register of Protected Areas as a protected “Recreational Lake”, “Nutrient Sensitive Lake” and “Drinking Water Lake”. The second stream flows in a southerly direction and discharges into the River Shannon downstream of the proposed Shannon Bridge Crossing.

Flood Records

A review of the Office of Public Works (OPW) Flood Information website indicates that major flooding occurred in the Shannon catchment in January 1925, December 1954, Winter 1959/1960, February 1990, Winter 1994/1995 and Winter 1999/2000. As advised by ESB, a peak flood level of 34.01m OD Poolbeg occurred on 01/02/1995 within the study area at Pier Head Killaloe, while a peak flood level of 34.31m OD Poolbeg was recorded at the same location in November 2009.

The OPW website indicates the existence of a narrow floodplain along the eastern bank of the River Shannon within the study area. It does not appear to impact on the R494, or the proposed scheme. The website indicates flooding on the western bank of the River Shannon, upstream (north) of the proposed bridge crossing location, which was recorded in 1994/1995. The website also indicates flooding in Ballina, on the eastern side of the River Shannon, which was recorded in 2004. However it is reported on the website that this flooding occurred on the R404 Summerhill Road on the eastern outskirts of the town, which is not adjacent to any watercourse affected by the proposed scheme. There is also a hydrometric station (flow measurement device and/or rain gauge) on the River Shannon, approximately 400m upstream of the proposed bridge crossing location. Refer to **Figure 7.5.1** ‘*Surface Water Quality & Existing Flooding’* for details.

Consultation with members of the public has indicated that flooding occurs at Kilmaglasderry, Co. Tipperary where the River Ford crosses the R494 via an existing bridge structure at chainage 1+120. It is understood that this flooding is caused due to insufficient capacity of the bridge. Approximately three properties have been affected by flooding which has occurred several times over the last five years.

Flooding has also been reported at the adjacent watercourse at chainage 0+980 on the R494, which is a tributary of the River Ford. These flooding instances are believed to occur during intense rainfall events.

The Kilmastulla River is known to flood at certain locations. The OPW website indicates flooding on a recurring basis at the intersection of the Kilmastulla River with the R445 (approximately 2km upstream of the study area). Flooding of the Kilmastulla River is also known to occur downstream of the study area, adjacent to the River Shannon Flood Embankments at Fort Henry. There is a hydrometric station (flow measurement device and/or rain gauge) on the Kilmastulla River approximately 500m downstream of where it was diverted from its original discharge point to the River Shannon. Refer to **Figure 7.5.1** for details.

Water Quality

Consultation with the Environmental Protection Agency (EPA) Water Quality Mapping indicates that there are a number of water quality monitoring stations that are relevant to this study. Refer to **Figure 7.5.1** for details. These stations are as follows:

Table 7.5.4 Environmental Protection Agency – Water Quality Monitoring Stations

EPA River Code	Station No	Location of Station	River Monitored	Relationship to Development
25K04	1000	Approximately 5km upstream of Cool Bridge on R494	Kilmastulla	Upstream
25K04	800	Approximately 8km upstream of Cool Bridge on R494	Kilmastulla	Upstream

As can be seen in the above table, both stations are located on the Kilmastulla River, upstream of the proposed R494 section of scheme, in Co. Tipperary.

Water quality results from the station approximately 5km upstream of Cool Bridge indicate that the station was slightly polluted in 2002 with a Q-value of 3-4, but improved to unpolluted in 2005 with a Q-value of 4 for that year.

Water quality results from the station approximately 8km upstream of Cool Bridge indicate that the station was moderately polluted in 2002 with a Q-value of 3, but improved to slightly unpolluted in 2005 with a Q-value of 3-4 for that year.

Groundwater

Aquifer Classification

Consultation with the Geological Survey of Ireland (GSI) indicates that the following bedrock aquifer classifications occur beneath the proposed Killaloe Bypass, Shannon Bridge Crossing & R494 Improvement. Refer to **Figure 7.5.3** '*Bedrock Aquifer Map'* and **Figure 7.5.4** '*Bedrock Geology Map'* included in this assessment for details.

Table 7.5.5 Geological Survey of Ireland – Bedrock Aquifer Classification along Proposed Scheme

Aquifer Classification	Aquifer Code	Road Chainage (Approximate)	Bedrock Formation	Geology Code
Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones	**Pl**	0+000 – 1+450 (KBP)	Silurian Metasediments and Volcanics	SMV
Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones	**Ll**	1+450 – 2+030 (KBP)	Devonian Old Red Sandstones	DORS
Locally Important Aquifer – Bedrock which is Moderately	**Ll**	0+000 – 0+860	Devonian Old	DORS

Aquifer Classification	Aquifer Code	Road Chainage (Approximate)	Bedrock Formation	Geology Code
Productive only in Local Zones		(SBC)	Red Sandstones	
Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones	**Ll**	0+000 – 0+100 (R494)	Devonian Old Red Sandstones	DORS
Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones	**Pl**	0+100 – 1+000 (R494)	Dinantian early Sandstones, Shales and Limestones	DESSL
Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones	**Ll**	1+000 – 3+050 (R494)	Dinantian Lower Impure Limestones	DLIL
Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones	**Pl**	3+050 – 3+150 (R494)	Dinantian early Sandstones, Shales and Limestones	DESSL
Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones	**Ll**	3+150 – 3+300 (R494)	Devonian Old Red Sandstones	DORS

The Geological Survey of Ireland's bedrock mapping for the area illustrates that the proposed scheme crosses over four distinct geological formations / members (**Figure 7.5.4**). These strata range from Silurian metamorphosed sedimentary and volcanic rocks to Carboniferous Limestones. The main lithologies encountered by the road scheme are sandstones, shales and limestones. There are some fault lines encountered by the proposed scheme. These fault zones, depending on the nature of the material in the fault zone, may act either as barriers to groundwater flow or as groundwater conduits. The folding and faulting of the rocks may also confound the locations of recharge and discharge zones of the flow systems in the area.

Five bedrock formations have been classified as **locally important aquifers** that are **moderately productive only in local zones** (**Ll**). This aquifer classification is characterised by a limited and relatively poorly connected network of fractures, fissures and joints, giving a low fissure permeability which tends to decrease further with depth. A shallow zone of higher permeability may exist within the top few metres of more fractured / weathered rock, and higher permeability may also occur along fault zones. These zones may be able to provide larger 'locally important' supplies of water. In general, the lack of connection between the limited fissures results in relatively poor aquifer storage and flow paths that may only extend a few hundred metres. Well yields from this aquifer are expected to be within the range of 40-100m^3/day, however the supply is often unsustainable during the dryer months of the year.

Three bedrock formations have been classified as **poor aquifers** that are **generally unproductive except for local zones** (**Pl**). This aquifer classification is characterised by few and poorly connected fractures, fissures and joints. This low fissure permeability tends to decrease further with depth. A shallow zone of slightly higher permeability may exist within the top few metres of more fractured/weathered rock, and higher permeability may rarely occur along large fault zones. In general, the poor fissure network results in poor aquifer storage, short flow paths (tens of metres) and low 'recharge acceptance'. Groundwater discharge to streams ('baseflow') is very limited.

Consultation with the Geological Survey of Ireland (GSI) also indicates that a **Gravel Aquifer** occurs along the proposed R494 Upgrade section of the scheme, from Ch 1000 to Ch 3300, within this aquifer classification type. Coarse-grained surficial materials such as sand and gravels have the potential to store and are capable of transmitting large quantities of ground water and are generally the most productive groundwater resources due to their high permeability. Such aquifers would require controlled dewatering techniques to be applied if large cuts were planned in such areas. However no cuts are planned in this area so the requirement for dewatering does not arise.

Vulnerability Assessment

The GSI has produced an Irish Interim Vulnerability map. The proposed scheme will intercept variable vulnerability along the scheme from extreme to moderate vulnerability. A summary assessment of the range of vulnerability that exists for the bedrock aquifers at the site, according to chainage location is given in **Table 7.5.6**. Refer to **Figure 7.5.5** '*Aquifer and Groundwater Vulnerability Map'* included in this assessment for details.

Table 7.5.6 Geological Survey of Ireland – Irish Interim Vulnerability Mapping

Road Chainage	Irish Interim Vulnerability Rating
0+000 - 0+650 (KBC)	High
0+650 – 0+850 (KBC)	Extreme
0+850 – 2+030 (KBC)	High
0+000 – 0+200 (SBC)	High
0+200 – 0+650 (SBC)	Moderate
0+650 – 0+750 (SBC)	WATER – River Shannon
0+750 – 0+860 (SBC)	Extreme
0+000 – 3+300 (R494)	High to Low (only an interim study took place)

From **Table 7.5.6**, the most vulnerable sections of underlying aquifers are identified. Combining these "extreme" vulnerabilities with aquifer classifications provides an understanding of both the risk and the significance of the resource in terms of protecting groundwater form construction and operation phase contamination. The resultant "resource protection" categorisation assists in assigning mitigation measures to prevent deterioration in the water quality of aquifers and more importantly of groundwater itself which is protected under the Water Framework Directive.

Table 7.5.7 Groundwater Resource Protection for Vulnerable Sections of the Scheme

Road Chainage	Vulnerability	Aquifer	Resource Protection
0+650 – 0+850 (KBC)	Extreme (E)	Poor Aquifer – Bedrock which is Generally Unproductive except for Local Zones **(PI)**	**PI/E**
0+750 – 0+860 (SBC)	Extreme (E)	Locally Important Aquifer – Bedrock which is Moderately Productive only in Local Zones **(LI)**	**LI/E**

Groundwater Supply Wells

Using GSI mapping, five wells have identified within a 1,250m buffer zone of the proposed scheme. Refer to **Figure 7.5.6** *'Groundwater Well Map'* of this assessment for details. An additional well was identified at Creeveroe (road chainage - 1+500 KBP) which does not appear on the GSI mapping. This well is also included in the table below.

Table 7.5.8 Well Details within 1,250m of the Proposed Alignment (including side roads)

Well ID	Road Chainage	Buffer Zone Range (m)	Distance from Centreline (m)	Bedrock Aquifer	Main Aquifer Lithology	Yield (m^3/day)	Yield Class	Usage
1417SE W024	0+800 KBP	50	1250	PI	Sandstone	1260	N/k	Public Supply
1417SE W033	0+900 KBP	100	150	PI	Sandstone	13.1	N/k	Domestic
N/A	1+500 KBP	N/k	850	LI	Sandstone	236	N/k	Public Supply
1417SE W039	R463	50	250	PI	Sandstone	124	Good	Other
1717SW W055	1+000 R494	1000	400	LI	Limestone	43.6	Moder ate	N/k
1717SW W107	0+500 R494	50	900	PI	Sandstone/ Limestone	N/k	N/k	N/k

N/k = Not known

The wells identified above are the nearest wells to the centreline of the proposed alignment existing within the buffer zone. Three of these wells are within a 500m distance of the proposed road centreline.

The well identified as W024 is an infiltration gallery owned by Clare County Council and is located at a reservoir which forms part of the public water supply for Killaloe, over a kilometre away from the proposed road centreline. According to Clare County Council records, this well is approximately 150m deep. Typically groundwater flow patterns mirror topography and so groundwater divides often coincide with surface water / topography divides. A desk study assessment has been previously undertaken on behalf of the EPA, of water supply abstraction points and their zones of contribution in the Killaloe area, as part of a larger study within Co. Clare. From a review of this work it is concluded that there is negligible impact by the proposed road on the water supply abstraction points, or their zones of contribution. This is also true of the public water supply well identified at Creevroe, in which vicinity it should be noted no cutting is proposed as part of the scheme.

The level of impact on any well is not just a function of distance from alignment, but it is dependent on a number of factors that include:

- Location and distance of well relative to proposed cuts and excavations for the road scheme;
- Elevation (datum) of well response zone relative to proposed cuts and excavations;
- Direction of groundwater flow between the well and the scheme;
- The extent of the Zone of Contribution (ZOC) for the well relative to the proposed scheme;
- The continuity of the aquifer in which the well's response zone is located relative to the location of the road scheme;
- If the well is located in bedrock, evaluate the control of mapped / recorded faults or other discontinuities on the direction of groundwater flow;
- Determine if there are surface water bodies (rivers, streams, lakes) that will act as flow barriers between the well and the proposed scheme.

A hydraulic impact assessment of the proposed road scheme on the wells identified in **Table 7.5.8** within the 1,250m buffer zone has been undertaken and is summarised in Section 7.5.7 below.

Water Quality

No site specific information has been acquired for the purpose of providing a baseline understanding of groundwater quality. However baseline sampling of groundwater wells will be undertaken at least 3 months prior to start of construction within 500m buffer distance of the proposed scheme to ensure maintenance of existing groundwater quality in all cases.

7.5.7 Predicted Impacts

The proposed scheme has the potential to impact on surface water and groundwater via two main hydrological and hydrogeological mechanisms. These mechanisms are (a) hydraulic impact and (b) hydrochemical impact.

(a) Hydraulic impact is a change on water levels, water supply, flow rates and flow regime either above the ground (surface water) or below the ground (groundwater);

(b) Hydrochemical impact is a change in water chemistry or water quality and is often an indirect consequence of hydraulic impact, but also occurs independently of hydraulic impact where artificial contaminants are released to the water environment.

These mechanisms of impact are discussed below in the context of different causes of impact (e.g. road cuts) and also in the context of sensitive receptors (e.g. Lower River Shannon SAC and Lough Derg pNHA) that have been identified in this study.

Identified Receptors

The main hydrological and hydrogeological receptors that are identified for this scheme are:

Wells – relatively few groundwater wells have been identified within 500m and 1,250m of the proposed scheme. Groundwater flow to these wells could be affected due to excavations and cuts by the road scheme. Additionally groundwater chemistry could be impacted by introduced contaminants or by mobilisation of residual trace contamination in the aquifer.

Groundwater – there are six bedrock aquifers underlying the site. Three are locally important aquifers and three are poor aquifers, therefore none are very high yielding. However, aquifers have very low attenuation capacity for pollutants, thus transmitting the pollutant rapidly to discharge at wells, springs, streams and other receptors. This fact combined with extreme and high vulnerability ratings highlights the requirement for aquifer protection during construction. Groundwater itself is a resource that requires protection and improvement to at least a “good status” by 2015 as part of the Water Framework Directive.

Surface Water – the risk of flooding from road runoff discharge to receptor drainage and by the proposed bridge crossing of the River Shannon has been considered in the design and appropriate attenuation measures have been included to prevent any unacceptable impact. In a similar manner to groundwater, surface water is also part of the Water Framework Directive and has targets of maintaining “high status” of waters where it exists, preventing any deterioration in the existing status of waters and achieving at least “good status” in relation to all waters by 2015. Similarly, all drainage and streams that are crossed by the scheme will eventually discharge to the River Shannon and thus require high level protection in terms of pollution control. This is ensured by ensured by appropriate inclusion of appropriate pollution interception in the design together with controls during the works.

Construction Phase

Hydraulic Impacts

Most hydraulic impacts arise during the operation phase when the road scheme is completed. Progression of the excavation and construction phase is clearly the start of these impacts, but the main impact is felt during the operation phase on completion of permanent cuts and excavations. With the exception of temporary excavations (discussed below), the main hydraulic impacts are discussed under the operation phase of the project in order to avoid duplication of text.

Temporary Excavations

There may be some temporary excavations during the construction phase of the project for the purpose of supplying earth materials for road construction. These excavations are often backfilled with poor quality geotechnical materials in order to manage earth volume budgets and minimise natural soil “inert waste” generation for the project. At this stage of the project, there are no specific details of temporary excavations or borrow pits for the proposed road scheme. However, the locating of such borrow pits will be undertaken using constraints zoning to ensure there are no indirect negative impacts on hydrological and hydrogeological receptors such as water supplies, waterways and protected ecological sites.

Permanent Excavations

Please refer to sections below for relevant details on hydrogeological impacts arising from permanent excavations (operation phase).

Supply Wells

The results of the well identification and location survey (**Table 7.5.8**) are summarised as follows:

- Three (3) wells have been identified at <500m from the centreline of the proposed scheme;
- Three (3) wells has been identified as being between 500m and 1,250m from the centreline of the proposed scheme.

In terms of evaluating whether some of these wells will be impacted by the proposed scheme, **Table 7.5.9** provides a well impact assessment based on the data examined.

Table 7.5.9 Well Impact Assessment

Proximity to Road Ranking	Well ID	Road Chainage	Distance from Centreline or Side Road (SR)	Is Road in Cut of Fill?	Category of Cut	Is Road in Same Aquifer as Well	Well Aquifer (Tb 7.5.8)	Estimated Daily Abstraction (m^3/day)
1	1417SE W033	0+900 KBP	150	Cut	Moderate Minor	Yes (CL)	PI	13.1
2	1417SE W039	R463	250	Fill	-	Yes (**CL)**	PI	124
3	1717SW W055	1+000 R494	400	Fill	-	Yes (CL)	LI	43.6
4	N/A	1+500 KBP	850	Fill	-	Yes (CL)	LI	236
5	1717SW W107	0+500 R494	900	Fill	-	Yes (CL)	PI	N/k
6	1417SE W024	0+800 KBP	1250	Cut	Minor	No(CL)	PI	1260

[1] This table is based on well data for wells <1250m from centre line and using desk information obtained from the GSI database. A well audit and pump tests will be completed before construction stage for the scheme to ensure that measures can be identified to preserve abstraction rates and water quality.

From the above assessment, no significant hydraulic impact has been identified on any of the wells recorded for the study. The probability of hydraulic impact ranges from “none” to “low”. Therefore from the results of this desk based assessment, the road scheme will have an imperceptible to slight negative impact on groundwater wells. It is noted that this assessment does not include a well audit carried out for wells within 1.25km of the proposed road. These wells require validation in the field in the form of hydraulic pump tests. Also, other wells may be present that have not been recorded to date. A comprehensive well audit survey will be conducted within 1.25km of the proposed scheme at the Pre-Construction Stage to ensure that measures can be identified to preserve abstraction rates and water quality.

<u>*Hydrochemical Impact*</u>

Suspended Solids

During excavation, earth materials will be stripped of vegetation cover and will be exposed to rainfall. Sustained rainfall will entrain the finer components of the exposed earth materials (clay, silt and fine sand), which increases the turbidity of runoff waters. This water will discharge from the construction site into receptor waterways unless checked and attenuated by "construction drainage" mitigation measures. Suspended solids concentrations above regulatory limits could cause aquatic ecological problems which include clogging fish gills, smothering spawning grounds, reducing light penetration for flora growth, and adding bacteria and algae to the water. Nutrients are often associated with the solids (inorganic nutrients such as phosphorus and organic such as hydrocarbons, sewage if present) and in turn can cause significant deterioration of water quality and damage to aquatic life due to eutrophication of the water environment and eventually to fish-kills due to lowering of oxygen supply. Surface water quality concerns are all the more significant in the context of proximity of the River Shannon (SAC and pNHA) and associated tributaries. For these and other reasons, it is critical that water runoff from a development site involving earth movement activity is controlled and attenuated before discharging to the existing drainage network. This is considered to be a short-term, temporary but significant moderate negative impact. However, with appropriate environmental engineering controls and measures, this impact can be reduced to within water quality regulatory limits, which is 25mg/l of suspended solids.

Hydrocarbons

The majority of plant equipment used for the construction phase of the road scheme runs on hydrocarbons. This poses the potential for spillage and leakage of hydrocarbons from plant equipment and associated transfer stations during the construction phase of the project. The baseline vulnerability of the scheme is 'Extreme' over c.400m of the proposed scheme, with 'High' vulnerability characterising ground conditions over c.2,000m of the proposed scheme. The 3,300m of the R494 Upgrade section of the scheme may be described as 'High' over its entire extent. This is prior to vegetation stripping and any cuts and excavations being undertaken. This information combined with the presence of well supplies and sensitive ecological designations, highlights the vulnerability of these receptors to contamination by hydrocarbons unless active prevention and management of risk is undertaken. An accidental hydrocarbon spillage would have a medium term, significant, moderate negative impact on both groundwater and surface water quality at and down-gradient of the site.

Other Dangerous Substances

Aside from suspended solids, nutrients and hydrocarbons, there are other potentially "dangerous" or polluting substances that are used during the construction phase of the road scheme. The construction phase of all engineering projects introduces a risk of pollution from fuel, lubricant and other introduced chemical materials that are used in equipment or for actual construction. The most likely introduced pollutants other than hydrocarbon products to surface water and groundwater are cement products, concrete curing compounds, sealers and paints. Herbicides and insecticides are generally restricted to operation phase usage. Aside from concrete products, the volume of other potentially polluting chemicals used for road construction is low, with the majority of construction material being derived from natural soils and geology and of inert chemical reactivity. As a result the risk of contamination is low for road schemes. It is noted that the soils and geology section of the EIS (**Chapter 7.6**) identifies a record of "contaminated lands" at Ballyvally, due to suspected fly-tipping at the northern end of the proposed Killaloe Bypass, and also a small section along the R494 alignment. These are the only records of "contaminated lands" along the scheme alignment, thus the assumption is made that the Killaloe Bypass and Shannon Bridge Crossing sections of the scheme are located on a greenfield site. Once environmental constraints are used where the road scheme is proximal to sensitive surface water locations, such as the River Shannon, Kilmastulla River and groundwater locations, the risk of contamination from "dangerous substances" other than hydrocarbons as discussed above is a short to medium term, slight negative impact.

Supply Wells

The construction phase of the scheme increases the vulnerability of the underlying aquifers to contamination by stripping away protective vegetation and subsoils cover. By stripping away vegetation and subsoils, the recharge to the underlying aquifer is increased, which may in turn cause the mobilisation of residual trace contaminants such as metals in the aquifer towards abstraction wells. It is noted that this impact is generally temporary in duration and is usually restricted to the construction phase. At the end of the construction phase, an impermeable paved road, side road drainage, and landscaping and re-vegetation of excavated grounds will reduce recharge 'flushing" and restore a balance to groundwater movement. The results of the well impact assessment outlined in **Table 7.5.9**, indicate that the risk of hydraulic impact ranges from "none" to low". However, this does not necessarily correlate to a low risk of hydrochemical impact due to migration of waters in the aquifer for longer distances than the zone of contribution to the wells. Recent experience in groundwater monitoring for the construction phase of road schemes in Ireland indicates evidence of the mobilisation of residual contaminants such as trace metals (e.g. aluminium, antimony, lead, arsenic) in the aquifer by increased recharge over exposed and excavated grounds for the road scheme. As a result, the distance at which wells can experience hydrochemical impact by the road scheme are often much greater than the distances of direct hydraulic impact. It is not practical to identify which wells are vulnerable to contamination in this way, because of the uncertain nature and extent of possible flow paths. However appropriate mitigation measures exist and are described in detail in **Section 7.5.8** below. The potential for hydrochemical impact on some wells by the construction phase of the scheme is considered to be a short to medium term, moderate negative impact.

Operation Phase

<u>Hydraulic Impacts</u>

Cuts & Excavations

Cuts and excavations are the main reasons for hydraulic impact on groundwater. Hydraulic impact occurs when the water table or piezometric surface is intercepted, lowered (dewatered) or the direction of groundwater flow is diverted locally. For this scheme, **Table 7.5.1** has been updated to reflect the impact of the design's proposed cuts on interpreted water table. The assessment is based on water levels recorded in standpipes from the boreholes and coreholes taken during the ground investigation carried out for the scheme.

Table 7.5.10 Road Cut Details & Assessment of Impact on Groundwater

Cut No.	Road Chainage	Karst Aquifer Yes / No	Maximum Cut Depth (m)	Maximum Excavation Depth (m) (incl. F&D) [1]	Significance of Cut[2]	Estimated Maximum Depth of Excavation Below Water Table (m)
1	KBP - 0+060-0+640	No	17.70	19.20	Major	3.9m
2	KBP – 0+740-1+000	No	3.40	4.90	Moderate	0.9m
3	KBP – 1+400-1+500	No	0.70	2.20	None	-
4	KBP – 1+800-1+920	No	2.00	3.50	Moderate	0.9m
5	SBC – 0+360-0+440	No	1.50	3.00	Moderate	0.9m
6	R494 – 0+000-0+200	No	1.00	2.50	Moderate	0.8m
7	R494 – 0+320-0+460	No	0.40	1.90	None	-
8	R494 – 1+320-1+800	No	0.50	2.00	None	-
9	R494 – 2+140-2+225	No	0.50	2.00	Minor	0.1m

[1] F&D = Foundation and Drainage impact for road design, estimated at 1.5m below proposed road surface.

[2] Significance of Cut: Minor Cut = <2m, Moderate Cut = >2<5m, Major Cut = >5<10m.

[3] Estimate of maximum depth of excavation below water table calculated using water strike data from site investigation boreholes..

Based on **Table 7.5.10**, there is potential for hydraulic impact on the water table or piezometric surface by Cut No.1 and to a lesser degree by Cut No.2 and Cut No.4. Cut No.1 is classified as major (>5m) in vertical extent and is likely to intercept the water table / piezometric surface locally. Independent of an impact on a local well or on the Lower River Shannon SAC, the hydraulic impact by Cut No.1 is identified as a direct minor negative, permanent impact on the water table, which may be lowered locally on a permanent basis. The impact will be restricted to a local geographic distribution due to the aquifer status, distribution and characteristics of the subsoils and underlying bedrock in the study area.

It is not known at this stage of the road design development, whether some temporary “dig and replace” of in-situ earth materials is required for the construction of proposed embankments for the scheme, but it is considered unlikely. It is generally expected that minimum excavation of in-situ subsoils will be required for the construction of embankments. Whichever is the case, it is expected that temporary excavations for the scheme will have an insignificant impact on groundwater levels or flow.

Road Foundation and Road Drainage

In areas where the new road alignment will intercept the water table, which includes cuts and possibly embankments, following initial dewatering measures to progress road construction, the higher permeability of the new road materials and associated road drainage will cause a diversion of groundwater flow towards the new drainage (interception) and in some cases along the alignment of the road foundation itself (due to higher permeability materials). This is likely to be more pronounced in those areas of the development where the road alignment is located parallel to maximum slope, the main example of which is located between chainage 1+400 and chainage 2+000 of the proposed Killaloe Bypass. Cut No.3 occurs at the southern end of this section. In the context of the site's hydrogeology, and independent of potential impacts on well supplies and the Lower River Shannon SAC, the impact by diversion of groundwater into road drainage or along the road alignment is considered to be a direct minor negative, permanent impact that will be restricted to local geographic distribution.

Lower River Shannon Special Area of Conservation (SAC)

The Lower River Shannon is a Special Area of Conservation (site code 2165). SACs are protected under the European Union Habitats Directive (92/43/EEC), as implemented in Ireland by the European Communities (Natural Habitats) Regulations, 1997.

The impacts of the scheme on the SAC are further discussed **Chapter 7.2** of this document.

The proposed alignment crosses the SAC between chainage 0+610 and chainage 0+790 (c. 180m). This section of the scheme also contains embankment abutments that will support the proposed multi-span bridge crossing of the River Shannon. In terms of hydraulic impact, there is potential for dewatering or diversion of groundwater flow for embankments that possibly require "dig and replace" for foundation materials. From **Chapter 7.2**, the terrestrial habitats that the proposed scheme will encounter when crossing the River Shannon SAC corridor include pastureland, woodland and narrow fringes of reed adjacent to the river. Evaluation of the type, distribution and location of these habitats relative to the proposed road scheme and the River Shannon indicate that they are more dependent on surface water inundation from the river rather than from groundwater seepage from their water supply. This implies that they are not sensitive to local changes in groundwater levels or groundwater flow arising from the construction of the road scheme. Similarly any interception of baseflow to the River Shannon by this narrow strip of road will not impact on its flow regime, considering the very large catchment size that feeds the River Shannon. There will be no perceptible hydraulic impact by the proposed scheme on the River Shannon SAC terrestrial and aquatic habitats.

Flood Risk in River Shannon

The chosen location of the river crossing is relatively similar in characteristics compared to its upstream profile width (c.180m). The proposed scheme will cross the River Shannon and associated canal, which runs parallel to the river on its western side, between chainage 0+610 to chainage 0+790. The canal, which is approximately 10-12m wide at the bridge site, is separated from the river by a strip of land approximately 25m in width.

The river hydraulics prevailing at the proposed bridge site are rigorously controlled by the ESB by means of Parteen Weir at the head of the Ardnacrusha Headrace canal, some 5km downstream. The water level at the bridge site is virtually the same as in the basin above the weir, which is maintained at a target upper level of 33.56m OD Poolbeg (30.86m OD Malin). However ESB have advised that the target maximum level of 33.56m OD Poolbeg is not always achievable and has been exceeded as records show.

Records indicate that the level in Parteen was 33.98m OD Poolbeg on 24/10/1938 and almost the same at 33.97m OD Poolbeg on 16/12/1994. The highest ever recorded flood level at Killaloe (from ESB records) and post-construction of the Hydroelectric Scheme was 34.01m OD on 01/02/1995 (report prepared by ESB International in November 2000 titled River Shannon Flood of Winter 1999/2000 report No PA449-R46-006). However in November 2009 this level was exceeded when a peak flood level of 34.31m OD Poolbeg was recorded at Pier Head (as advised by ESB). Indeed ESB have advised that 33.56m OD Poolbeg has been exceeded on many occasions since the Shannon Hydroelectric Scheme came into operation. It is considered that levels can rise quickly in Lough Derg due to sudden rainstorms or snow melt in the Lough Derg catchment. ESB endeavour to maintain a minimum level to facilitate navigation of 32.80m OD Poolbeg, although the statutory low water level is 32.00m OD Poolbeg, which has been recorded on occasion.

The maximum recorded peak flow at the bridge site is 950m^3/s (1960) and based on this flow and the existing cross-section area, the expected maximum average flow velocity across the section will be 1.9m/s at the bridge site. The average of the annual peak flow volume is 535m^3/s, which would result in a correspondingly lower velocity.

The configuration for the proposed Shannon Crossing has been selected to avoid any deleterious effect on the existing flood regime.

Road Runoff

The proposed scheme consists of the construction of a low permeability road surface over a baseline environment in which the ground is relatively permeable. This change in surface permeability will cause an increase in surface water runoff and hydraulic loading to receptor waterways. Due to the speed in which water will run off the road surface relative to the baseline “natural” environment, this will cause a spiking of the hydrograph which in turn can cause localised flooding of drains and streams if their flow capacity is exceeded. Hydraulic loading from surface water runoff from the new paved road surface has the potential to cause a moderate, long term but intermittent, negative impact on receiving hydrology, which could ultimately result in localised flooding of drains and streams. Mitigation of this impact is achieved however by appropriate hydrological road design, where outflows are attenuated to green field conditions This ensures that flows into drains and streams are not increased . Appropriate land take has been identified for this purpose of accommodating the attenuation systems.

Catchment Loss

The proposed scheme crosses a number of hydrological sub-catchments. It is considered that the calculated percentage loss of each sub-catchment as a function of the road development is insignificant in terms of impacting on the baseline mass water balance. Therefore it is considered reasonable to assume that the proposed scheme will have no perceptible impact on recharge or baseline water balance in the sub-catchments traversed.

<u>Hydrochemical Impacts</u>

Road Runoff

Surface water runoff from motorways and national primary roads has been identified as a source of diffuse pollution to receiving waters. Studies in the UK since the 1970’s and more recently in Ireland in 2006 confirm that the main contaminants from road runoff are:

- Suspended solids
- Heavy metals
- Hydrocarbons including PAH's
- Chlorides
- Nitrates
- Phosphorus

Irish roads including this proposed bypass have "low traffic flow rates" compared with major UK and European roads. Contamination of sediments, waters, and vegetation is restricted to immediate downstream locations relative to road drainage outfall. No evidence of contamination in invertebrates and fish was recorded from recent research for the M4 and M7 motorways. In the absence of mitigation the potential impact of water quality deterioration and pollution from road runoff during the operation phase of the project would be identified as a long term, moderate negative impact on the receiving water environment.

Accidental Spillage

The operational phase of the road scheme has the additional risk of hydrocarbon and other dangerous substance contamination as a function of accidental spillage by vehicles using the bypass. This risk is present for all roads including the existing R494 regional road, where this risk already exists. It is a low probability potential risk only, but it is a risk that can have a major negative impact on receptor water quality. As a result, environmental response mechanisms will be required to be provided by the relevant local authority, taken in combination with appropriately designed mitigation measures including ability to intercept contaminants in holding areas.

7.5.8 Mitigation Measures

As outlined in **Section 7.5.5** of this report, the proposed scheme is required to comply with the Water Framework Directive (WFD). Where predicted impacts have been identified in the preceding section which may impact on the requirements of the WFD, measures are required to mitigate against same.

Construction Phase

<u>Hydraulic Impacts</u>

Temporary Excavations

No locations for temporary excavations and borrow pits have been identified at this stage of the project. Should the need for borrow pits arise, a number of well established mitigation measures exist in relation to impacts on groundwater and surface water. Any proposal to create a borrow pit would be subject to local authority planning controls. The measures which would be considered in this process include:

- Identify the location of wells within 500m of the proposed borrow pit and undertake a well audit to determine likely hydraulic and hydrochemical impact;
- Identify the location of surface water bodies within 200m of the proposed borrow pit and identify whether the excavation of the borrow pit and lowering of the water table will impact on the surface water bodies (e.g. reduce baseflow, reduce runoff contribution, affect water quality by recharge flushing through exposed substrates);
- Where possible move the borrow pit to >500m from an operation well and >200m from a stream / river to mitigate impact by avoidance;

- Consider the need for dewatering of the borrow pit in advance or in tandem with excavation works and also consider how the pumped water will be treated (water quality controlled) prior to outfall to ensure compliance with surface water regulatory limits for receptor streams and rivers;
- If excavations and borrow pits are being backfilled, consideration will be given to ensuring that the backfill is of “natural” ground origin, is of local origin and is inert in relation to leaching and mixing with underlying groundwater.

Supply Wells

The well impact assessment which has been carried out, based on available information, indicates that no significant impact has been identified on any of the wells identified., Further investigations are required in order to establish baseline conditions for water quality (hydrochemical impact, discussed below) and also to check for other operational wells that may have gone undetected to date. It should be noted that the number of such wells is expected to be minimal, given the existence of a municipal water supply system in Killaloe/Ballina.

In order to establish existing supply conditions and provide information on all wells that may be present, the following action items are required prior to the construction phase of the project:

- A comprehensive well audit will be carried out within a buffer distance of 1250m of the proposed alignment.
- The audit will allow for house-owners commuting to work and therefore will be undertaken over a number of weekends or evenings during the summer period (lighting).
- A short pump test (c.0.5hr) will be undertaken on each well in order to confirm yield, drawdown and calculate zone of contribution.
- This information will be processed and interpreted by a qualified hydrogeologist in order to confirm impact level on the well, if any, and appropriate mitigation measures.
- Potential mitigation measures are: well deepening, well replacement at a separate geographic location on the land holding, installation of a grout curtain or an alternative water supply.
- The results of the well audit including pump tests will identify those wells that are at risk of hydraulic impact by the road scheme, and which will form the basis of any appropriate alternative measures which will be required in the tender documents for the scheme;This assessment will be undertaken in advance of the detailed design / tender stage of the project. in order to allow enough time to include for the required potential mitigation measures
- During construction all existing wells will be monitored on a monthly basis to monitor evidence of any impact. In order to validate change in water levels, a minimum of three months continuous monitoring will be carried out prior to commencement of construction.

<u>*Hydrochemical Impacts*</u>

Suspended Solids

This is one of the most significant impacts on surface water quality during the construction phase of the project. In order to reduce this impact to meet compliance with regulatory limits of surface water quality and the requirements of the Water

Framework Directive, the following mitigation measures will be incorporated into construction methodology:

- An interceptor drain will be installed upslope of the construction footprint in order to intercept and divert "clean" runoff water away from the exposed grounds, silts and clays of the construction area. This will reduce the volume of "dirty" water that will require attenuation treatment prior to discharge.
- The water that falls directly on the exposed earth materials will naturally flow to the lowest topography of excavations. This water needs to be collected into receptor drainage to a series of catch pits and settlement ponds and soakaways (rip-rap).
- The outfall will not discharge directly to any drains, streams or rivers, but indirectly through a percolation area following retention in catch pits and settlement ponds.
- In order to ensure no direct discharge to receptor waterways, the outfall from construction phase drainage will be placed no closer than 50m from receiving waterways including drains (to allow enough buffer distance for percolation and riparian vegetation attenuation).
- To ensure that discharge waters from the construction footprint is not causing suspended solids loading of receptor waterways, a sampling programme for Total Suspended Solids (TSS) including Nutrients (phosphorus, nitrate) and Total Petroleum Hydrocarbons (TPH) will be set up at locations where the road scheme is proximal to sensitive waterways. The results taken at both low and high flow will be checked against regulatory limits for compliance. Pollution control measures will, at a minimum, comply with HA 103 of UK DMRB.
- Monitoring of the receiving watercourses will be conducted during the construction phase and will be in line with the Water Framework Directive monitoring recommendations. Refer also to **Chapter 7.2** –Ecology Mitigation.

Hydrocarbons

The construction phase of the road scheme introduces the risk of hydrocarbon leakage, spillage and pollution of the underlying groundwater aquifers and of the surface water drainage. In order to avoid and reduce this impact on the water environment, the following mitigation measures will be incorporated into construction methodology:

- If Above Ground Tanks (AGT's) are proposed for refuelling of plant equipment, then the fuel stations will require bunding to 110% volume capacity of fuels stored at the site. The bunded area will be drained by an oil interceptor and this drainage will be controlled by a penstock valve that will be opened to discharge storm water from the bund. A suitably qualified management company will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis, including decommissioning at the end of the construction phase.
- Alternatively, plant equipment can be refuelled by a mobile bowser which will refuel the plant near the area in which it is operating. This will eliminate the environmental and health and safety risk of hydrocarbon storage in above ground tanks (AGT's) but requires operational vigilance to ensure there are no leakage incidents during transfer. If a mobile bowser is used, refuelling will take place on in-situ, unexcavated ground that is covered with vegetation and is >100m away from any waterways or drainage.
- There is also the risk of leakage from vehicles and plant equipment during construction activity, as opposed to refuelling. The plant equipment used on site will require regular mechanical checks and audits to prevent spillage of

hydrocarbons on the exposed ground during construction. This will be part of the site environmental management system (EMS).

- All plant equipment will have a stock of synthetic absorbent mats or "spill-dry" sand in their cabins to contain and clean up minor spillages from plant equipment during re-fuelling or mechanical leakage.
- Larger spillages or leakage of hydrocarbons will be reported to the environmental manager for immediate clean up.
- If a significant hydrocarbon spillage does occur, the environmental manager must have an approved and certified clean-up contractor available on 24-hour notice to contain and clean-up the spill. The faster the containment or clean-up starts, the greater the success rate, the lower the damage caused and the lower the cost for the clean-up.
- Monitoring of the receiving watercourses will be conducted during the construction phase and will be in line with the Water Framework Directive monitoring recommendations.

Other Dangerous Substances

With the exception of cement products, the list of chemicals / compounds that may be used for road construction is short and their volume of use and storage is low. These chemicals and compounds will be stored in designated locations within a bunded area of the site compound within secure can clearly labelled containers. The EMS will define the range of chemicals / compounds that will be used for the scheme and detail under what conditions they can be safely applied to ensure protection of the receiving environment, particularly of groundwater and surface water receptors.

Supply Wells

In addition to introduced contaminants, there is also the risk of mobilising residual trace elements or residual contamination in the aquifer (e.g. historic contamination) due to increased recharge over exposed sections of the scheme (excavations and cuts). It is almost impossible to prevent the latter type of scenario occurring due to the absence of detailed site investigation and geochemistry data, which is impractical for a scheme of this size. The following mitigation measures are identified to anticipate, manage and resolve hydrochemical impacts to wells if they arise for the road scheme:

- Appropriate auditing will be carried out as part of the hydraulic well audit referred to above;
- Based on the findings of the well audit, those wells identified within 500m of the scheme will be sampled by means of carrying out appropriate chemical tests. The well audit will also identify other wells greater than 500m from the scheme which are considered to be at risk. These wells will also be tested;
- This sampling analysis of water quality will be undertaken as part of the three months continuous monitoring process prior to start of the construction phase of the scheme referred to above in relation to well yield. The purpose of this analysis is to determine water quality in the wells, presence of any pollutants, or evidence of elevated trace elements prior to road construction;
- The wells will be sampled according to the "audit" parameter list under Irish Drinking Water Regulations, which is currently defined in Tables A and B of Part 1 of SI No. 106 of 2007;
- After the initial sampling, the same wells will be sampled at quarterly intervals during the construction phase of the project for the relevant check parameter list contained in Table A of Part 2 of SI 106;

- Any changes in chemistry will be notified to the environmental manager of the scheme as well as to the local authority;
- Where hydrochemical impacts are identified that exceed Irish Drinking Water Regulations, intervention and corrective measures will be undertaken to ensure safe drinking water supply is provided to any affected well owners;
- At the completion of the construction phase, another post-construction "audit" sampling event will be undertaken in order to sign off and confirm avoidance of contamination of relevant wells by the road scheme;
- To reduce recharge and stabilise groundwater movement and chemistry at the end of construction, landscaping and re-vegetation of exposed grounds will be carried out for any sections where trace metals may have become elevated during the construction phase (as evidenced by independent sampling).

Operation Phase

Hydraulic Impacts

Cuts & Excavations

The hydraulic impacts arising from permanent cuts and excavations are considered to range from minor negative to insignificant depending on location. No mitigation measures are recommended for these impacts outside of well supplies, Lower River Shannon SAC considerations and Lough Derg pNHA considerations.

Road Foundation and Road Drainage

There is likely to be some groundwater interception and local diversion by road foundation and drainage for the road scheme. This impact is identified as a permanent, minor negative impact but one that does not require mitigation action outside of well supplies, Lower River Shannon SAC considerations and Lough Derg pNHA considerations.

Lower River Shannon SAC

There will be no perceptible hydraulic impact by the proposed scheme on the Lower River Shannon SAC terrestrial and aquatic habitats. As a result no mitigation is required.

Flood Risk to River Shannon

The bridge design layout proposed has been selected to ensure it does not cause flooding either upstream or downstream of the bridge crossing. It is noted that the river hydraulics at the proposed bridge crossing location are rigorously controlled by the ESB by means of Parteen weir and the Ardnacrusha Hydroelectric Scheme, and the proposed bridge design reflects these conditions.

Road Runoff

Runoff waters from the impermeable road surface will cause increased hydraulic loading of receiving surface waterways if left unchecked and unattenuated. This has the potential to cause local flooding of receiving drainage due to "spiking" of the hydrograph. In **Chapter 3** of the EIS, it is proposed that:

"The design of this scheme has included provision for storm water attenuation. Storm water attenuation ponds will have adequate capacity to cater for the fifty year rainfall event. Flows will be restricted to greenfield runoff rates by a flow control device at the outlet. Ponds will permanently contain a 300mm depth of water to encourage plant life develop over time which will also act as a water quality treatment facility".

In addition to these design measures, the following mitigation measures are included in the road drainage design:

- For sensitive parts of the site where runoff volume may overwhelm baseline hydrology, attenuation / retention ponds are installed at the end of road drainage prior to outfall. Retention ponds will "hold" back road runoff until a storm event passes and afterwards slowly release the runoff water at a controlled discharge rate to natural drainage (avoid "spiking" of hydrograph);
- A hydraulic evaluation has been undertaken for all road drainage outfall points in order to determine the impact on receiving waterwaysA benefit of using retention ponds as part of runoff discharge treatment is that it has the dual role of discharge control and water volume retention but also provides water quality control for discharge waters;
- A programme of inspection, auditing and maintenance of the road scheme drainage and water quality pollution control system will be undertaken for the scheme. The design of these pollution control schemes is such that, once properly maintained, the pollutant levels will be kept within required limits (i.e. 25mg/l of suspended solids).

Loss of Catchment

The loss of catchment for surface water contribution and / or for recharge to groundwater is considered insignificant in terms of percentage loss. No mitigation measures are required.

<u>Hydrochemical Impacts</u>

Road Runoff

The impact of road runoff on receiving water quality is identified to be a moderate negative impact. However with appropriate constructed drainage that includes water quality control measures to attenuate identified contaminants from road runoff, this impact can be reduced to minor or slight impact. The following pollution control measures are recommended for road runoff water quality control:

- Retention ponds have been recommended as a runoff discharge and volume control measure to prevent hydraulic loading of receiving waterways, as well as providing associated water quality control;
- Retention ponds are designed to provide the dual capacity to hold water discharge volume and also improve its water quality before discharging to the natural environment by producing a low flow regime in which natural sedimentation of suspended solids occurs. Many other road runoff contaminants are associated with suspended solids, therefore by reducing the suspended solids load a lot of the other pollutants are also reduced from the discharge waters;
- Retention ponds "hold" storm runoff waters and in the case of a significant accidental spillage of a contaminant such as hydrocarbons, the volume holding capacity of the retention / attenuation pond will provide "buffer" time for an emergency response team to contain and clean up the contamination;
- A petrol interceptor will be installed as a "final cleansing" system for discharge water quality in light of the designation status (SAC and pNHA) and sensitivity of the receiving waters to contamination from road runoff or a larger scale accidental release event;

- Recent studies into road runoff water quality indicate that a significant volume of water is lost to groundwater through percolation through the filter drains before every reaching outfall treatment. This is of concern in those areas where sensitive receptors have been identified such as (a) wells, (b) Lower River Shannon SAC, (c) Lough Derg pNHA as well as (d) surface water and groundwater itself. Closed (sealed) drainage will be installed for those parts of the scheme that transverse the Lower River Shannon SAC and where aquifers are characterised by extreme vulnerability. Elsewhere, the aquifer status of the underlying groundwater and the attenuating properties of overlying subsoils will provide sufficient protection of underlying groundwater.

Accidental Spillage

Accidental spillage of hydrocarbons or other chemicals from a vehicle during the operation phase of the scheme has the potential to have a major negative impact on receiving waterways. In combination with the other water quality mitigation measures it is anticipated that the local authority will have a 24 hour “Spill and Clean Up” contractor signed up to provide an immediate response to accidental spillage. Appropriate mitigation measures including interception systems will be included in the scheme to assist this process.

7.5.9 Residual Impacts

The residual impacts of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement are:

- Some permanent lowering of the water table will occur in some sections of the road scheme, where the water table will be intercepted. In the context of regional hydrogeology and identified hydrological and hydrogeological receptors, this impact ranges from a minor negative to insignificant impact;
- There will be some loss of catchment and sub-catchments, but this is considered insignificant in context of remaining catchment area and contribution to hydrology;
- There may be impacts on some wells identified in the well audit that will be undertaken at the pre-construction phase. If wells are impacted, accommodation works provided by the local authority will ensure that there is no residual impact.

7.6 Soils and Geology

7.6.1 Introduction

This chapter outlines the various geological impacts of the proposed route, which includes a western bypass of Killaloe in County Clare, a new crossing of the Shannon River approximately 1km downstream of the existing Killaloe Bridge, together with an improvement of the existing R494 between Birdhill and Ballina in County Tipperary.

The objective is to identify and quantify any significant impacts on the existing environment as a result of construction and operation and to propose mitigation as required.

7.6.2 Methodology

Various data sources were consulted during the preparation of this chapter, information is available on the Geological Survey of Ireland (GSI) website including mapping of subsoils, bedrock and associated features. A site visit was undertaken in July (2008) to assess areas of interest, to investigate where there was a change in ground conditions and to scope out locations suitable for site investigations.

A Preliminary Ground Investigation, comprising cable percussion boreholes, rotary coring, trial pitting, dynamic probing window sampling and laboratory testing was carried out along the route alignment between October 2008 and January 2009. Further investigation, field and laboratory data was subsequently undertaken in between July and August 2009 to assess the ground conditions along revised sections of the route.

Geotechnical laboratory testing of selected samples collected during these works was carried out to determine soil properties and strength parameters. Geophysical surveying techniques were also used and the geophysics reports were prepared including interpretation of the ground profiles and mapping (Geophysical Report (2007) and (2009)).

7.6.3 Topography

The route is broken up into three distinct sections; the Killaloe Bypass, the River Shannon Crossing and the R494 Improvement as described in **Chapter 3**. The topography of the proposed Killaloe Bypass is generally one of high relief with steep and undulating slopes to the north with more gently undulating terrain to the south. Relief of the site ranges from +86m above Ordnance Datum (AOD) at the northern end of the site to +35.6m AOD at the southern end of the site.

The R494 section is approximately 3,340m long and mainly involves an online improvement. The general topography is relatively flat with minor undulations varying between +42.3m OD in the north and +28.9m OD in the south.

Three separate offline sections exist along the R494 improvement section, the first is 300m long extending from chainage 0+600 R to chainage 0+900 R, the second is 200m long from chainage 1+150 R to chainage 1+350 R and the third is located at the most southern end of the scheme from approximately chainage 2+400 R to chainage 3+300 R and is 900m long. The most significant cut and fill areas along the R494 Improvement originate from these offline options.
The Shannon Crossing is generally in low lying flat ground located in the flood plain of the river extending from chainage 0+000 S to chainage 0+800 S. This is an area

which is slightly undulating; with minor cut and fill requirements. An embankment of less than 3m high is required from chainage 0+000 S to chainage 0+420 S and a cut section less than 2m from chainage 0+420 S to chainage 0+530 S.

7.6.4 Existing Soils and Geology

Overview of Subsoils

The northern section of the Killaloe Bypass is founded in Shale Tills from the Lower Palaeozoic era. The southern section of the bypass and the Shannon crossing are founded in undifferentiated Glaciofluvial sands and gravels with the Shannon crossing encountering gravelly alluvium close to the River. The R494 is chiefly founded in Tills derived from Lower Palaeozoic rocks. Some rock outcrops are evident in the region however none will have a significant impact on the route. To the west of the Killaloe Bypass in Knockyclovaun the GSI has mapped an area of rock outcrop in the hill top, similarly along the east bank of the Shannon there is also evidence to suggest the presence of rock outcrop. Areas surrounding the River, west of the R494 may be prone to alluvium deposits associated with the Kilmastulla River and the numerous tributary streams of the Shannon itself while glaciofluvial sands and gravels can be expected to the south east of the R494. See Subsoils Geology Map **Figure 7.5.4**.

The following general characteristics of the ground profile along the proposed route are summarised in **Table 7.6.1** below.

Subsoils: Killaloe Bypass

A thick glacial overburden (>5 metres) generally of till and granular deposits covers the rock in the region. The overburden is generally characterised as firm – very stiff clay with cobbles and boulders interbedded above or below with medium to dense gravel with occasional cobbles.

The exploratory holes put down along or near the alignment indicate 0.1 to 0.3m of topsoil, generally overlying gravelly clay deposits, and/or granular deposits. The only recorded presence of groundwater was in TP's103, 104 & 105 where rapid groundwater ingress was recorded at approximately 2m bgl.

The rapid groundwater ingress is due to the very high permeability sands through which the pits were excavated and the low lying topography of the area. These trial pits were excavated to the south of the proposed route and therefore the groundwater encountered will not be an issue as this will most probably be in an area of embankment construction.

Cuttings

There is one major cutting at the beginning of the proposed Killaloe Bypass which has a maximum depth of 17m. The remaining cuttings are generally shallow (<3 metres depth). The significant 17m cutting is located at Knockyclovaun (chainage 0+060 K to chainage 0+640 K). The other cuttings are <3.5m located at Knockyclovaun (Ch. 0+740 K to Ch.1+000 K), at Shantraud north (chainage 1+400 K – chainage. 1+510m K) and at Shantraud south (chainage 1+800 K – 1+920 K).

The cutting at Knockyclovaun (chainage 0+060 K – chainage 0+640 K) is expected to consist of topsoil over soft to very stiff gravelly clay, revealed to a maximum depth of 4m bgl. Below this stratum sand and gravel deposits were recorded to a maximum depth of 9m bgl in BH112A. Rock head was encountered at levels ranging from 5m to 9m bgl approximately and was described as moderately weak to strong

siltstone/sandstone. Laboratory testing confirmed varied rock strengths along this section, recording results ranging from 2.7MN/m2 to 115MN/m2. No groundwater was encountered during the construction of any of the exploratory holes. A standpipe was installed in RC112 and readings during winter/ spring 2009 recorded groundwater levels of 10.5m bgl and dry
The cutting at Shantraud north (chainage 1+400 K – chainage 1+510 K) and Shantraud south (chainage 1+800 K – chainage 1+920 K) are both <3m excavations and will most likely encounter firm to stiff gravely clay and/or fine to coarse sandy gravel. The available exploratory holes excavated near the north cutting do not encounter groundwater and therefore it should not be an issue in this excavation. However groundwater was encountered at 2m bgl near the southern excavation and may be present at or above foundation level in this cutting.

Based on the findings of the Preliminary Ground Investigation the ground conditions are generally believed to be acceptable for forming the proposed earthworks at side slopes of one vertical to two horizontal with an adequate factor of safety in the boulder clay, sand and gravels soil overburden.

Sections of the cuttings will be below the current groundwater level. Generally water ingress into cuttings in the till overburden will comprise of minor seepage from thin lenses of water-bearing granular deposits although more significant flows are likely to occur locally from thicker granular deposits. Interceptor ditches, batter and filter drains will deal with any groundwater flow seepages.

Embankments

Many small embankments are required along the alignment of the Killaloe Bypass with typical heights of less than 3m. The embankments include Ballyvally (chainage 0+000 K – 0+060 K) of maximum height 2m along the mainline and up to 6.5m on the roundabout and approach roads; Knockyclovaun (chainage 0+640 K – 0+740 K); Knockyclovaun South; Shantraud North (chainage 1+000 K – 1+400 K); Shantraud South (chainage 1+510 K – 1+800 K); and at Shantraud Woods (chainage 2+000 K – 2+026 K).

The founding strata for the main line embankment at Ballyvally (chainage 0+000 K – 0+060 K) will be firm fine grained glacial till over coarse grained glacial till. The roundabout and associated approach roads are underlain by firm clay with cobbles over medium to dense gravel to a depth of 7m bgl. RC107 was extended to 15m bgl and encountered only glacial till to this depth.

Made ground was encountered to the north of the Killaloe Bypass in BH107 from ground level to 2.5m bgl. This material is described as made ground (comprising of clay and gravel) and what was described as domestic waste between 1.6 and 2.5m bgl. A further two trial pits, TP106A and TP106B, were excavated to determine the extent of this material. The extent is expected to be 40/50m east to west and 20/30m north to south and is positioned under the footprint of the proposed roundabout and this material will require excavation and replacement with suitable fill material. Groundwater was encountered at a depth of 8m bgl in this area and recorded readings from a standpipe were on average 1.48m bgl with only a 60mm range.

At Knockyclovaun (chainage 0+640 K – 0+740 K), the proposed <1m embankment will be underlain by medium/ dense and/or firm to stiff coarse and fine grained glacial till. Groundwater has not been recorded in this section but is anticipated that it may be <1m bgl.

At Knockyclovaun South (chainage 1+000 K – 1+100 K); the proposed <2m high embankment will be underlain by medium /dense and/or firm to stiff coarse and fine grained glacial till. Groundwater has not been recorded in this section but it is anticipated that it may be <1m bgl.

At Shantraud North (chainage 1+100 K – 1+400 K); the proposed <2.5m high embankment will be underlain by medium /dense and/or firm to stiff coarse and fine grained glacial till in the north-western end of the embankment. Towards the south-eastern section, the proposed embankment will be underlain by grey oxidised silt overlying firm brown silt/ clay deposits. Groundwater was recorded at 2.3m bgl (+48.13m AOD) in TP104.

At Shantraud South (chainage 1+510 K – 1+800 K); the proposed <4.5m high embankment will be underlain by firm medium /dense and/or firm to stiff coarse and fine grained glacial till. Groundwater has not been recorded in this section but it is anticipated that it may be <1m bgl.

At Shantraud Woods (chainage 2+000 K – 2+026 K), the proposed <2m high embankment will be underlain by grey sand grading to clay /silt to 2.2m bgl with silty sand below to 3m bgl, as revealed in TP104. Groundwater was recorded as seepage at 1.4m (+37m AOD) and as fast flow at 2.2m (+36.25m AOD) in TP104.

Side slopes for embankment construction will depend on the quality of available fill material. It is expected that slopes of 1 vertical to 2 horizontal will be satisfactory given the likely materials excavated along this section of the route.

Subsoils: R494 Improvement

A thick glacial overburden (>10 metres) generally of till and granular deposits covers the rock in the region. The overburden is generally characterised as firm – very stiff clay or medium dense sandy gravel with cobbles and boulders.

The exploratory holes put down along or near the alignment indicate 0.1 to 0.3m of topsoil, generally overlying sandy gravelly clay deposits, and/or granular deposits with occasional soft to firm silt deposits. Peat has been recorded along the route and is described as soft. Made ground has been identified along the route and generally consists of granular fill material with cobbles and boulders, mostly associated with the existing road.

There are numerous water strikes recorded along the route, described below; however this should have little impact on the construction as the majority of the route is at grade or on embankment.

At-Grade Construction

There are two areas of at grade construction along the route. These areas include small, <0.5m embankments and cuttings either side of the route. The two areas identified are located at (chainage 0+000 R – 0+200 R) and (chainage1+350 R – 2+450 R) referred to as G1 and G2.

At G1 (chainage0+000 R – 0+200 R) the ground conditions reveal made ground to 0.3m bgl, consisting of granular fill, associated with the road construction, over firm to stiff fine grained glacial till to a depth of 5.5m bgl where the exploratory hole terminates on an obstruction. Groundwater is encountered at 1.7m depth and described as seepage.

G2, (chainage1+350 R – 2+450 R), the ground conditions encountered are made ground to a depth of approximately 1.2m, consisting of sand, cobbles and boulders with timber and plastic between chainage 1+600 R – chainage 1+850 R. The remaining section is underlain by fine grained glacial till. Rock was encountered at a depth of approximately 18.5m bgl. Groundwater was encountered in this area between 1m and 4m bgl.

There should be no significant difficulties constructing the road at grade in both areas. The only area of concern is the presence of made ground between chainage 1+600 R – 1+850 R. This material may have to be excavated and replaced if it is determined to be unsuitable for use as founding stratum.

Cuttings

There is one cutting at the beginning of the proposed route which has a maximum depth of approximately 2m at chainage 0+330 R – 0+650m R referred to as C1.

The cutting at C1 is expected to consist of topsoil over firm to stiff clay with cobbles. These deposits were revealed to a maximum depth of 5.5m bgl during the investigation. Groundwater was encountered in BH122 at 1.9 and 5.5m bgl and described as slow flow for both water strikes. It is not anticipated that groundwater will be an issue in this area.

Embankments

Many small embankments are required along the alignment in this section with typical heights of less than 1m associated with the realignment of the existing road. Many of these have embankment construction on one side and occasionally cutting on the other side of the existing road. The majority of these areas are discussed above in the at grade construction section.

Three embankments along the alignment are discussed in this section. These are located between chainage 0+200 R and 0+330 R of maximum height less than 1m, referred to as E1; between chainage 0+650 R and 1+350 R of maximum height of 3m, referred to as E2 and between chainage 2+450 R and 3+300m R of maximum height of greater than 7m, E3. The latter embankment includes the structures for crossing the Kilmastulla River and the existing railway line.

The founding strata for the main line embankment at E1 (chainage0+200 R - 0+330 R) will be less than 0.5m of made ground, associated with the existing road, over firm fine grained glacial till. Groundwater was encountered at a depth of 3.7m bgl and 5.6m rising to 3.4m bgl recorded as seepage and slow flow respectively.

E2 (chainage 0+650 R - 1+350 R), the embankment should be underlain mostly by fine grained glacial till. This section includes two new-build sections of the alignment, between chainage 0+650 R to chainage 0+940 R and chainage 1+150 R to the end of this section (chainage 1+350 R). The northern end of this section is underlined by fine grained glacial till from the commencement of this section to approximate chainage 0+900 R. This material is described as firm brown silt/clay with cobbles underlain by medium/dense sand to 2.6m bgl over gravel and gravelly clay at 5.3m bgl. Groundwater was recorded at approximately 4m depth, rising to 3.5m after 25 minutes; groundwater seepage was recorded in TP115 at 2.6m depth.

The middle section of E2, from approximate chainage 0+900 R to chainage 1+350 R, is underlain by approximately 1m of made ground comprising of granular fill, most probably associated with the existing road. This is in turn underlain by up to 1.7m of peat, with gravel deposits recorded to a maximum depth of 6.5m below this. BH125 revealed a further layer of firm grey/brown sandy silt from 4.7m to 8.4m bgl, before encountering fine grained glacial till when this BH terminated at 10m. Groundwater was encountered between 3.5 to 4.4m BGL rising to 2.8m after 20 minutes and described as seepage and slow flow respectively.

This section will require some form of ground improvement to allow the construction of the road. At a minimum, the made ground and peat will have to be excavated and replaced with suitable material. The area around BH125 may also require ground improvement of the silt layer at depth, depending on further investigation.

The new build section of the alignment will be founded on fine grained glacial till. This material is recorded as soft from ground level to 0.9m bgl with an approximate 1m thick layer of gravelly sand returning to fine grained glacial till where this BH terminates on an obstruction. BH127 reveals firm glacial till from ground level to 5.5m bgl where again this BH terminates on as obstruction. Groundwater was encountered at 1.8m and 3.1m depth, both described as seepage. No significant construction difficulties are anticipated in this area, however any local soft spots will have to be excavated and replaced with suitable material.

E3 (chainage 2+450 R - 3+300 R), the embankment should be underlain mostly by coarse grained glacial till and or alluvial silts and gravels over Limestone rock.

At the northern section, around the location of the Kilmastulla River, the strata encountered will consist of soft to firm silt/clay to a maximum depth of 2m over loose to medium dense sands and gravels. The sands and gravels are underlain by firm to stiff laminated clay/silt to a maximum depth of 17m bgl. Limestone rock was encountered between 17 and 19m bgl.

The northern abutment of the river structure should encounter 2m of soft clay over loose to medium dense gravel to a depth of 4.7m over a stiff to hard brown clay to 17m bgl. A 1.4m layer of dense gravel is encountered with Limestone rock head at 18.4m bgl (+12.6m AOD).

The southern abutment of the proposed river structure will encounter 2m of soft to firm silt/clay over a 1.5m thick medium dense gravel over firm to stiff laminated clay to 12.7m bgl. The stratum is then described by the driller as “gravelly clay” to 18.2m bgl (+12.45m AOD) where limestone rock head is encountered.

Groundwater was encountered at 2.5m bgl rising to 2m after 20 minutes and described as moderate flow in BH135. The foundations for both these abutments will most probably have to be piled to bedrock due to the presence of significant clay deposits at depth which could create an unacceptable amount of settlement post construction.

At the southern section, around the location of the railway bridge, the strata encountered will consist of soft to firm silt/clay to a maximum depth of 2m over loose to medium dense sands and gravels to a depth of between 7.2 and 9m bgl. The sands and gravels are underlain by soft to firm/stiff clays with a maximum thickness of 3m. Overburden from approximately 10m bgl is described as “gravelly clay” to a maximum depth of 23m bgl (+6.87m AOD), where limestone rock is encountered.

The northern abutment of the railway structure should encounter 1.5m of firm clay over medium dense sandy gravel to a depth of 7.2m over soft/stiff sandy clay to 9m bg over 0.5m of sand over dense gravel to 10.5m. Rotary open hole drilling of the area revealed gravelly clay to 23m bgl over limestone rock.

The southern abutment of the proposed railway structure will encounter 2.2m of soft to firm clay over a medium dense gravel to 9.7m bgl over stiff clay with cobbles to 12.8m bgl. Rotary coring was carried out and confirmed rock head at depths of 17.2m and 18.2m bgl from east to west.

Groundwater was encountered typically at 1.5m and 9 mbgl described as rapid flow in 8.7m. The foundations for both abutments will most probably have to be piled to bedrock due to the presence of significant clay deposits at depth which could create an unacceptable amount of settlement post construction.

Subsoils: River Shannon Crossing

According to the GSI the area surrounding the Shannon Crossing is comprised mainly of made ground due to the urban sprawl of Killaloe on the west and Ballina on the east with an area of soft alluvium soils to the south.

A mixture of glacial and alluvium deposits were proven by trial pits put down close to the alignment in August 2009. As expected the soil is quite layered with soft to firm silt/clay over loose gravels above more clay layers and loose sands. This is generally a direct result of river deposition laying down sorted layers of material. In TPE1 at chainage 0+040 S made ground was identified in the top 0.7m comprised of grey gravel and cobbles and a 0.3m layer of clayey peat was also determined near the surface. BHA1 was put down at chainage 0+150 S along the Shannon crossing section. This borehole recovered sandy gravels over silty/ clayey gravels to a depth of 6.4m BGL.

Groundwater strikes were recorded in the trial pits at approximately 2.5m bgl in a loose sand layer which is highly permeable but not in BHA1. Groundwater encountered will not be an issue in this low lying topography as there are no significant cuttings proposed, only embankments less than 3m high are required to raise the alignment slightly.

The following table give a summary of the ground investigation results determined along the proposed alignment.

Table 7.6.1 Summary of Ground Investigation Results

Approximate Chainages		Material	Profile Cut/Fill
From	To		
Killaloe Bypass			
0+000	**0+060**		Fill
0+060	**0+640**	MG / CLAY SAND top 0.8 to 2.5m Medium to Dense GRAVEL 9m	Cut
0+640	**0+740**	Fine to Coarse Sandy GRAVEL 3m	Fill
0+740	**1+000**	No SI	Cut
1+000	**1+400**	Dense GRAVEL 0-1.6m Sandy Gravelly CLAY 4m	Fill
1+400	**1+510**	CLAY / SAND top 1m to 2.7m GRAVEL to depth of 3m to 5.2m.	Cut

Approximate Chainages		Material	Profile Cut/Fill
From	**To**		
		Groundwater NA	
1+510	**1+800**	SILT over SILT/CLAY 2.8m GW rapid at 2.3m.	Fill
1+800	**1+920**	No SI	Cut
2+000	**2+026**	SILT/ CLAY 2.3m GRAVEL or SAND to a depth of 3.7m	Fill
Shannon Crossing			
0+000	**0+150**	MG 0-0.7m. Soft CLAY/PEAT 1.2m Gravel /CLAY/SAND 3m	Fill
0+150	**0+340**	Gravel with Cobbles 6.4m	Fill
0+340	**0+420**	CLAY /GRAVEL/ CLAY /SAND SOFT/LOOSE 3m	Fill
0+420	**0+530**	No SI	Cut
0+530	**0+590**	No SI	Cut
0+590	**0+650**	No SI	Fill
R494 Improvement Section			
0+000	**0+ 200**	Sandy gravelly CLAY/ SILT 1.6m	Cut /At grade
0+ 200	**0+330**	Made ground top 2m. Sandy gravely CLAY over Clay with Cobbles to 6m	Fill
0+330	**0+650**	Sandy gravelly CLAY/ SILT to 3m. Sandy gravel/ Clay 6.3m	Cut
0+650	**1+350**	Made Ground 0-1m. (Probes soft layer 1-1.5m) PEAT 1-3m. BH124 GRAVEL 3-6.5. BH125 SILT/CLAY 3-10m (soft 4.7m)	Fill
1+350	**2+450**	1-2m of SOFT ground DP107/108 and BH129. (MG 0 to 1.2m TP118) Sandy Gravelly CLAY 10m.	Cut /At grade
2+450	**3+300**	Sandy gravelly CLAY/SILT top 2-2.5m. Underlain by Gravel to depth of 4 – 10m (approx). CLAY/SILT to a depth of 10.5 – 17m. Rock head between 17 and 23mBGL.	Fill

7.6.5 Existing Bedrock Geology

Bedrock: Killaloe Bypass

The underlying bedrock of the area west of the river, from the available GSI information, consists of Upper Palaeozoic greywacke sandstone, conglomerate and shale/mudstone. The dominant formations are the Broadford formation of fine to conglomeratic graded greywacke in the northern section and Old Red Sandstone of red conglomerate, sandstone and mudstone in the southern section of the bypass. The bedrock is likely to be medium strong to very strong apart from the top 1-2m which is likely to be weathered. Bedrock geology underlying the proposed route has been described in available boreholes as moderately weak to strong thinly bedded to laminated, bluish dark grey, fine grained siltstone/sandstone.

Rotary cores sunk in the northern sections of the route reached a depth of 15m respectively but did not encounter bedrock. Rock was identified in RC112 and

RC112A, between 8.5m and 9m bgl and confirmed to a depth of 15m. RC112 returned moderately strong to moderately weak thinly bedded laminated, bluish dark grey find grained siltstone/sandstone. Slightly to highly weathered with an average total core recovery of 44%. RC112A recovered layers of calcareous siltstone/sandstone and sandstone. The Calcareous siltstone/ sandstone is moderately strong to strong, thinly to medium bedded bluish dark grey /locally greenish fine to medium grained, slightly to moderately weathered. Discontinuities are smooth to slightly rough and slightly undulose to planar. Apertures are open to tight with brown weathered surfaces. Dips are sub-50 with commonly 50-90 dipping fractures. The sandstone is moderately strong to strong thinly to medium bedded, green fine to medium grained. Slightly to locally moderately weathered.

Bedrock: R494

The underlying bedrock of the area east of the river (R494) consists of Lower Carboniferous limestone and shale at the northern end comprised mainly of sandstone, mudstone and thin limestone. However the southern part and majority of the route is expected to be underlain by dark muddy limestone and shale of the Ballysteen formation. The bedrock is likely to be medium strong to very strong apart from the top 1-2m which is likely to be weathered. Rock was not encountered close to the surface along the alignment in the exploratory holes constructed to date.

Rotary core were predominantly sunk around the southern section of the R494 where bridges over the Kilmastulla River and the Railway are required. Limestone bedrock was encountered between 17.2 and 18.9m BGL between chainage 2+080 R and chainage 2+650 R and confirmed to depths between 27 and 29mBGL. The logs describe the bedrock as strong to locally moderately strong thin to medium bedded grey/dark grey/ black fine grained limestone (fossiliferous, slightly siliceous and argillaceous). The rock is fresh to locally slightly weathered with local calcite veins.

Rotary cores RC137 and RC138A between chainage 2+950 R and chainage 3+030 R encountered bedrock at a lower level between 22.7m and 23m BGL to depths on 33.2m and 29m BGL respectively. The core logs described the bedrock as strong to locally moderately strong, thin to medium bedded, grey / dark grey /locally black find grained limestone (fossiliferous, slightly siliceous and argillaceous). The rock is fresh to locally slightly/ moderately weathered with local calcite veins. Discontinuities are smooth and planar to slightly undulose. Apertures are open to locally tight with locally clay smeared surfaces. Dips appear sub-horizontal with local sub-vertical fractures.

Bedrock: River Shannon Crossing

The Shannon crossing section is founded in Old Red sandstone. Rivers generally carve out their channels along weaker planes or soft spots in the rock. A cable percussion borehole at the east bank terminated at an obstruction at 6.4mbgl and presence of rock head is inferred. Exposed rock was observed at river bed level in the western half of the channel during a dive survey carried out as part of the project Cable percussion boreholes at the southern end of the Killaloe Bypass from chainage 1+700 K to chainage 2+030 K, all terminate between 4m and 6m bgl respectively. This indicates that bedrock is relatively shallow in this area and this has been confirmed by rotary core holes carried out. A generalised Bedrock Geology Map is shown in **Figure 7.5.4**.

Karst Features

Karst features manifest in predominantly limestone regions therefore the risk associated along the Killaloe bypass or the River Shannon Crossing are very low as these areas are dominated by sandstones, siltstones and shales.
A search for any Karst features along the R494 section was conducted through the GSI Groundwater Department, using their Karst database. The database search was conducted using the online mapping and direct contact with the GSI. The only Karst feature identified near the study area is a “Swallow Hole”, located east of Ardnacrusha which is approximately 15km south west of Birdhill (south of the R494).

The possibility of undisclosed Karst features along the route cannot be completely discounted but the risk is considered to be relatively low.
A summary of the various rock types identified in the area are listed in **Table 7.6.2** below.

Table 7.6.2 Bedrock Geology

Period	Formation	Rock Types	Excavatability	Dip angle	Map Symbol (where used)
Carboniferous	Lower Limestone Shale	Sandstone, mudstone & thin limestone	Generally Rippable	No Data	LLS
	Ballysteen Formation	Folssiliferous dark grey muddy limestone	Generally Rippable	Sub horizontal to sub 10°	BA
Devonian	Old Red Sandstone	Red conglomerate, sandstone, mudstone	Generally Rippable	5^0 to 20^0 to the southeast	ORS
	Keeper Hill Formation	Pale and red sandstone, grit & claystone	Generally Rippable	No Data	KH
Silurian	Broadford Formation	Fine to Conglomeratic graded greywacke	Generally Rippable	85^0 to the northwest	BF

7.6.6 Mineral Aggregate Resources

The GSI Directory of active quarries, pits and mines in Ireland was consulted for the presence of any such features. The database identified a metallic deposit near of the town of Killaloe and an aggregate quarry located east of Birdhill.

The active aggregate quarry is located off the R445 to east of Birdhill, the quarry is operated by Irish Cement Ltd. Birdhill quarry is situated outside the study area and does not pose any constraints but could potentially be a good source of aggregate for the new road and improvement scheme.

The metallic deposit recorded near the town of Killaloe was a gold deposit located in the drift of the west bank of the River Shannon. Bedrock as previously discussed is of the Devonian age, and no source for mineralisation was found in this area.

Approximately 1km south of Birdhill quarry are two non mineral localities identified in the townland of Lackenavea from the GSI database. This is an area of working quarries, pits and non metallic mines comprising predominantly of sandstones and shales. The first deposit is located at E171546, N168392 and is comprised of sandstone (in general), shale and chalcopyrite. The quarry generally yields in grey grits and shale with chalcopyrite coating on some joint planes. The second (E171975, N168545) is an active quarry producing greywackes, sandstones, siltstones and mudstones for cement with a scale 150,000 - 200,000 tpa. See Figure 7.5.4 Bedrock Geology Map for aggregate and mineral locations.

7.6.7 Geological Heritage

The Geological Survey of Ireland (GSI) in partnership with the National Parks and Wildlife Service (NPWS) are charged with the task of identifying and selecting important geological and geomorphological sites throughout the country for designation as Natural Heritage Areas (NHAs). This is being addressed under sixteen different geological themes; due to the large number of potential sites many will be overlooked. Therefore a number of County Geological Sites (CGS) are also being identified to be included into the county development plans so as to receive a measure of recognition and protection.

The GSI and NPWS were consulted on the issue of geological heritage sites occurring in this region, however no such site is listed in the vicinity of this scheme and therefore the proposed route will have no impact on such an area.

7.6.8 Impacts of Development on Soils and Geology

Soft Ground

The lands surrounding the R494 have been improved by local farmers who incorporated drainage ditches into their fields to improve the quality of their land. These drainage channels flow in a westward direction and ultimately drain into the River Shannon. Presently they extend under the existing road through old box culverts; these culverts will be extended and potentially replaced in some sections. Localised areas of soft ground are also typically associated with these streams produced as a result of flowing water sorting deposits and removing clay/ silt particles from particular area and depositing them further downstream.

Localised areas of soft ground were identified at culverts CC1 & CC2 between chainage 0+950 R and chainage 1+250 R, alongside and area of forestry; between chainage 1+400 R and chainage 1+550 R; and near culvert CC07 around chainage 2+300 R. Depths of soft ground ranged typically between 2.5m and 3m BGL, however near culvert CC2 a soft layer was determined from 4.7 to 7m. Isolated pockets of peat and silty peat were also determined in boreholes set down near culverts CC1 and CC2.

Soft Clay and Silts were identified near the Kilmastulla River between chainage 2+600 R and chainage 2+700 R, depths of which ranged between 2 to 4 m BGL, but a soft layer between 4 and 7m was also identified in BH133. Soft Clays/Silts were also identified near the Railway line between chainage 2+950 R and chainage 3+100 R, here the depth of soft ground varied from 0-3m to 0-7m BGL.

Soft soil can be problematic for road construction. To construct pavement directly on to untreated soft soils can lead to excessive settlements and result in the cracking of pavement which can be expensive to maintain or replace. Another option is to excavate and replace the soft soil in order to achieve acceptable settlement limits. Slope stability of the newly constructed embankment can also become a problem if it is founded on soft soils, the load will cause a slip surface to develop in the underlying material. The removed material may have to be disposed of in a suitable facility located off site or may be reused as Class 4 Fill for landscaping along the route.

Peat soils are normally consolidated and thus are moderately to highly compressible. Therefore these soils require special measures for embankment construction however as the deposits identified are not extensive and exist near the surface; excavation and replacement may be the more favourable method to overcome the engineering problems associated with peat. Due to its compressibility and high moisture contents this material is not suitable for reuse in earthworks and may have to be disposed of in a borrow area on or off site.

Contaminated Lands

The EPA was consulted on the issues of contaminated sites or registered landfill sites in the vicinity of the proposed route. Similarly Clare County Council and North Tipperary County Councils were both consulted on the issue of illegal or historical landfill sites. No information was received regarding historical quarries that have since been infilled or illegal dumping grounds. However areas of made ground that contain domestic waste were identified at chainage 0+150 K (BH107) and chainage 1+730 R (TP118) during the site investigation. Such areas are at high risk of contamination. Appropriate precautionary measures will be observed during construction such as disposal in appropriately licensed facilities. Other areas of possible contamination along the route cannot be ruled out and will be dealt with on the same basis.

Excavations and Surplus Excavated Materials

Classification of Material

Fill materials to be used in earthworks must satisfy certain acceptability criteria detailed in the NRA Specification. In general these criteria relate to moisture content, plasticity, density, CBR, strength and grading.

The Sand and Gravels will be classified for re-use as General Granular Fill, Class 1A, 1B or 1C, depending upon the actual grading of the materials. Some of these deposits may also be suitable as selected granular fill to structures and possibly for capping and road sub-base materials.

Sandy Gravely Clays will be classified for re-use as General Cohesive Fill, predominantly as Class 2C. These Class 2 materials will be susceptible to deterioration due to increases in moisture content and poor handling.

Peat and Made Ground encountered along the route will most probably be classified as U1 unacceptable material. However, much of the made Ground may be suitable for use as general fill if it meets the acceptability criteria specified by the NRA.

It should be noted that the above recommendations are an assessment based upon the ground investigations carried out to date and used to inform the Preliminary Design process for the Scheme. The results of the ground investigation are sufficient to make a reasonable assessment on the extent of re-use of earthworks materials and the resulting overall earthworks balance which is anticipated for the scheme. Some adjustments to the balance may occur during construction. However these adjustments will not generate a significant environmental impact.

Acceptability of Material

The acceptability limits below do not take into account potential for improvement due to addition of lime or cement, but are primarily based upon the distributions of moisture content found during the fieldwork of the ground investigation carried out to date. The proportions of acceptable earthwork material to be excavated from the cuttings in this section have been assessed by examination of the earthworks relationship testing performed during this ground investigation.

Over the site, excavated material will be glacial till suitable as General Fill, Class 1 and Stony Cohesive Material Class 2C. The occurrence of granular deposits of clayey silty sand & gravel between may produce exploitable capping material.

Results from classification testing, grading, Atterberg Limits and moisture contents have led to the following assessment of re-use acceptability proportions of 95% for the deposits of sand and gravel found along the proposed route and 60% - 80% for the sandy gravely Clays which are encountered along the route. The lower proportions of acceptability occur in the wetter deposits in the top 1 – 2 metres below ground surface which are more readily influenced by prevailing weather conditions and deeper localised zones around water-bearing silty sand / gravel lenses.

Earthworks Quantities

Earthwork volumes have been derived from the digital ground model incorporating the earthwork outlines of the Design. These earthworks quantities include an allowance for assumptions and limitations contained within this modelling which may affect the derived quantities.
The main limitations are that topsoil is assumed to be removed from beneath all embankment areas, though it is often acceptable for topsoil to be left in place beneath embankments of 3 metres or more in height. Replacement topsoil on side slopes will be 150mm thick and hence deeper landscape planting requirements are not considered. Landscaping and bund areas are not included in the earthwork quantities, although the requirement for these is limited on this scheme. All side slopes have, at this stage, been assumed to be 1 vertical to 2 horizontal. **Tables 7.6.3 and 7.6.4** show the overall predicted cut and fill volumes generated for the Killaloe Bypass and the R494 Improved alignment.

Table 7.6.3 Cumulative Earthworks Quantities for the Killaloe Bypass Section

Killaloe Bypass					
Chainage From	**Chainage To**	**Cut**	**Reusable Cut**	**Fill Required**	**Surplus/Deficit (+/-)**
0+000 K	2+028 K	205,400.00m^3	150,000m^3	35,135.00m^3	+114,865m^3

The fill quantities required along the route are significantly less than the cut quantities so this part of the scheme is in surplus. Some of or all of this generated cut could be suitable for reuse elsewhere along the Scheme, including the Shannon Bridge Crossing section and the R494 Improvement section subject to phasing. Any cut material which requires disposal will be collected and disposed of at a suitably licensed facility.

Table 7.6.4 Cumulative Earthworks Quantities for the Shannon Bridge Crossing Section

Shannon Bridge Crossing					
Chainage From	Chainage To	Cut	Reusable Cut	Fill Required	Surplus/Deficit (+/-)
0+000 S	2+028 S	2,250 m^3	Nil	42,500 m^3	-42,500 m^3

A relatively small amount of cut material will be won from this section of the Scheme but is anticipated to have little engineering value due to the shallow nature of the cuts involved. Appropriate suitable fill material would be available from the excavation for the Killaloe Bypass Section should phasing of the works occur.

Table 7.6.5 Cumulative Earthworks Quantities for the R494 Improvement Section

R494 Improvement Section					
Chainage From	Chainage To	Cut	Reusable Cut	Fill Required	Surplus/Deficit (+/-)
0+140 R	3+330 R	10,405 m^3	Nil	97,710 m^3	-97,710 m^3

Along the R494 Improvement section a relatively large amount of fill material will be required as very little acceptable cut material is generated along the route. This is due to the shallow nature of the majority of the earthworks cuts along this section of the proposed route. Much of the excavated fine grained till material is anticipated to be unsuitable for reuse due to its moisture characteristics. As is the case with the Shannon Bridge Crossing, appropriate suitable fill material would be available from the excavation for the Killaloe Bypass Section should phasing of the works occur.

The optimum predicted overall earthworks balance for the Scheme is presented in **Table 7.6.6**. below.

Table 7.6.6 Cumulative Earthworks Quantities for overall Scheme

Overall Scheme – Earthworks Balance				
Section	Cut	Reusable Cut	Fill Required	Surplus/Deficit (+/-)
KBP	205,400.m^3	150,000m^3	35,135.m^3	+114,865m^3
SBC	2,250 m^3	Nil	42,500 m^3	-42,500 m^3
R494	10,405 m^3	Nil	97,710 m^3	-97,710 m^3
Overall Scheme	**218,055 m^3**	**150,000m^3**	**175,345m^3**	**-25,345 m^3**

Based on a review of the ground investigation and the predicted reusability factors applicable to the materials anticipated to be encountered in the Scheme, an optimum overall fill deficit slightly in excess of 25,000m^3 arises, and this is dependent on the assumption that the Scheme would be all constructed within one contract. Thus even in this scenario there will be an import requirement for the Scheme. Any import requirement arising will be addressed by sourcing suitable material from licensed borrow pits of which there are a number in the region of south- east Clare and North Tipperary.

As can be seen above phasing of the Scheme will have an important bearing on the contractor's ability to minimise the deficits that arise in the Shannon Bridge Crossing and the R494 Improvement sections, and the corresponding requirement for increased import and disposal of material. Construction of the Killaloe Bypass section in advance of the Shannon Bridge Crossing and the R494 Improvement would result in the surplus material from the Killaloe Bypass Section not being available for use in the latter two sections. Similarly, prioritising the construction of the Shannon Bridge in programme terms, whether within an overall contract for the Scheme, or by tendering a standalone contract in advance of the R494 Improvement, would facilitate transportation of some of the surplus material from the Killaloe Bypass section of the scheme across the River Shannon to be utilised for the construction of the embankments of the R494. This would assume that the Killaloe Bypass section would be built as part of the same contract as the Shannon Bridge Crossing.

Irrespective of what phased sequence might be adopted for the construction of the overall Scheme, should unforeseen circumstances arise which would change the programme or the reusability of excavated material, for example the occurrence of inclement weather during the construction phase, the contractor may be required to import additional suitable fill material from suitable licensed borrow pits, of which there are a number in the region.

Piling at River Shannon and at Other Structures

The development will have no environmental impact on the soils and geology however access for piling operations may cause temporary localised disturbance. The duration of piling operations is dependent on the final design of the bridge foundations. The piling operation is likely to take several months to complete.

Piling works will also be carried out at other overbridge structure locations but should generally be less intense.

7.6.9 Mitigation Measures

Piling at River Shannon and at Other Structures

The possible impacts of piling operations can be mitigated by good site management and other basic mitigation measures.

Excavations and Surplus Excavated Materials

The earthworks surplus volume can be reduced by steepening the side-slopes in rock cuttings. For design purposes they have been assumed at 2H: 1V (horizontal: vertical) which is much shallower than is generally stable in rock. Due to the size of the cuttings, the side slopes may need to be this shallow if rock is persistently poor. Slopes which are considered at risk from erosion are to be topsoiled and seeded as soon as possible to prevent the deterioration due to weathering effects. Further ground investigation will provide information allowing optimised cut volumes possibly using ground improvement techniques, subject to consideration of environmental benefits. Better understanding of the viability of excavations using mechanical plant may be gained by carrying out further excavation trials where necessary.

All suitable material excavated within the cut sections shall be used to the greatest possible degree as fill material on the development. Storage of such soils will be required during the construction phase in designated on/off site facilities.

If any soft ground is present, excavation of soft materials, preconsolidation or surcharging of the soil will be required for the embankments. Organic/peat soils must be removed.

Topsoil will be removed from all temporary access roads in advance of construction and stored. Following removal of temporary structures the underlying soil will be scarified, the topsoil replaced and seeded.

Contaminated Lands

All contaminated lands including areas of made ground that have tested positive for excess levels of contamination and areas that support the invasive alien plant Japanese knotweed (refer to **Chapter 7.2**) shall be disposed of in accordance with legislative requirement with due regard for the impact on the disposal site.

Groundwater

To ensure groundwater remains free from pollution as a result of this scheme a number of mitigation measures will be implemented as follows:

- Contamination of ground water though pollution of surface water by road drainage will be mitigated by means of suitable drainage systems.
- Oil interceptors will be provided in order to prevent runoff of pollutants to river.
- Closed drains will be used in areas where there is potential interaction between the drainage waters.
- An emergency plan to deal with accidental spills will be drafted.
- Any land drains or pipes served along the route will be connected into new pipes or ditches.
- Drainage will be provided to collect seepage water and slope angles provided suitable for materials in side slopes.
- A monitoring programme for reading of the existing groundwater monitoring installations installed during the initial site investigation at the sites will take place.

Soil Erosion Prevention

- Exposed areas will be re-vegetated as soon as practicably possible
- Surface of overburden and topsoil mounds will be vegetated;
- Where practical there will be a progressive restoration of construction areas, the areas of topsoil overburden stripping will be limited and sumps and lagoons will be available to cope with all reasonable anticipated conditions;
- Stockpiling will be within bunded areas;
- Temporary fencing will be erected on site indicating the route to be taken by vehicles in order to minimise compaction of soils outside of areas proposed for excavation;
- On completion of construction, reinstatement will take place, stock piled soils will be backfilled and landscaped in accordance with best engineering practice.

Chapter 8

Landscape & Visual Impact

Chapter 8 Landscape and Visual Impact

8.1 Introduction

Landscape and Visual assessment of the overall preferred route is discussed under three main sections:

(i) Killaloe Bypass;

(ii) Shannon Bridge Crossing; and

(iii) The R494 Improvement.

The landscape and visual impact assessment of the proposed Scheme examines the existing landscape in terms of its visibility and scenic quality. The proposed route is designed as a single carriageway regional class road. The Killaloe Bypass will be a newly constructed route approximately 2km in length while the upgrade of the existing regional road the R494 will be for a distance of 3.3km. The proposed Shannon Bridge Crossing will connect both roads and has a proposed length of 0.86km. The will be three roundabouts included in the overall scheme and six new major / minor junctions.

This chapter describes the visual characteristics of the overall route within the receiving environment. The assessment evaluates the general and specific effects of the route within this context.

The impact of the proposed route in general terms on the character of the area is assessed, including views into and out from the site. In determining the impact, consideration is given to reducing any significant impact associated with the roadway proposal and accordingly mitigation measures are considered.

8.2 Description of the Receiving Environment

8.2.1 General Characteristics

In this section of the report, the baseline landscape is described and classified. The various components of the landscape which are influenced by the scheme are considered. These components include settlement, existing woodland, topography, agricultural fields, field patterns, the scenic quality of the study area, the natural heritage and finally the cultural heritage.

The objective of this part of the assessment is to define a baseline of landscape and scenic quality against which the impacts of the various routes can be measured. The existing landscape is described from the context of both Clare and Tipperary County Development Plans and also in a more specific manner based on site survey of the proposed route.

8.2.2 Landscape Planning Context

County Clare

There are a number of listed views which are within the Killaloe area however only one is identified as being impacted upon by the proposed scheme. In the Clare Development Plan the R463 from O'Briensbridge through Killaloe to outside Ogonnelloe is listed as a protected scenic route (code 27).

There are two historical estates located within the study area: Ballyvally House and Clarisford House which were identified using the National Inventory of Architectural

Heritage and Clare Development Plan. Ballyvally consists of a principal building, gate lodge, woodland and parkland, accessed off the R463. Within the Clare Development Plan the 1820 single storey gate lodge is a listed and protected structure. Located on the opposite side of the R463 is the famous Brian Boru Fort which is presently used as a local tourist amenity with a pedestrian entrance. It is completely surrounded by woodland on the shores of Lough Derg and is a National Monument.

The East Clare Local Area Plan 2005 lists a number of trees identified for preservation within the environs of Killaloe town (items 23, 24 and 25). The general locations of these trees are roadside beside Lough Derg, trees on the northern edge of Killaloe town constituting an entrance/ exit to the town and deciduous trees stretching around Ballyvally House to the lakeshore. There are no Tree Preservation Orders (in accordance with the Planning and Development Act of 2000) currently listed within either the Clare County Development Plan or East Clare Local Area Plan.

County Tipperary

The North Tipperary Development Plan including Variation Number 1 lists river banks and the shoreline of the lake as vulnerable landscape and areas of scenic importance, which should be protected (Policy ENV2). There are no protected views listed in the development plan that are affected by the proposed works. There are a number of listed tree groups considered by North Tipperary County Council to contribute to amenity and are identified as T26, T27 and T23B on the North Tipperary Designations Map. Policy ENV6 and Policy ENV 44 states that it is the strategy of the Council to protect mature trees and that development that requires the felling or harming of such trees will be discouraged. The Local Settlement Plan for Ballina describes Policy HE1 which is the local authority’s intention to develop a heritage trail in the town in cooperation with neighbouring Killaloe. There is one historical estate located within the study area known as Fort Henry which overlooks the Shannon River. It was identified using the National Inventory of Architectural Heritage (NIAH) and consists of a principal building accessed via two separate avenues from the R494 through parkland and woodland.

8.2.3 Landscape Character

Settlement Pattern

The settlement pattern of the study area forms a typical rural type and can be divided into three categories, which are:

Town centres

Killaloe and Ballina have significant appeal for development because of their proximity to Limerick city, numerous tourist attractions within their vicinity and their location on one of the few crossings over the River Shannon. Limitations have been created however on their growth for various reasons, one major constraint being their physical location between two mountains which encourages development on a north to south axis. It could be said that Ballina has offered more building opportunities in recent years than Killaloe (due to its gentler topography) and thus has experienced expansion in the form of new dwellings and small residential estates. Both towns are designated as heritage towns due to the unique architectural character they exhibit.

Ribbon development

It is apparent that the increasing pressure for suitable land for residential development has meant that linear strips of housing are developing out of both towns along all of the approach roads, on Lough Derg lakeside and along the riverbanks of the Shannon. The occurrence of single housing development is a significant element in the baseline landscape of the study area. These houses are generally located along the local and regional road network of the region.

Scattered development

Historically the only dwellings within this rural agricultural landscape would have been dispersed farmhouses and their associated outhouses.

Existing Landscape Features & Existing Vegetation

The study area is located in a corridor west of Killaloe town, County Clare, beginning in a townland of Ballyvally and ending in the townland of Moys, on the banks of the River Shannon 1km approx. south of the existing bridge in Killaloe / Ballina. It resumes on the eastern bank of the river, on the southern outskirts of Ballina town, Co. Tipperary continuing in a southerly direction and ending north-east of Birdhill town on the R445 (previously the N7). Within the wider landscape context, the major landscape features include Lough Derg to the north of the study area, Slieve Bernagh Mountains to the west, the Arra Mountains to the east and Birdhill town to the south.

Killaloe town is located at the base of the Slieve Bernagh Mountains and is separated from Ballina town by the River Shannon. On the opposite side of the valley situated at the base of the Arra Mountains is Ballina town which forms a twin township with Killaloe. The two towns are joined by a protected stone bridge which dates back to the 17th century (although has had many alterations over the subsequent years). This interconnecting bridge allows a single row of traffic in one direction only, through signalled junctions at either end.

The topography can be described as steeply sloping at the northern end of the study area becoming more gently sloped as it progresses southwards and finishing as gentle undulating pasture at its southern end. The study area for the proposed road development is linear in nature and generally can be considered to extend no further than 500m to either side of the proposed route. It is located within an agrarian hinterland with ribbon residential development on the regional and third class roads radiating from the two adjacent towns of Killaloe and Ballina. There are some impacts outside this distance from the Lough Derg Way on the Arra Mountains however these are considered insignificant since at this scale the proposed route merges with the existing urban fabric of Killaloe town. Another impact includes views of the proposed Shannon Bridge Crossing from Ballina town centre however these are such limited long distance oblique views that its impact is regarded as slight for the most part.

The land uses of the study area are predominantly residential, agricultural, amenity and silvicultural. In general, the density of the residential development increases on the lower slopes of the valley and gentler riverside plains. It decreases on the steeper slopes. The main landscape features or elements of the area includes the backdrop of the mountains, the agricultural fields surrounded by mature hedgerows, pockets of mature trees, numerous waymarked walks and the Shannonside location.

Landscape Classification

The landscape of the study area may be divided into areas of homogenous or dissimilar visual/landscape character. This process is known as landscape classification. The purpose of classifying the landscape is to evaluate the distribution of landscape types within the study area and to determine the potential effects of the proposed scheme within specifically defined landscape units.

The landscape classification is detailed in **Table 8.5**. Generally the landscape classification of the study area is of a rural agricultural landscape situated at the base of two mountains, punctuated by a large watercourse and with scattered and linear settlement along its principal regional roads and third class road network. The principal units are broken down and described as follows:

Regional roads and environs

There are three regional roads, which are located within the study area. The R494 and R496 are located in County Tipperary while the R463 is located in County Clare. The R494 runs on a north to south axis through Ballina town while the R496 branches from the R494 south of Ballina town running in a south-easterly direction. Both the R494 and R496 link Ballina with the R445 road to Limerick.

The R463 is of particular interest within the study area since it is with this road that the proposed bypass route begins North of Killaloe town. The R463 runs on a north to southwest axis through Killaloe town. The Clare Development Plan states that the R463 from Ogonelloe to O'Briensbridge villages is a protected scenic route.

Generally, mature hedgerow cover containing a significant number of mature trees bound these regional roads. In many instances, the residential houses located along these roads are screened or hidden from road users by the aforementioned roadside vegetation. Many of these properties have mature garden vegetation also. Travelling through the towns to their centres, the roadside cover diminishes resulting in exposure to the townscape and the waters edge. The orientation of these houses varies but generally the majority of these properties face onto the existing regional road network.

Minor roads and environs

The Slieve Bernagh Mountains to the west constrict all of the tertiary local roads radiating from Killaloe town centre. This is presumably the main reason for their small size since the further westwards they travel the greater the rise in topography levels. Similarly on the opposite side of the valley the Arra Mountains constrain the local roads radiating eastwards out of Ballina town, the preferred routes for ease of travel and road construction have been traditionally along the valley floor in a north to south axis.

These roads are rural in character with a moderate volume of traffic. They provide access to a number of residential dwellings, farms and agricultural fields. Most have mature hedgerow vegetation with limited or no space for narrow grass verges. Views outwards are generally restricted due to these roadside hedgerows although occasional gaps do afford the road user glimpses into pastureland or dwellings but generally prohibit views down the valley towards Shannon. The proposed bypass section of the route intersects with two tertiary roads from Killaloe town. One of which forms part of the East Clare Way while the second forms part of The Lough Derg Way.

Fields – irregular pattern

This landscape unit is characterised by fields whose shape and size are irregular, particularly at the northern end of the study area. This presumably is a result of the steep topography. The topography does not lend itself well to working the land mechanically or for the production of vegetable or tillage crops therefore the majority of these fields are grazed by animals and are surrounded by mature or semi-mature hedgerows. However it is evident that more intensive farming methods are causing the internal hedgerows to be removed thus enlarging the field sizes. In the southern section of the study area the fields become larger and some crop production is visible since the topography is more gently undulating along the banks of the river Shannon.

Deciduous / mixed woodland

Generally, the largest mixed or deciduous woodland areas within this study area are located near historical estates and were once included within their boundaries. There is a large mature woodland situated in the north of the study area with a plot of roughly 15 ha. The proposed bypass route begins on the western edge of this woodland. It appears to have been created as part of the Ballyvally demesne and is located on the shores of Lough Derg. Another mixed woodland is located in the centre of the study, north of Clarisford House. The section of the proposed route known as the Shannon Bridge Crossing cuts across the southern edge of this wooded area.

Coniferous woodland

There are numerous coniferous plantations present in the centre and southern end of the study area. The majority of them are relatively young and are edged with deciduous hedgerows. Plantations such as these are not a traditional element in the Irish landscape and restrict views significantly due to their presence as a dense block form. They are also very distinct in views into the study area due to the dense form and dark colour.

Demesne

There are three historical estates located within the study area; Ballyvally Estate located north of Killaloe, Clarisford House located south of Killaloe town and Fort Henry located south of Ballina town.The grounds of Clarisford House contain a principal building, a walled garden, parkland and mature boundary woodland. Its front vista will be slightly affected by the proposed route however; its landscape will not. The Tree Register of Ireland currently lists fifty-seven significant trees in County Clare. Seven of these are located within Killaloe within the boundaries of Clarisford House. Ballyvally consists of a principal building, a protected gate lodge, woodland and parkland and is accessed off the northern section of the R463. Within the Clare Development Plan the 1820 single storey gate lodge is a listed and protected structure (RPS no. 440). The proposed route will have an impact on this estate since it will cut into its southern woodland boundary and contains a roundabout adjacent to the protected Gate Lodge. The proposed route will not visually impact upon Fort Henry Estate however will cause a minor landscape change to one of its entrances located off the R494.

Plate 8.1 View taken on the R463 of Ballyvally entrance directed northwards out of Killaloe town

Protected archaeological features

There are a number of ringforts within the study area however none are affected by the proposed route alignments. One well known ringfort in the locality includes Brian Boru Fort on the shores of Lough Derg opposite Ballyvally House which is within close proximity of the beginning of the proposed Killaloe Bypass section of the route.

Scrub woodland

There are areas containing patches of scrub vegetation situated within the study area. Some of these areas occur where older coniferous plantations have been felled. Other areas of scrub include areas of land which are zoned for housing but have not as yet been developed or areas of land close to the waters edge which may receive periodic flooding or which are protected / are candidate Special Areas of Conservation (cSAC).

Town extents

Killaloe and Ballina towns have developed at the base of a valley between Slieve Bernagh and Arra Mountains. They are separated by the river Shannon but are connected by a narrow thirteen arch stone bridge. They are within close proximity to Limerick city and numerous tourist attractions within the locality. Both Killaloe and Ballina are described as heritage centres due to their street vernacular. Killaloe, in particular has a network of charming narrow steep streets, flanked by old shops, houses, a thirteenth century cathedral, St. Lua's ninth century oratory and St. Flannan's twelfth century oratory, that look down over the Shannon and Lough Derg. Despite its waterside location it contains a canal opened in 1799 but which was made redundant with the opening of the Shannon Hydroelectric Scheme in 1929.

Banks of the River Shannon and Lough Derg Shoreline

The existing thirteen arch stone bridge linking the centre of Killaloe and Ballina towns is the demarcation between the Lough Derg and the River Shannon. North of the bridge is Lough Derg which is a proposed Natural Heritage Area (pNHA) and a Special Protection Area (SPA). South of the stone bridge is the River Shannon. The location at which the proposed route intends to cross is known as Lower River Shannon and is a candidate Special Area of Conservation (cSAC). Numerous private and public harbours/jetties are located along the river and the lakeshore.

St. Lua's oratory was originally located on Friar's island located within the Lower River Shannon west of Ballina's present day town park and south of the proposed bridge crossing. It was removed and re-erected in the grounds of the Catholic church in Killaloe town before the island was submerged with the opening of the Shannon Hydroelectric Scheme in 1929.

Green Spaces

There a small number of public green open spaces within the study area, most of which are located within Ballina. These include a GAA pitch located off the approach road to Ballina town from Portroe, two small riverside parks off the R494 and a GAA pitch within Killaloe on Convent Hill road. One of the parks is located within Ballina town and is a newly rejuvenated tree lined Park with plentiful moorings and a Marina catering for the leisure craft that visit Killaloe/ Ballina. It is located on what was once a railway line. The second small park commemorates the original site of St. Lua's oratory on Friars island which is now inundated, located within the Shannon river west of the present day town park.

Hedgerows

The majority of the hedgerows in the study area tend to be well maintained and contain mature species; this is particularly true along the R494. Some more poorly developed hedgerows are present and these are located on the higher topographical areas within pastureland.

Views

The study area begins on the northern outskirts of Killaloe town in County Clare. It progresses west of the town and is composed of a rural stretch of land on the lower slopes of the Slieve Bernagh Mountains. The topography of this northern section of the study area can be described as forming part of a narrow valley between Slieve Bernagh and the Arra Mountains, in County Tipperary. The central section of the study area is concerned with the proposed Shannon Bridge Crossing. The River Shannon is at the base of the aforementioned valley and has a view to the surrounding townscapes and mountain scenery. The scenic quality of the northern and central study areas is considered high.

In visual terms, there are a number of listed views within these study areas. The most significant views from the study area are those of the mountains and of the river Shannon flowing out of Lough Derg. Within the study area, distant views are sometimes limited due to the screening effect of mature hedgerows and trees, coniferous woodlands, intervening houses and local projections in topography from some viewpoints. This is particularly true of the southern section of the study area along the R494.

Sensitive viewer groups (“Receptors”) are mainly the local residences. The areas of highest significance to residents, which are also of a high visual quality, are views of the opposing valleys and views over the river Shannon. Where distant views are available, the most significant elements in such views are the Slieve Bernagh or Arra Mountains. There are some important tourist viewpoints that have also been taken into consideration since Killaloe and Ballina are heritage towns. The East Clare Way and the Lough Derg Way are two scenic trails that cross the proposed scheme.

The study area for this assessment includes an area of land 500m either side of the proposed route alignment. Visual effects outside this distance are considered unlikely to be significant. In theory however, the potential development could have effects outside the study area therefore any such sensitive viewpoints have been identified and included in the assessment where considered necessary.

8.2.4 Sensitive Receptors

There are a number of categories of receptor which can be classed as sensitive. These are specific elements or features which would potentially be more affected by the proposed route than the general landscape per se. The sensitive receptors were classed as follows:

Existing dwellings

The proposed route traverses the outskirts of two heritage towns through a semi rural landscape of agricultural lands with settlement defined by the local road network, watercourses and a steep to undulating topography. The majority of the dwellings located within the study area are single dwellings along the local road network. The minority of dwellings are scattered farmhouses within pasture or small clusters of houses within residential developments located on the outskirts of both towns.

Areas of natural heritage

There are a number of designated areas of natural heritage within the overall study area however one particular area of natural heritage which will be impacted upon by the proposed route is the River Shannon. The proposed Shannon Bridge Crossing is located at the Lower River Shannon candidate Special Area of Conservation (cSAC). A second area comprises the trees on the northern edge of Killaloe constituting an entrance/ exit to the town and deciduous trees stretching around Ballyvally Estate to the lakeshore. Although these are listed as trees for preservation in the Clare Development Plan they do not have TPO's (Tree Preservation Orders) allocated to them. The proposed route will have an impact upon them also.

Plate 8.2 North-westward view of the River Shannon cSAC, taken from Ballina town park, of the proposed bridge crossing

8.2.5 Significance of the Local Landscape Visual Amenities

The local landscape elements are of international, national and local importance. The study area forms part of an overall high amenity landscape. It is set on mature pastureland in a valley with a mountainous backdrop through which the river Shannon flows southwards from Lough Derg at the valley base. Particular views of merit are located from the highest topographical locations on either the Lough Derg waymarked way or the East Clare Way. It is this scenic countryside that acts as an important tourist attraction for the area.

8.3 Assessment Methodology

8.3.1 Terminology

Landscape impacts are defined as changes in the fabric, character and quality of the landscape as a result of the development. This includes direct impacts to landscape receptors and greater effects that can alter the wider distinctiveness of the landscape. Landscape receptors are the physical or natural resource, special interest or viewer groups that will experience an impact. The sensitivity (of a landscape receptor) is the vulnerability to change. The extents of the landscape impacts have been assessed by professional evaluation using the terminology defined in **Tables 8.1, 8.3 & 8.4.**

Table 8.1: The extent of Landscape Impact

No Impact	There are no changes to landscape context, character or features.
Moderate Impact	There are minor changes over some of the area (up to 30%) or moderate changes in a localised area.
Significant Impact	There are notable changes in landscape characteristics over a substantial area (30-50%) or an intensive change over a more limited area.
Profound Impact	There are notable changes in landscape characteristics over an extensive area (50-100%) or a very intensive change over a more limited area.

Visual impacts relate solely to changes in available views of the landscape and the effects of those changes on people. They include the direct impact of the development on views, the potential reaction of viewers, their location and number and the impact on visual amenity. The intensity of the visual impacts is assessed by professional evaluation using the terminology defined as per **Tables 8.2, 8.3** and **8.4** below:

Table 8.2: The extent of Visual Impact

No Impact	There are no changes to views in the visual landscape.
Imperceptible Impact	The proposal is adequately screened due to the existing landform, vegetation or constructed features.
Slight Impact	The affected view forms only a small element in the overall visual composition, or changes the view in a marginal manner.
Moderate impact	The proposal affects an appreciable segment of the overall visual composition, or there is an intrusion in the foreground of a view.
Significant Impact	The proposal affects a large proportion of the overall visual composition, or views are so affected that they form a new element in the physical landscape.
Profound Impact	The view is entirely altered, obscured or affected.

Table 8.3: The Quality of the Landscape & Visual Impact

Neutral Impact	Neither detracts from nor enhances the landscape of the receiving environment or view.
Positive Impact	Improves or enhances the landscape of the receiving environment or a particular view.
Negative Impact	Detracts from the quality of the landscape or view.

Table 8.4: The Duration of the Landscape & Visual Impact

Temporary	Impacts lasting one year or less
Short-term	Impacts lasting one to seven years
Medium-term	Impacts lasting seven to twenty years
Long-term	Impacts lasting twenty to fifty years
Permanent	Impacts lasting over fifty years

The landscape and visual assessment methodology is utilised in conjunction with a professional evaluation of the route to determine the degree of impact in relation to the various routes.

8.3.2 Methodology

The methodology employed in the landscape and visual impact assessment of the EIS is as follows:

- Desktop study of the route and the geography of the receiving environment.
- Site survey and photographic survey to determine landscape character of the general and specific landscape.
- Assessment of the potential significant effects of the proposed scheme utilising the horizontal and vertical drawings of the scheme to determine the main impacting features, the degree to which these elements would be visible, and by the relation of these drawings to field survey. In determining visibility, the views to and from the route will be considered. In addition, a height of 4 metres above carriageway shall be utilised to determine visibility to the route, as this is the maximum height of vehicles which would be present on the route.
- The proposal of mitigation measures. These will be defined as measures which will be generally implemented and specific landscape measures (SLM's).
- An evaluation of the impacts of the scheme with and without amelioration. For the purposes of assessment, the predicted visual effects of the scheme are assumed at 20 years following the opening of the scheme.

8.4 Characteristics of the Proposed Development

This section of the report will describe in detail the characteristics of the landscape through which the route passes, and the visual characteristics of the proposed route in this landscape. Consideration will also be given to evaluating the visibility of the route and the identification of areas where the route will have significant visibility.

8.4.1 Killaloe Bypass

Subsection A: Killaloe Bypass Chainage 0 to 1+000 K (Historic wooded area associated with Ballyvally Demesne and undulating pastureland with low boundary hedgerows).

The proposed scheme begins at its northern end with the construction of a new three-arm roundabout on fill. It will be located 30m approx. east of the existing R463 and 50m south east of the main entrance to the Ballyvally Estate. It will be necessary to construct a northbound realigned slip road (to Ogonnelloe) and a southbound realigned slip road (to Killaloe) for a distance of 240m and 190m from the roundabout respectively. These realigned slip roads will join the existing R463 and traverse predominately deciduous woodland. An attenuation pond will be constructed east of the roundabout on the R463 on an area of existing deciduous woodland. An access road from the northward R463 will run 70m parallel to it permitting access into the adjacent demesne. The route of this access road will follow that of the proposed disused section of the R463.The third exit will connect the roundabout to the first section of the scheme (i.e. the proposed Killaloe Bypass).

This part of the landscape is low lying and gently slopes down towards the Lough Derg. Mature boundary hedgerows of Ballyvally Estate and predominately deciduous woodland located east of the R463 screen inward views of the roundabout and Killaloe Bypass until chainage 0+340 K. The construction of the roundabout and realigned roads will result in the removal of three acres approx of the aforementioned woodland. The woodland east of the R463 varies in age. The trees that border the road are mature and consist of Fir, Sycamore, Ash, and Beech. However; in some areas such as at the location of the proposed roundabout, the woodland is immature. It is composed of young Alder, Willow and Ash fronted by a hedgerow of the aforementioned mature trees.

The Killaloe Bypass veers in a southwesterly direction from the roundabout and cuts across the existing R463 and the mature hedgerow boundary of the Ballyvally Estate in significant cut until chainage 0+680 K. Where it penetrates the demesne boundary it is 80m south approx. of the main entrance to Ballyvally and just outside the garden limits of the protected Gate Lodge. Thirty linear metres of mature Ash and Sycamore trees with a small area of young saplings to their rear will be lost to the construction of the scheme at this location. As the Killaloe Bypass progresses, the lands become elevated immediately west of the R463. The scheme dissects the south-easterly corner of a field within the Ballyvally estate and exits through an area of young saplings and a mature hedgerow of predominately specimen Beech and Ash trees. The cut at this point will be 15m approx. deep and therefore a large area of existing boundary (0.9 acres of mature woodland and 1.2 acres of saplings approx.) will be removed.

Ballyvally house has a north-east to south-west orientation located 180m away from the proposed scheme at chainage 0+100 K at the closest point. It may have some oblique side views of the top of the Scheme’s cut slope but the existing mature trees within its grounds will screen these for the most part. The existing views from the front of the house will remain unchanged. Since the Killaloe Bypass will be in cut, road users will not have a view into the private grounds of the estate. The outward views from the protected Gate Lodge will be impacted upon by the proposed roundabout and realignment of the existing R463, as the roundabout will form a new element in its foreground view.

Emerging from the demesne the Killaloe Bypass travels onwards in a south-westerly direction crossing a dwelling at chainage 0+350 K and a house plot at chainage 0+400 K. Here it changes alignment, curving in a south easterly direction. Still in a cut it encompasses a small wooded area consisting of Birch and Ash and continues into adjacent pastureland. The pastureland is located to the rear of a housing development, which is at a lower level. A semi-mature boundary hedgerow separating the fields from the residential area is located on a ridgeline and prohibits rear views from the dwellings below into the aforementioned upper fields. Within this low-density residential development there is good plant cover. Semi-mature hedgerows and mature garden vegetation encircle the houses and focus their view in a northeastward direction towards the Shannon. The rear and sides views of three houses located 65m approx. away from the Killaloe Bypass (at chainages 0+350 K, 0+360 K and 0+400 K) will be impacted upon. They will not have a view of the scheme however the woodland and mature boundary hedgerow that previously surrounded them will have been removed.

At chainage 0+680 K the Killaloe Bypass becomes elevated briefly on slight fill until chainage 0+730 K where it returns into a slight cut until chainage1+000 K. This part of the landscape is upland undulating pasture with low fragmented hedgerows consisting of Hawthorn, Blackthorn, Elder, Bramble and interspersed occasionally with mature Ash trees. The field sizes vary in size and shape. The Killaloe Bypass will divide the first field it passes through (after Ballyvally) reducing its size significantly. Only the corners of the next three fields will be dissected by the scheme, which has little affect on their size. As the Killaloe Bypass passes through the fourth field it will separate two-thirds of the original space from the remaining third. The Killaloe Bypass passes over numerous low hedges at chainages0+750 K, 0+825 K, 0+900 K and 1+010 K. An access road will run parallel to the scheme from an adjacent local road permitting entry to the aforementioned separated fields and segregated field sections. Three dwellings at chainages 0+900 K, 0+950 K and 0+975 K will have a rear view of the scheme although an intervening hedgerow will help screen them.

Subsection B: Killaloe Bypass Chainage 1+010 K to 2+028 K (Third class roads, waymarked walks, linear rural housing, coniferous woodland and pastureland with mature boundary hedgerows).

The Killaloe Bypass continues in a southeasterly direction over the edge of two small fields, their boundary hedgerows and a small agricultural shed before reaching a third class road called Hill Road. The scheme fluctuates rapidly between slight cut and slight fill for 70m. At chainage 1+090 K it returns to a moderate cut until chainage 1+200 K. The dense boundary hedgerows crossed (at chainages 1+070 K and 1+200 K) contain semi-mature Sycamore, Ash and Hawthorn tree species. Generally the roadside hedge on Hill Road is 4m in height consisting predominately of large Hawthorn shrubs with some Elder, Fushia and Bramble. Semi-mature Beech trees are interspersed along its length also. Two semi-mature Sycamore and two semi-mature Fir trees are located in this roadside hedge where the Killaloe Bypass crosses it.

On intersecting with Hill road, the Killaloe Bypass passes between ribbon development to the east and west. Some houses located along this road will be visually impacted upon to various degrees. The nearest dwelling is a two storey terraced house 40m approx. to the east and a two storey house 130m approx. to the west.

Plate 8.3 Hill Road view east towards Killaloe

Hill road will be realigned to meet the Killaloe Bypass at two T-junctions in order to safely reconnect the local traffic using it. A slip road will be constructed to the west through pasture from the scheme at chainage 1+050 K. It will traverse a small agricultural shed and will be 72m in length approx. This will cause 50 metres of the existing Hill Road to become superfluous. A second slip road will be constructed from chainage 1+150 K eastward for 80m through pasture to Hill Road. As previously mentioned an access road permitting entry to agricultural land subdivided by the Killaloe Bypass will terminate on this disused section of Hill Road with a final length of 269m.

The eastbound slip road constructed on fill will cut across the foreground view of a number of properties and thus cause them to undergo a significant visual impact. The houses located off the westbound slip road will be visually impacted upon to a much lesser degree, ranging from imperceptible to moderate.

The Killaloe Bypass then crosses at grade a large field whose internal hedgerows have been removed due to intensive farm management. A two-storey dwelling located at the eastern edge of this field will have rear views of the scheme however; these will be at a distance of over 250m. An agricultural track which passes the boundary of the house and which is flanked by a low Hawthorn hedge divides this large field from smaller fields to the south.

These smaller fields slope down to meet another local minor road (Crossroads road) to their south. In a slight cut the Killaloe Bypass passes through the edge of one of these pasture fields, which have a semi-mature hedgerow composed of Ash along its eastern boundary and a mature hedgerow consisting of hawthorn on its west. Two newly constructed slip roads will travel in cut 80m east and 204m west from t-junctions on the scheme through these hedgerows at chainage 1+440 K and chainage 1+480 K respectively. They will realign the existing minor local road with the Killaloe Bypass and cause a small section of the existing road to become disused.

Ribbon development has begun to form along the northern and southern sides of the existing third class road to Bridgetown however it is not continuous on both sides as of yet. The Killaloe Bypass crosses this existing local road where a corridor of pastureland separates the dwellings. The nearest dwelling east of the scheme is a two-storey house at the distance of 29m approx. which will have side and oblique front views of the road. It is also one of three dwellings that will face the eastern slip road which will have a slight visual impact. These visual impacts are set in the context of the existing Shantraud road that currently cuts across their foreground view. Two of the dwellings will continue to use a portion of the disused local road to gain access in and out of their properties from the newly constructed eastern slip road. The closest dwelling to the west is a single storey house located 280m approx. away which is screened for the most part by intervening hedgerows and topographical differences.

As the Killaloe Bypass progresses through a medium sized pasture field it changes from being in cut at chainage 1+520 K to being elevated slightly on fill for a distance of 250m. Curving in a southeasterly direction through the corner of a small coniferous wood, the bypass at chainage 1+770 K is in cut. At chainage 1+810 K an attenuation pond will be constructed on the western side of the proposed bypass within an area of existing woodland. At chainage 1+820 K it changes briefly to fill until chainage 1+860 K where it crosses a small narrow fallow field containing naturalised scrub vegetation, Willow and Alder. This field borders a small stream, which runs parallel with the Killaloe Bypass until the proposed roundabout junction with the R463. An attenuation pond will be constructed north of this proposed roundabout at Ch. 2+029 K. Before reaching the roundabout the bypass is screened either side by existing semi-mature hedgerows consisting of Ash, Oak, Birch, Willow and Alder. The Killaloe bypass route section terminates on fill with a regional road called the R463. The closest dwelling to the scheme at this location is a bungalow 75m to the east, which will have screened side views only.

8.4.2 Shannon Bridge Crossing

Subsection C: Shannon Bridge Crossing Chainage 0+000 S to 0+860 S

The proposed section of roadway included in the Shannon Bridge Crossing is 860m in length and includes a major bridge structure spanning the River Shannon for a distance of approximately 168m. Commencing at a proposed roundabout with the R463 it curves gently in an easterly direction between a newly constructed residential development and a disused warehouse site. The disused warehouse is proposed for use as a compound area for the duration of the proposed works. The road is on fill until chainage 0+420 S with a maximum height of 2.9m approx. The Shannon Bridge Crossing crosses a compound site which may have housed the equipment and materials for the construction of the adjacent houses. A poor quality low hedge demarcates the boundary between the compound and the warehouse site. This hedgerow will be removed to make way for the scheme. Three dwellings will have direct views within 100m of the road while two will have rear views within 50m from second storey windows. The doorways into two dwellings along with their associated porch and bathroom windows will face the Shannon Bridge Crossing however once the boundary wall of the development is complete these will not be permitted a view. Similarly the textured glass from the small porch and bathroom windows will not allow outward views.

The Shannon Bridge Crossing transverses a boundary hedgerow with mature specimen Beech trees at chainage 0+120 S, which were once part of the original Clarisford demesne boundary. The road progresses over pastureland with the edge of a coniferous plantation to its north. A large pasture field stretches out to the south whose internal hedgerows have been removed allowing an open view of the relatively flat topography. Clarisford House is located in the centre of this parkland setting enclosed by mature trees.

At chainage 0+300 S the Shannon Bridge Crossing enters a small deciduous wooded area, which forms the edge of the aforementioned coniferous woodland. An approx area of 1.2 acres will be removed which includes a very broad mix of both deciduous and coniferous mature trees such as Ash, Alder, Field Maple, Larch, Beech, Oak, Sycamore, Elder, Birch and Pine. An access road will form a t-junction curving southwards from the proposed road at chainage 0+335 S for a distance of 60m to link with an existing local road providing access to the back of Clarisford house and the surrounding lands. An attenuation pond will be constructed west of this proposed access road at Ch. 0+260 S. A second access road will extend perpendicular from that of the first in an easterly direction for 60m before gently curving southwards for another 60m connecting with the front entrance drive to Clarisford House and that of an adjacent dwelling. Both of these houses are encircled with mature trees which obscure most of the inward and outward views with the exception of a small number of upper storey windows.

On exiting the woodland the Shannon Bridge Crossing section of the scheme crosses the Moys local road and at this point is approximately 180m north of Clarisford House and 260m south of a secondary school (Coláiste Phobal Naomh Áine). This local road will become a cul-de-sac. A drop-off/ pick-up facility is proposed for St. Anne's Community College on the northern side of the road, between Ch. 0+270 and Ch. 0+440 S. This facility will include provision for 30 parking spaces and a 3.0m wide shared cycleway/footpath from the drop-off/pick-up point to the school. The shared cycleway/footpath to the school will be constructed along the western side of the adjacent road with the existing hedgerow proposed for retention. At chainage 0+460 S the road continues in cut (at a depth of up to 1.6m difference) through an existing residential property and surrounding mature trees on its way to the western bank of the Shannon. North of this property are numerous large detached houses located off the Moys local road. They have large gardens with mature trees and boat docks for access to the Shannon via a submerged canal at the rear of their properties. Due to their west to east orientation and the intervening mature trees they do not have a view towards the scheme with the exception of the nearest dwelling which will have an oblique front and side view. The scheme will have a significant visual impact on this dwelling in the short term.

Mature trees extend to the river's edge on both sides of the Shannon. On the western bank the topography gently slopes from the Moy's road towards the water. The remains of an inundated canal runs parallel between the riverbank and the end of the back gardens associated with the aforementioned low density detached houses. Recreational craft wishing to access these properties can do so by entering the canal from the river. At chainage 0+620 S approx. the Shannon Bridge Crossing crosses the submerged canal and the bridge structure commences on the western bank of the river at chainage 0+630 S approx. A culvert structure will be provided over the canal to allow vessels to continue using the canal while vehicular traffic can pass over it on the bridge overhead. The culvert structure will maintain an 8m wide waterway with headroom of 4m and an adjacent 4m wide towpath for vehicle and pedestrian access. The proposed canal culvert will be 22.5m in length. The Shannon Bridge Crossing will be constructed on a fill embankment with a proposed depth of fill on top of the culvert structure of 1.6m.

The western abutment of the bridge will be constructed on a strip of land 20m wide approx. between the canal and the river bank. It is proposed that a multiple span arch bridge will be supported by two reinforced concrete abutments, one on each riverbank and by four reinforced concrete piers within the river channel on piled foundations. The bridge will have a width of 13.4m and an overall length of 168m. At each pier, small projections will extend 2.35m out from the bridge as outlook points for pedestrians. A lighting column will be located at each outlook. Beneath the road deck are supporting steel arches with a span of 42m from pier to pier and a rise of 4.2m. Half arches with a span of 21m support the most outer piers with the riverbank abutments. Parapets will be mounted on the sides of the bridge and will be 1.06m high.

The bridge reaches the eastern bank of the Shannon at chainage 0+800 S on significant fill and finishes at chainage 0+820 S. The topography on the eastern side of the river is more steeply sloping than that of the western bank and is also slightly higher. An area of wetland woodland will be removed from the lower banks while on the higher slopes a mature Ash hedgerow which includes a specimen mature Oak tree will be felled.

Continuing in an easterly direction the Shannon Bridge Crossing passes through a derelict plot of land towards a proposed four arm roundabout at the existing junction of the R494 and the R496. A young to semi-mature Ash hedgerow demarcates the boundary between the empty plot and the R494. All 65 metres of this hedgerow will be removed. Four dwellings are located immediately east of the new roundabout and bridge. For road safety reasons and changes in levels, the existing driveways into the two centre dwellings will be relocated. This will require the construction of new retaining front boundary walls and the removal of existing shrub and small garden trees. These houses will have a direct view of the new junction and bridge structure. Similarly the remaining outer two properties will have new retaining front boundary walls installed. They will also have oblique front views towards the new junction and bridge.

The northbound R494 road (to Ballina) will be realigned slightly for a short distance of 80m. For a dwelling located on the R494 directly north west of the new roundabout this realignment will result in the partial removal of a number of large coniferous trees and the stepping back of the front garden boundary wall. Views of the house opposite and of the R494 previously screened from this dwelling will now be visible. A mature hedgerow south of this two storey house will screen views to the new roundabout. Linear development lines both sides of the R494 as it progresses into the town centre however they will not be permitted a direct view of the R494 upgrade or bridge crossing due to their east to west orientation, the intervening mature vegetation and neighbouring houses. An exception to this are three bungalows located on the banks of the river, which are likely to have oblique rear views of the proposed bridge.

Realignment of the R496 will be necessary for a short distance from the roundabout, affecting the boundary walls of two dwellings on the road (as discussed earlier). The remaining houses on the eastern side of the road there will not experience a change in their outwards views.

8.4.3 R494 Upgrade

Subsection D: R494 Upgrade Chainage 0+000 R to 1+265 R

Extending southwards from the roundabout the upgraded R494 (to Birdhill) begins in a slight cut until chainage 0+095 R where it changes briefly to being at grade for a distance of 20m. The driveways into two properties east of the Scheme at chainage 0+040 R and chainage 0+090 R will have their locations revised and a new retaining wall will replace their existing front boundary fences. The Scheme will encroach slightly into their front gardens resulting in the removal of some shrub planting at the second dwelling (e.g. willow shrub and rhodendrum hedging).

Plate 8.4 View of R494 and R496 Roolagh junction

Between chainages 0+115 R and 0+210 R the R494 Improvement is in a slight cut. The road will cross the rear boundary wall (40 metres) and hedgerow planting composed of Elder, Hawthorn, Ash, Bramble and Ivy (110 metres) belonging to a dwelling at chainage 0+150 R which is accessed from the R496. This will open up views into the garden area of this property to road users which were not previously possible. Existing garden vegetation will however continue to screen this house from the road to a large extent. A retaining wall will replace the rear boundary.

Between chainages 0+210 R and 0+325 R the R494 Improvement will be raised slightly on fill. The ground level of two properties located east of the road is higher than that of the open space to the west of the road at this section; therefore the fill embankments do not affect the boundary of these dwellings but rather extend into Ballina town park. Two park trees (semi-mature Maples) will be lost as a result of the change in soil levels here.

This fill material also extends into an adjacent wooded area resulting in the removal of the roadside hedgerow that borders it. This hedgerow consists of semi-mature hawthorn, blackthorn and damaged multi-stemmed semi-mature Beech.

The R494 Improvement enters a slight cut at chainage 0+325 R. Since the existing landform is sloping gradually from east to west, only the eastern side of the road is in cut while the western side, for the most part remains at grade (although infrequently requires some fill). The driveway and garden boundary of a dwelling east of the road at chainage 0+340 R will be regraded in order to reduce the severity of the slope between the property and the road. The front concrete boundary walls will be removed and a new entrance into this property including driveway will be constructed at chainage 0+385 R as part of this regrading work. This cut continues along the eastern side of the road until chainage 0+480 R. This results in the removal of 65 metres of roadside hedgerow (mature Spruce, Ash and Sycamore) and the realignment of a new private driveway at chainage 0+425 R.

There is an entranceway at chainage 0+370 R to a dwelling on the western side of the scheme whose boundary and grounds are planted with mature trees. A localised area of fill to the north and south of this entrance iwill cause the removal of some semi-mature Ash, Hawthorn and Beech trees. As part of the road widening works the front boundary wall and piers of this dwelling will be removed also. At chainage 0+465 R the entrance into an existing dwelling on the western side of the scheme will be upgraded resulting in the removal of adjacent mature Ash trees. The remainder of the mature roadside hedgerow fronting properties on the western side of the road until Ch. 0+520 R will also be lost since the road widening works and cyclepath will extend over them.

The R494 Improvement becomes elevated on a slight fill between chainage 0+480 R and chainage 0+520 R but then changes into a cut for the next 40m. The existing entrance and driveway of a dwelling at chainage 0+480 R east will be realigned causing the removal of the boundary walls. Similarly the private driveway of a dwelling at chainage 0+500 R east will be realigned causing the removal of a boundary wall and a cluster of semi-mature coniferous garden trees. This will open views into and out of the dwelling previously screened by the trees. While the road is in cut, 40m approx of semi-mature trees and roadside hedgerow will be removed from the eastern side of the existing road since the road crosses them. This vegetation consists of Birch and a high percentage of Ash.

The outward views along the R494 are limited for the most part to tall roadside hedgerows, roadside dwellings and their front gardens. Generally the topography along the road slopes from high to low from east to west. However the closer the road is with the R445 the less pronounced this topographical difference becomes. The tree canopies at irregular intervals along the road touch to form a small scale and enclosed space. An upgraded entrance into an existing dwelling at chainage 0+565 R west will be provided. At chainage 0+575 R road users are afforded an unusual westward glimpse of the River Shannon.

At chainage 0+500 R the R494 Improvement which had closely followed the line of the existing road, deviates to the east of the existing road until chainage 0+675 R. This causes it to move slightly further away from two house entrances on the west side of the scheme (at chainage 0+570 R and chainage 0+620 R) and closer to three dwellings adjacent to the eastern side of the scheme (at chainages 0+510 R, 0+580 R and 0+650 R). The regrading of driveways into dwellings at chainage 0+580 R east and chainage 0+620 west will result in the removal of part of the existing entrance walls. Similarly at chainage 0+650 R the R494 Improvement encroaches into the front garden of a dwelling known as “Whiteoaks” causing the removal of a number of specimen Oaks (after which the house is named) as well as mature Ash and Pine trees. This will result in a significant landscape and visual impact.

At chainage 0+560 R the route returns at grade for a short distance of 15m but then becomes elevated on a slight fill at chainage 0+575 R. It enters a small cut at chainage 0+630 R for 10m before returning on fill until chainage 0+850 R. On the eastern side of the road at chainage 0+700 there is a two storey dwelling with a large garden whose mature internal and roadside vegetation conceals its front views of the R494. The R494 Improvement will cause the driveway into this property to be extended. Some existing mature trees may be removed from the boundary with the R494 due to the proposed route but the majority can be retained.

On the opposing side of the road the hedgerow vegetation is not as mature but is extremely dense. It consists predominately of Ash with the occasional Sycamore tree. The widening of the R494 at this location for a distance of 250 metres will result in the loss of some of this hedgerow and exposure of the coniferous tree plantation behind. Two driveways will also be extended into existing dwellings at chainage 0+795 R and 0+820 R east, from the new position of the R494 road over the redundant section of the old R494.

Between chainage 0+820 R and 0+860 R a field with a wooden post and rail fence on the eastern side of the R494 gently slopes down towards the road. The lack of front and side boundary hedgerow allows a more extended outward view from the road, which contrasts with the closed tree canopies of the previous road section. Between chainage 0+850 R and 0+900 R the road is at grade but becomes raised on fill until chainage 1+320 R. The fill material varies in height but is never greater than 3m. At chainage 0+900 R the R494 Improvement changes direction slightly moving away from the western side of the road and towards the gravel margins of a petrol station and warehouse buildings opposite. However; the dense 12m high Ash hedgerow on the western side will be removed for a distance of 200 metres to expose the coniferous plantation to its rear. At chainage 0+950 R an attenuation pond will be constructed on the western side of the road within coniferous planting.

At chainage 1+100 R a new opening will be created at ninety degrees to the R494 Improvement, through the western hedgerow and over a stream to link into the entrance to Fort Henry Estate. This realigned entrance will be 42m in length and will remove a Crab Apple tree and a small number of Ash and Willow. Numerous streams and drains flanked with wetland tree species are located in this part of the study area. Between Ch. 700 R and Ch. 1+180 R on the western side of the road an area of land located within the Henry Ford Estate will be temporarily acquired for stream enhancement works. This will result in a moderate short-term landscape impact but will in the long term will be a negligible landscape impact. The upgrade to the R494 continues on a south easterly course crossing a small stream and bridge wall at chainage 1+130 R. At chainage 1+150 an attenuation pond will be constructed on the western side of the road. At chainage 1+175 R the road deviates on fill to the west of the existing R494 through an early mature hedgerow consisting of Willow, Elm and Alder and into a young coniferous plantation. In total an area of 0.9acres of deciduous hedgerow and coniferous woodland will be felled in order to make way for the R494 Improvement. At chainage 1+265 R an opening is created through the existing roadside hedgerow (of Alder, Blackthorn, Ash and Hawthorn) eastward to connect with the entrance of an existing property known as “Ardglas”. This dwelling is not visible from the existing road due to local topographical differences.

Plate 8.5 Southward view of existing closed canopy hedgerow vegetation on the R494

Subsection E: R494 Upgrade Chainage 1+265 R to 3+330 R

Between chainages 1+320 R and 2+135 R the route varies frequently between been at grade or being on a very slight fill (of less than 0.4m approx). A local side road providing access to a dwelling at chainage 1+330 R from the R494 Improvement will be upgraded for a distance of 28m. A new access will be constructed into an existing coniferous plantation at chainage 1+365 R and will be 24 metres in length. The R494 Improvement reconnects with the path of the existing regional road at chainage 1+360 R. Dense hedgerows predominately of Ash but which also contain Willow, Alder, Hawthorn and Sycamore line both sides of the existing road until chainage 1+600 R. These mature hedgerows confine road users outward views. The R494 Improvement will widen the existing road causing these hedgerows to be removed. This will result in some coniferous plantation to the rear of the hedgerow to be exposed and will also open up short distance views of a field to the east also.

Plate 8.6 Southward view taken on R494 at chainage 1+300 R approximately

The eastern hedgerow between chainage 1+600 R and chainage 1+730 R becomes less dense but still screens the adjacent fields from road users. As part of the works it will be removed opening up eastward short distance views of pastureland behind. The R494 Improvement encroaches onto the gravel path fronting three dwellings west of the road at chainage 1+640 R chainage 1+680 R and chainage 1+740 R. The entrance driveway into all three properties will be upgraded. The front boundary wall of two of these dwellings (located between chainage 1+610 and 1+715 R) will need to be reconstructed due to the change in levels created by the road works. The existing gated access at chainage 1+715 R will also be extended. Similarly three dwellings east of the road at chainages 1+760 R, 1+790 R and 1+830 R will be a maximum of 2m closer to the R494 Improvement. Their views will be slightly affected by it since the Ash hedgerow on the opposite side of the road will be removed for a distance of 250 metres and Woodcock Hill will be more clearly visible in the background. An attenuation pond will be constructed at chainage 1+715 R east which will have a slight negative visual and landscape impact. The access into an existing field at chainage 1+810 R west will be upgraded. A low 2m high, managed hedgerow (composed of Ash, Willow and Field Maple) between chainage 1+840 R and 2+000 R will be removed, thus opening up views into a two-storey dwelling and an adjacent field at a higher level than the R494 Improvement.

The dense roadside hedgerow on the western side of the R494 Improvement which varies in height between 5 - 11m will be lost (80 metres). It contains Ash, Hawthorn and Blackthorn. At chainage 2+080 R this hedgerow reduces in height to 5m and is composed mainly of Hawthorn, Ivy and Bramble. 70 metres of this hedgerow will also be lost due to the widening of the road. The front boundary walls of two dwellings east of the road at chainages 2+020 R and 2+110 R are set back from the existing road and therefore will be unaffected by the scheme. At chainage 1+960 and 2+020 two attenuation ponds will be constructed on the western side of the road. A site located in the centre of these two properties will lose its protruding boundary hedgerow of Willow to reveal a small sloping field with hardcore tracks.

The R494 Improvement enters a slight cut (of max. depth of 1m) between chainages 2+135 R and 2+220 R but returns to a slight fill (of max. height of 1m) between chainages 2+220 R and 2+430. Between chainages 2+125 R and 2+300 R a 3m high hedgerow on the eastern side of the road will be removed. It consists of Willow, Hawthorn, Wild Rose and is interspersed with mature Ash trees. The opposing roadside hedgerow will be removed also. It contains Hawthorn and mature Ash trees averaging 15m in height. Views of pasture to the east and west will now be visible to roadusers. At chainage 2+300 R the first 26m of a local side road on the eastern side of the R494 will be upgraded. The road will cross a low concrete wall at chainage 2+305 R and part of a semi-mature garden hedge of Golden Leyland.

The hedgerow located at chainage 2+305 R east until chainage 2+400 R varies in height between 4m-12m. It is composed of Ash, Elder, Hawthorn and Elm and will be removed as part of the R494 Improvement works. At chainage 2+330 an attenuation pond will be constructed on the western side of the road. The front boundary walls of a two storey house at chainage 2+390 R west will be removed as part of the upgraded road works and cycle lane. A shed will also be removed at chainage 2+410 R west. The boundary walls and garden shrubs of a dwelling located at chainage 2+420 R east will be crossed by the road as it deviates from the original path of the R494 in an easterly direction. As it continues into pasture, it passes over 160 metres of mature hedgerow located on the eastern side of the existing road. This hedgerow varies in height between 6–10m and consists of Ash, Elder, Hawthorn and Wild Rose. The hedgerow on the western side of the existing road will be retained.

From chainage 2+430 R until chainage 3+289 R the R494 Improvement is raised on a moderate fill (reaching a max. height of 7m approx). The road as it traverses through pasture (between chainages 2+460 R and 2+670 R) is elevated on 3.5m approx of fill. To the east, Cappanakeady Hill is visible in the distance. Its lower slopes are used as pasture while its higher slopes are covered with a coniferous plantation. At chainage 2+630 R the R494 Improvement crosses the Kilmastulla River which catches water from the Arra and Silvermine Mountains, passing the base of Cappanakeady Hill on its route to unite with the Shannon. A new wider bridge structure will be constructed east of the original Kilmastulla River bridge crossing at chainage 2+630 R and will result in the removal of riverbank vegetation.

Continuing onwards through pastureland, the R494 Improvement will be 25m east of the original R494. An access road will be constructed at chainage 2+650 R west of the R494 Improvement for a total distance of 73m. This road will travel west for 20m before curving southwards to link into the existing R494. This side road will provide access to existing dwellings, woodland & farmland situated along the existing regional road. As a direct result of the works and access road construction 90 metres of hedgerow will be removed east of the existing R494 between chainages 2+630 R and 2+720 R, which will have a moderate landscape impact. This hedgerow consists of a hawthorn and bramble understorey with a mature Ash and Sycamore upperstorey. A 2m high Hawthorn and Holly garden hedge (40m in length) will be lost at side road chainage 15 to 55. Four dwellings west of the existing R494 will experience a significant visual impact as a result of these aforementioned works. At chainage 2+650 R an attenuation pond will be constructed on the eastern side of the road, adjacent to the river.

The R494 Improvement crosses the existing driveway of a two storey dwelling at chainage 2+720 R separating it from its walled entrance and necessitating a revised driveway alignment. The front lawn of this property will be reduced in size by one third and 30 metres of semi-mature Golden Leyland hedging will be removed also. The road passes over a narrow strip of land and 30 metres of semi-mature boundary Leyland before entering the grounds of Shannonside Business Park. The R494 Improvement is approximately 25m closer to the business units located within this business park than the existing R494. The 3m high walls and panel fencing along the western boundary of the park will be removed as part of the new road works by the road and a new entrance will be constructed into the park at chainage 2+940 R. This newly constructed avenue will be 108m in length and will cross an existing grassed open space. The mixed tree and shrub planting west of the building known as “Brodericks” will be crossed by the scheme also. It will be the closest building to the R494 Improvement at a distance of 20m.

A new railway crossing will be constructed at chainage 3+030 R over the existing bridge known as Dooly’s. A cluster of Ash planting will be removed from both sides of the existing road between chainage 3+000 R and 3+100 R since the footprint of the fill embankments of the R494 and bridge installation will extend over the existing vegetation. The R494 Improvement will cross a small existing track at chainage 3+120 R between chainages 3+120 R and 3+220 R and will run parallel to the existing R494 over the edge of a field and its boundary hedgerow of semi-mature Ash. A field entrance is proposed at chainage 3+190 R west and chainage 3+210 R an attenuation pond will be constructed on the western side of the road.

A dwelling at chainage 3+270 R and its outhouses at chainage 3+240 R east of the Scheme will experience a significant visual impact since the R494 Improvement will encroach onto its grounds. Presently there are separate driveways into the house and its associated sheds however the R494 Improvement on fill will cause the farm entrance to close. A new driveway will branch from the avenue to the house crossing the lawn allowing access to the farm sheds. The road will also cause the removal of a front boundary wall and 9 no. mature trees, which currently screen views into the property. These trees are planted at close centres and consist of Ash, Macrocarpa, Spruce and Cedar. At chainage 3+300 R the road ties into the recently constructed slip road from the Birdhill roundabout on the R445. The shared entrance at chainage 3+290 R into two properties west of the R494 Improvement will be realigned for a short distance resulting in an entrance wall been lost.

8.5 Potential Landscape and Visual Impacts

8.5.1 General

The visual characteristics of the proposed route have been described in the previous section of this report. This section of the report will evaluate the landscape and visual effects of the route without any mitigation measures. The purpose of this method of assessment is to determine the gross visual effect of the route without any direct physical mitigation measures, in order to fully determine the effects of the scheme. Following this, a scheme of mitigation will be proposed for the route and will be assessed in the context of a 20-year timescale.

In overall terms, the form of the route will contrast with the existing landscape pattern which is predominately agrarian in nature ranging from upland pasture on the base slopes of the Slieve Bernagh Mountains to undulating low lying pasture on the banks of the river Shannon. Linear individual settlements, mature hedgerows and small coniferous plantation are commonplace throughout this landscape also. Generally the majority of effects occur within 500m of the proposed route. Areas of particular impact are associated with where the route causes the removal of existing mature trees, hedgerows and woodlands. Due to location of the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement on the peripheral of two towns there are few parts that do not have visual sensitive receptors (i.e. residential dwellings, or important tourist sights) within a short distance and therefore visual impact registers particularly high on the scale. Landscape impacts are highest where the route enters into a cut on the more elevated slopes changing the topographical profile and treeline patterns. Significant negative impacts are also generated where is it is raised crossing the river Shannon and on fill to create slip roads connecting into the existing road network.

Potential Landscape and Visual Impacts are tabulated with proposed Mitigation measures and Predicted Impacts in **Table 8.5** and **Table 8.6**.

Figures 8.10 to 8.17 provide existing and proposed views of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement Scheme. **Figures 8.18 to 8.21** show existing views throughout the scheme.

8.5.2 Landscape and Visual Impacts – Summary

Landscape Impacts

The following are the principal landscape impacts experienced through the construction of the Killaloe bypass, Shannon Bridge Crossing and R494 Improvement. A significant cut south of Ballyvally House causes the removal of existing mature woodland and creates a significant topographical difference particularly evident from the opposing side of the valley. A large number of existing hedgerows and wooded areas are lost along the entire length of the route corridor.

The construction of the bridge across the River Shannon will have a profound landscape impact.

Visual Impacts

The primary impacts occur at the crossing of existing local roads and the upgrading of the R494. The fill embankments of the local roads realigned to meet the scheme at T-junctions and the construction of roundabouts generates negative visual affects. Similarly the widening and realignment of the R494 causes the removal of existing roadside vegetation, which previously screened dwellings from road users. The construction of the bridge across the River Shannon will have a significant visual impact.

Sensitive Receptors

There are a number of categories of receptor which were classed as sensitive and are discussed below:

Existing dwellings

The majority of dwellings located within the study area are single dwellings located along the third class and regional road network radiating from Killaloe and Ballina towns. The most affected dwellings with regard to views (without introduction of mitigation) are as follows (see also **Figures 8.1 to 8.9**):

Dwelling No. 3B/3A:

The existing view east from Ballyvally Gate Lodge (3B) is of the R463 which passes the front of the property with a backdrop of a mature deciduous hedgerow on the opposing side of road. This hedgerow prevents any long distance views. Significant impact will occur through the construction of an attenuation pond, roundabout and three slips roads to the front of this listed property on fill. This construction work will necessitate the removal of the aforementioned hedgerow. Ballyvally House (3A) is set further back from the road and has indirect views so there would be moderate impact during construction to this property.

Dwelling Group No. 4:

Three dwellings are included in this group. Their front views to the east are of garden vegetation, roofs of adjacent houses, the river Shannon and Ballina on the valley opposite. These views will remain unchanged. Existing westward and northward views from the rear and side views from these properties are of woodland & mature trees boundary trees of Ballyvally Estate. The Killaloe Bypass will be obscured from their side and rear views since it will be in cut however they will experience a moderate impact through the removal of the mature vegetation that previously enclosed them.

Dwelling Group No. 7:

Four dwellings are included in this group. Their front views to the east are of garden vegetation, roofs of adjacent houses, the river Shannon and Ballina on the valley opposite. These views will remain unchanged. The existing rear views are of garden vegetation, boundary field hedgerows and pastureland. For two dwellings this rear view will remain unchanged due to a raise in topography. However; the two closest dwellings, which are, less than 60m away will experience a moderate impact though the construction of the bypass route in a slight cut and an adjacent access track to farmland.

Dwelling Group No. 8:

Four dwellings are included in this group. They align on the northern side of Hill Road with either pasture or large gardens to their rear. As Hill road travels westwards from the town centre it becomes steeper and its boundary roadside hedgerows decrease in height. The first 2 no. dwellings nearest the town centre have foreground southward views of roadside hedgerows from their ground level windows and pastureland from their second storey windows. The next two dwellings have foreground southward views of pastureland and field hedgerows. Significant impact will occur to these properties with the construction of an access road, a slip road on fill and the realignment of the existing Hill road. Slight impact will occur through the construction of the road in the background or oblique viewshed.

Dwelling Group No. 10:

A single two storey dwelling off the third class road (Hill Road) to Bridgetown facing east. Primary views are of mature boundary conifers. Rear windows views of the surrounding fields. Slight impact to rear background views through construction of road on a slight fill.

Dwelling Group No. 11:

Seven dwellings accessed off a third class road (Hill Road). Five of them are detached two storey houses located on the southern side of the road and are orientated so that their primary views are in a north-easterly direction of pasture, mature trees, opposing houses and roadside hedgerow. There are two dwellings on the northern side of the road that face in a south easterly direction. The rear views of both are screened by tree belts while their front views are of hedgerows, mature garden vegetation and agricultural land in the foreground. Two of the houses will experience a slight impact to their front oblique views through the construction of the route in cut while a third will undergo a moderate impact to its front oblique view due to the construction of a slip road on fill.

Dwelling Group No. 15:

Three dwellings south of Creeveroe Road with north westerly views of mature trees, the road, agricultural lands and field hedgerows. One dwelling also has side views to the west of agricultural lands and field hedgerows. There will be a significant impact to one dwelling due to the construction of the scheme and slip road on fill to its front and side views. Two dwellings will experience a moderate impact as a result of the construction of the slip road on fill.

Dwelling Group No. 17A, 17B and 17C:

Three detached dwellings (a two storey house and two bungalows) which face south east onto the R463. The primary views are of a residential development on the opposite side of the road and of a mature treeline in the background. One dwelling also has a screened side view of low lying pasture and mature field hedgerows to the south west (17A). The outwards views of one dwelling will be unaffected (17C) while a second will be slightly affected by the construction of a slip road on fill in its foreground view (17B). The third dwelling will experience a moderate impact due to the construction of the scheme, attenuation pond and roundabout on fill in its side view and a slip road on fill in its foreground view (17A).

Dwelling Group No. 19:

This group is a newly constructed residential development with the majority of its dwellings facing north westwards. The foreground primary view is of the majority is of the road, garden vegetation and adjacent houses. A small number of dwellings face southwards with front or rear views of adjacent houses, a mature treeline, a low fragmented hedge and a warehouse. Two dwellings will have this rear view only while three will have it as a front view. All five dwellings will experience a moderate impact due to the construction of the road on fill and the proposed adjacent compound area.

Dwelling Group No. 20:

Four detached dwellings which front onto the R463. The most southerly dwelling has limited outward views due to its mature garden and boundary vegetation. For the remaining three dwellings, their foreground primary view is of the road, garden vegetation and adjacent houses. They have indirect views of an adjacent disused warehouse which is proposed as a compound area for the proposed construction works. All three will experience a moderate impact as a result of their proximity to the proposed compound area.

Dwelling Group No. 23:

Clarisford House is centred within a mature parkland setting and therefore mature tree and hedgerow cover is to the foreground of this dwelling's outward views. It will experience a slight impact with the construction of the scheme on fill and two slip roads.

Dwelling No. 24:

Mature trees screen existing front view westwards. Partial outward views contain an entrance driveway and parkland. Moderate impact will occur through the removal of the adjacent dwelling and the construction of the scheme on fill and access road to the property. Mature trees along northern boundary could be retained but are subject to detailed design and deviation of proposed fence.

Dwelling No. 25:

Existing front view westwards of mature trees, a third class road and a roadside hedgerow. Oblique and side views of an adjacent dwelling and mature trees will be significantly impacted upon through the removal of the adjacent dwelling and the construction of the scheme and set down area on fill.

Building No. 27:

A secondary school located on a third class road within close proximity to a junction with the R463. The school is known locally as Coláiste Phobal Naomh Áine. Its outward views are of adjacent dwellings, mature trees, sports pitches, tennis courts and roadside hedgerow. The school will experience a slight impact to its southward views through the construction of the road and set-down area on fill. The third class road will become a cul-de-sac.

Dwelling No. 29:

Existing front views of garden vegetation, adjacent dwellings and R494. Intervening mature garden hedgerows screen side views from the dwelling. Rear (eastward) views are of the River Shannon and mature trees on the opposing riverbanks. The upgrade works to the R494 will cause an imperceptible impact to the front or side views of this dwelling. The construction of the Shannon Bridge Crossing will have a slight impact to the rear oblique views of this dwelling.

Dwelling No. 30:

Existing front (eastward) views of mature evergreen garden vegetation and partial front views of neighbouring dwellings and the R494. Mature boundary hedgerows screen side views outwards while rear views are of the River Shannon and mature trees on the opposing riverbanks. The upgrade works to the R494 will cause a removal of the existing front boundary walls and mature evergreen hedging resulting in a significant impact. A moderate impact will be caused by the construction of the roundabout and Shannon Bridge Crossing south of the dwelling.

Dwelling No. 31:

Existing westward view of the mature evergreen vegetation, a stone wall and the R494. The construction of a roundabout and the Shannon crossing southwest of the dwelling will have a moderate impact on the oblique front views from this dwelling while the upgraded R494 works will result in a moderate impact to its direct front views.

Dwelling No. 32:

Existing westward views are foreshortened by the presence of a semi-mature roadside hedgerow on the opposing side of the R494. The construction of a roundabout, the Shannon crossing and the upgraded R494 works southwest and west of the dwelling will have a significant impact on existing views.

Dwelling No. 33:

The westward views from this dwelling are shortened by the presence of a semi-mature roadside hedgerow on the opposing side of the R494. A small grassed area and the road junction between the R494 and the R496 is in its foreground view also. The construction of a roundabout, the Shannon Bridge Crossing and the upgraded R496 works southwest and west of the dwelling will have a significant impact.

Dwelling No. 34:

The westward views from this dwelling are of garden vegetation, the R496, a small grassed open space and the rear of an adjacent single storey house. The upgrading works for a short distance along the R496 will cause a moderate impact to this dwelling.

Dwelling No. 35:

The westward views from this dwelling are of garden vegetation, the R496, and the rear of adjacent houses. The upgrading works for a short distance along the R496 will cause a slight impact to this dwelling.

Dwelling No. 36:

The westward views from this dwelling are of garden vegetation, the R496, and the rear of adjacent houses. The upgrading works for a short distance along the R496 will cause an imperceptible impact to this dwelling.

Dwelling No. 38:

The westward eastward views are of the R494, a house on the opposing side of the road and garden vegetation. The construction of an alternative entrance driveway, retaining boundary walls and upgrade of the R494 will result in a moderate impact while oblique front views to the north (of the roundabout and Shannon crossing) will also experience a significant impact.

Dwelling No. 39:

The existing westward views are of the R494, a house on the opposing side of the road and garden vegetation. The construction a realigned entrance driveway, retaining boundary walls and upgrade of the R494 will result in a moderate impact.

Dwelling Group No. 40:

The existing eastward views are of the R494, adjacent houses and garden vegetation. The upgrade of the R494 will result in a slight impact to these front views. The building of the Shannon Bridge Crossing will cause a moderate impact to oblique background rear views but for the most part the direct rear middleground and foreground views will be unchanged.

Dwelling No. 41:

The primary direct view from this dwelling is westward of garden vegetation, mature trees and the Shannon River. The installation of the Shannon Bridge Crossing will generate a significant impact to an oblique rear view from this dwelling.

Dwelling No. 42:

The primary direct view from this dwelling is westward of garden vegetation, mature trees and the Shannon River. Tall evergreen hedging screens its eastward view. The installation of the Shannon bridge crossing will generate a moderate impact to an oblique rear view from this dwelling.

Dwelling No. 43:

Existing westward views from this dwelling are of mature garden vegetation, which screen the adjacent houses and roads. The construction of a new retaining boundary wall due to the R494 upgrade works will result in a moderate impact.

Dwelling Group No. 44:

Existing westward views from these two dwellings are of mature garden vegetation, boundary walls and roadside hedgerow on the opposing side of the road. The R494 upgrade works will result in an imperceptible impact.

Dwelling No. 45:

Existing westward views from this dwelling is of the lawn, a low boundary wall and semi-mature roadside hedgerow on the opposing side of the road. The R494 upgrade works and driveway realignment will result in a significant impact due to the removal of existing trees and realignment of existing entrance driveway.

Dwelling No. 46:

Existing rear view of the River Shannon while its eastward front view is of specimen mature trees within its front garden, the road and a coniferous hedgerow opposite. The R494 upgrade works will result in a significant impact on its front view due to removal of wall, entrance piers and mature trees at entrance and along boundary with the existing road.

Dwelling No. 47:

Existing westward front view is of specimen mature deciduous and coniferous trees which significantly screen outward view. The R494 upgrade and realigned driveway will result in a significant impact.

Dwelling No. 48:

Existing westward front view is of mature roadside hedgerow on the opposite side of the R494. The R494 upgrade will cause a significant impact due to removal of front walls and driveway realignment

Dwelling No. 49:

Existing westward front view is of mature garden trees and a partial view of the roadside hedgerow on the opposite side of the R494. The R494 upgrade and realigned driveway will cause a significant impact.

Dwelling No. 50:

Existing eastward front view is of mature garden trees, roadside hedgerow and the R494. The R494 upgrade will result in a significant impact due to removal of mature trees at entrance and along boundary with the existing road. Views of Shannon to west are unaffected.

Dwelling No. 51:

Existing eastward front view is of garden vegetation and a mature roadside hedgerow on the opposing side of the road. The R494 upgrade will result in a moderate impact.

Dwelling No. 52:

Existing westward front view is of garden vegetation, the R494 and glimpses of the river Shannon through mature roadside vegetation on the opposing side of the road. The R494 upgrade and realigned driveway will result in a moderate impact.

Dwelling No. 53:

Existing westward front view is of mature specimen garden trees, the R494 and adjacent avenue to the stables behind the house. The R494 upgrade will cause a significant impact due to the removal of trees.

Dwelling No. 54:

Existing westward front view is of mature roadside hedgerow and garden trees. The R494 upgrade will cause a moderate impact.

Dwelling No. 55:

Existing westward front view is of mature roadside hedgerow on the opposing side of the road. The R494 upgrade will cause a slight impact.

Dwelling Group No. 58:

Existing eastward views are of garden vegetation, low boundary walls and semi-mature roadside hedgerow on the opposing side of the road. The R494 upgrade will cause a significant impact to dwellings 58A and B due to the removal their front garden walls and piers. The impact to dwelling 58C will be significant also due to the addition of an attenuation pond on the opposing side of the road.

Dwelling Group No. 59:

Existing westward views are of garden vegetation, low boundary walls or fences and semi-mature roadside hedgerow on the opposing side of the road. The R494 upgrade will cause a slight impact.

Dwelling No. 60:

Existing westward views are of a managed two metre high roadside hedgerow. The R494 upgrade will cause a slight impact.

Dwelling Group No. 61:

Existing westward views are of garden vegetation, low boundary walls, mature trees and semi-mature roadside hedgerow on the opposing side of the road. The R494 upgrade will cause a slight impact.

Dwelling No. 63:

Existing eastward views are of low boundary garden wall and semi-mature roadside hedgerow on the opposing side of the road. The R494 upgrade will cause a significant impact due to removal of front boundary walls and shed.

Dwelling No. 64:

Existing westward views are of low boundary wall, garden shrubs and agricultural sheds on the opposing side of the road. The R494 upgrade will cause a moderate impact.

Dwelling No. 65:

Existing westward views are of a low boundary wall, lawn, mature roadside hedgerow and houses on the opposing side of the road. The R494 realignment on a fill embankment and regraded driveway will cause a significant impact.

Dwelling No. 66:

Existing eastward views are of a low boundary wall, garden shrubs, mature roadside hedgerow and a house on the opposing side of the road. The R494 realignment and lip road on a fill embankment will cause a significant impact.

Dwelling No. 67:

Existing eastward views are of a low boundary wall, low roadside hedgerow and tall evergreen hedges on the opposing side of the road. The R494 realignment on a fill embankment will cause a moderate impact.

Dwelling No. 68:

Existing eastward views are of low boundary walls, garden shrubs, tall roadside fencing and a warehouse on the opposing side of the road. The R494 realignment on a fill embankment will cause a moderate impact.

Dwelling No. 69:

Existing westward views are of low boundary walls, mature coniferous garden trees and a low hedgerow on the opposing side of the road. The R494 realignment will cause a significant impact.

Dwelling No. 70:

Existing westward views are of low boundary walls, mature garden trees and a house on the opposing side of the road. The R494 realignment will cause a slight impact.

Dwelling No. 71:

Existing eastward views are of low boundary walls, garden vegetation, mature coniferous trees and a house on the opposing side of the road. The R494 realignment will cause a slight impact.

Dwelling No. 72:

Existing eastward views are of low boundary walls, garden vegetation, mature trees and a house on the opposing side of the road. The R494 realignment will cause a moderate impact.

Areas of Natural Heritage

There are two areas of natural heritage affected by the Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement to various degrees. These include the Lower River Shannon (cSAC) and the boundary trees stretching around Ballyvally Estate.

The site for the proposed bridge crossing over the Lower River Shannon is such that its visual effects are predominately localised. The majority of views within Killaloe town are orientated to the north-east away from the proposed bridge which is south-east of the town. Mature tree vegetation located along the western bank also prohibits views of it from Killaloe. The existing stone bridge is located on a river bend in the centre of Killaloe/ Ballina and therefore the protruding western bank obscures views from it to the proposed bridge location. The main viewing locations within the locality for tourists are principally towards Lower Lough Derg and away from the proposed bridge.

A small minority of properties within Ballina would have a long distance view of the central section of the proposed bridge. Similarly, pedestrians in the town or in the riverside park in Ballina could be afforded a partial view of the proposed bridge but only if they correctly aligned themselves at specific locations on the eastern riverbank. Again existing mature trees extending down to the river edge on the eastern bank help screen it. The properties located closest to the proposed bridge have screened oblique views also. The only receptors with a direct view of the proposed bridge are a very limited number of dwellings on the R494 and infrequent small leisure craft on the River Shannon. Therefore the bridging of the river will cause a profound landscape and a significant visual affect for a limited number of receptors.

A large section of mature trees along the southern boundary of Ballyvally Estate will be removed to allow the Killaloe Bypass to pass in cut thus creating a significant landscape impact and a moderate visual impact. Although these trees do not have TPO's (Tree preservation Order) allocated to them they are listed as trees for preservation in the Clare Development Plan.

8.6 Avoidance, remedial and reductive measures

8.6.1 Landscape Mitigation

The proposed landscape treatments are illustrated on **Figures 8.1 to 8.9** and have been devised with reference to the National Roads Authority document "*A Guide to Landscape treatments for the National roads Schemes in Ireland*". It is recommended and fully expected that at the detailed stage a site specific set of landscape treatments will be devised within the framework offered by this assessment and with further reference to the relevant NRA Guidelines.

The primary objective of the proposed landscape mitigation works is to re-integrate the new route into the landscape through which it passes. The proposed Killaloe Bypass, Shannon River Crossing and R494 Improvement passes through a landscape defined by a pattern of hedgerows, woodland, settlement, pasture, existing infrastructure, water courses and uneven topography. In the northern section of the route, the landscape topography is steeply sloping but as it progresses towards the southern section it changes into undulating lowland.

The landscape mitigation will formulate a schedule of landscape types that can be used to provide a visual connection between the route and the existing environment at specific locations. Another aim of the landscape proposals is to mitigate adverse visual impacts of individual properties affected by the route by means of hedgerow or woodland screening. Finally it is the intention of the landscape proposals to take the opportunity to create a diverse range of ecological habitat types along the route corridor.

A suitably qualified landscape architect will devise the landscape drawings and specification for the proposed scheme during the detailed design stage in consultation with a suitably qualified ecologist. Consultation with a suitably qualified arboriculturist is required for the successful and safe retention of existing mature trees where possible. These documents will include for the treatment of the existing vegetation, soil preparation, seeding, planting, maintenance and establishment works. The specific landscape proposals that are put forward at the design stage must also adhere to the guidelines for road safety with respect to sightlines and the placement of planting at appropriate distances from the carriageway. In addition, requirements put forward in the ecologists report will be implemented.

The plants selected for the landscape treatments are found in the existing landscape and are appropriate to the local soil types and climatic conditions. The breakdown of the proposed landscape treatments, which have been devised to achieve the objectives for landscape mitigation, are as follows:

- H1: In order to re-establish hedgerow corridors that have been severed by the route the fencelines are to be established with native hedgerow material. Similarly, the removal of hedgerows with a screening function to front coniferous plantations must be re-established also. The only exceptions to this are where specific views of the surrounding landscape are to be preserved or where an alternative treatment is appropriate such as alongside urban areas. The native hedgerow material will include species which widely occur in the existing landscape area; these are – Hawthorn (*Crataegus monogyna*), Blackthorn *(Prunus spinosa*), Willow *(Salix aurita)* and Ash *(Fraxinus excelsior).*
- H2: In some instances where semi-natural hedgerows or treelines have been severed such as those alongside urban areas or original demesne boundaries, an alternative hedgerow treatment is more appropriate order to re-establish these hedgerow corridors. The semi-natural hedgerow material will include species such as – Hawthorn (*Crataegus monogyna*), Beech (*Fagus sylvatica*), Oak (*Quercus petraea*) and Ash (*Fraxinus excelsior*).
- M3: At specific areas, there will be a requirement for particular screening of properties. These will be established in woodland with a specific emphasis on quick establishment of a woodland screen, with larger material to create woodland screening and effective woodland in the long-term. Species to be included are: Scots Pine *(Pinus sylvestris*), Holly (*Ilex aquifolium*), Ash (*Fraxinus excelsior*), Oak (*Quercus petraea*), Birch (*Betula pendula*), Alder (*Alnus glutinosa*), Hawthorn (*Crataegus monogyna*), Willow (*Salix alba*). Some areas will be planted with SM3, which is a combination of M3, S1 and G2.

- M4: Selected areas are to be established with woodland (using a mixture of evergreen and deciduous both native and naturalised tree and shrub material) in order to provide visual screening, stabilise embankments, and for ecological reasons. Where screening is not a priority, this planting will be carried out in conjunction with scrub mix (S1) and wet grassland (G2), in order to create a mosaic of habitats. Species to be included are: Oak (*Quercus petraea*), Ash (*Fraxinus excelsior*), Beech (*Fagus sylvatica),* Birch (*Betula pendula*), Holly (*Ilex aquifolium*), Hawthorn (*Crataegus monogyna*), Scots Pine (*Pinus sylvestris*) Willow (*Salix caprea*), Buckthorn (*Rhamnus frangula*), Hazel (*Corylus avellana*) and Dogwood (*Cornus sanguinea*). Some areas will be planted with SM2, which is a combination of M4, S1 and G2.
- M5: Throughout the study area there are copses beside streams and riverbanks of wet woodland. These are generally scrubby in make-up and distributed at random in the boggy or low-lying areas in particular. In order to integrate the proposed route into the landscape it is proposed to plant copses or strips of appropriate tree species along the route. Species to be included are: Birch (*Betula pendula*), Willow (*Salix aurita, Salix caprea, Salix cinerea*), Alder (*Alnus glutinosa*), Pine (*Pinus sylvestris*) and Larch (*Larix decidua*). These areas of planting are to be integrated with scrub mix (S1) and wet grassland (G2) to create a mosaic of habitats.
- S1: Selected areas are to be established with scrub in order to provide variety, stabilise embankments, and for ecological reasons. This planting will be carried out in conjunction with wet woodland (M5), woodland (M4) and wet grassland (G2), where appropriate, in order to create a mosaic of habitats. Species to be included are: Holly (*Ilex aquifolium*), Hawthorn (Crataegus monogyna), Blackthorn (Prunus spinosa), Hazel (*Corylus avellana*) Spindle (*Euonymus europaeus*), Willow (*Salix caprea*), Buckthorn (*Rhamnus frangula*) and Dogwood (*Cornus sanguinea*).
- G1: Grass verges immediately alongside the carriageway (min. 1.0m width), slip roads, roundabouts and side roads are to be established with a low maintenance grass seed mix, consisting predominantly of indigenous fescue grasses.
- G2: Where screening is not a requirement semi-natural grasslands are to be established, in conjunction with other types of planting (selected from above) to create a mosaic of habitat types. The existing soil and climate prescribes the use of either dry grassland or a wet grassland mix. The wet grassland mix will include a range of suitable species such as Red and Sheep's Fescue (*Festuca sp*.), Bents (*Agrostis sp*.), rushes (*Juncus sp*.), Iris (*Iris pseudacorus*) and other locally occurring grassland species. However; the selection of suitable grass species at the detailed design stage will take into account the angle of the slope and soil characteristics of specific locations for the compilation of appropriate grassland mixes. Reference is to be made to the ecologist's report in devising this appropriate species list.
- D1: Drains and swales are to be established using a specific grass seed mix of predominately fescue grasses to stabilise the slopes, but that will not impede the flow of water once established.
- In the construction process, the excavation and grading of all areas will be carried out in a sensitive manner to marry in the new formations with the existing landscape. Sharp ridges or overly steep embankments will be avoided where possible.
- Care will be taken when clearing existing drains or streams to avoid damage to existing vegetation and the general character of these landscape features.

- With regard to the setting out and arrangement of planting this will be carried out using naturalistic planting arrangements associated with those already found in the landscape and in order to create a mosaic of habitats. For example, in wet woodland areas this may involve planting clusters of plants at wider randomised spacings. Where screening is required and a general covering of plants to integrate the scheme close planting densities of 1 plant per 2.2 square metres will be followed. Plant woodland mixes on significant cut embankments in varying widths in order that the linearity of the road is not emphasised and variety is maximised. Planting guidelines laid down by the NRA are to be referred to in this regard.
- Road verge or bank planting will consist of ‘bare root transplants’, ‘whips’ and ‘feathered trees’ which, due to their smaller stock size at time of planting, will adapt more easily to the disturbed ground and exposed site conditions. All plants are to be positioned in the locations and in the required numbers and centres indicated on the agreed planting plan.
- Existing semi-mature and mature tree groupings within the landtake area will be retained wherever practicable and protected through the erection of fencing prior to the commencement of construction works on site. The fence must remain intact for the duration of the works and will exclude any construction related activities. The fence type, installation method and location to be advised by a suitably qualified landscape architect. A suitably qualified arborist will assess the condition of the retained trees during and post construction works (and in particular will advise on the risk of windthrow, particularly where the route divides a large woodland area).
- All trees, shrubs, transplants, hedging material and ground cover planting shall be guaranteed for a period against death, deformation, die-back, or disease other than that caused by malicious damage.
- The contractor will prepare a landscape maintenance plan after the implementation of the scheme. All landscape works will be in an establishment phase for the initial three years. This will include (a) Weed and litter control including monitoring particularly during the early growing seasons of the landscape maintenance contract (b) Grass cutting and replacement of failed plants (c) Compliance with all health and safety standards in particular with regard to maintenance works during the operation phase of the road.
- Redundant sections of the disused road network will be reinstated as grassland, scrub or woodland where appropriate.
- Areas of particular significance in terms of landscape design considerations along the route, such as roundabouts shall be given a specific treatment. Individual dwellings visually impacted upon where the route passes very close to the property shall be treated, where necessary, with specific landscape measures (SLM), as appropriate to the conditions e.g. appropriate species selection e.g. evergreen, rapid establishment, height etc., if one of the above more general treatments is not suitable.

  <u>**SLM 1** Ballyvally Roundabout (Chainage 0+000 K)</u>

  This roundabout offers an opportunity to create a landscape or artistic feature at the entrance to Killaloe.

  <u>**SLM 2** No. 3B Ballyvally Gate Lodge (Killaloe Bypass, Chainage 0+000 K):</u>

  The provision of appropriate screen planting of maximum mature height of 4m to provide a balance between, aesthetics, screening and allowing light in to the property. Special design consideration must be given to this dwelling since it is a protected structure. Species to be included are: hazel (*Corylus avellana*) and holly (*Ilex aquifolium*) subject to agreement with the adjoining resident.

SLM 3 Group no. 7 (Killaloe Bypass, Chainage 0+900 K, 0+950 K & 0+980 K):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 4 Group no. 8 (Killaloe Bypass, Chainage 1+110 K, eastern slip rd. Ch 30 , 40, 60 & 80):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 5 Group No. 15 (Killaloe Bypass, Chainage 1+150 K, eastern slip rd. Chainage 30 & 70):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 6 Roundabout (on the R463 Killaloe to O'Briensbridge) Shannon Crossing Ch 0+000

This roundabout offers an opportunity to create a landscape or artistic feature.

SLM 7 Group No. 19 (Shannon Crossing, Chainage 0+040 S):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 8 No. 25 (Shannon Crossing, Chainage 0+500 S):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the property, subject to agreement with the adjoining resident.

SLM 9 No. 30 (R494 upgrade, slip rd. north Chainage 0+050):

The realignment and widening of the existing R494 will require reinstatement of garden boundary treatment. Appropriate screen planting south of the dwelling to provide a balance between, aesthetics, screening and allowing light in to the property. All works subject to agreement with the resident.

SLM 10 No. 31 (R494 upgrade, slip rd. north Chainage 0+050):

Driveway realignment will require reinstatement of garden lawn subject to agreement with the resident.

SLM 11 No. 32 (R494 upgrade, slip rd. north Chainage 0+020):

Driveway realignment and installation of retaining walls will require reinstatement of lawn and garden herbaceous border subject to agreement with the resident.

SLM 12 No. 33 (R496 upgrade, slip rd. southeast Chainage 0+020):

Driveway realignment and installation of retaining walls will require reinstatement of lawn, garden shrubs and small trees subject to agreement with the resident.

SLM 13 No. 34 (R496 upgrade, slip rd. southeast Chainage 0+040):

Installation of retaining walls will require reinstatement of lawn and garden shrubs subject to agreement with the resident.

SLM 14 No. 38 (R494 upgrade Chainage 0+040 R):

Driveway realignment and installation of retaining walls will require reinstatement of garden shrubs subject to agreement with the resident.

SLM 15 No. 39 (R494 upgrade Chainage 0+090 R):

Driveway realignment and installation of retaining walls will require reinstatement of garden hedging and shrubs subject to agreement with the resident.

SLM 16 No. 40 & No. 41 (R494 upgrade Chainage 0+050 R):

Appropriate screen planting north of the dwelling to provide a balance between, aesthetics, screening and allowing light in to the property, subject to agreement with the adjacent residents.

SLM 17 No. 43 (R494 upgrade Chainage 0+150 R):

Installation of retaining walls will require reinstatement of rear garden hedgerow subject to agreement with the resident.

SLM 18 No. 45 (R494 upgrade Chainage 0+340 R):

Driveway realignment will require reinstatement of garden lawn subject to agreement with the resident.

SLM 19 No. 47 (R494 upgrade Chainage 0+425 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden trees subject to agreement with the resident.

SLM 20 No. 49 (R494 upgrade Chainage 0+500 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden trees subject to agreement with the resident.

SLM 21 No. 52 (R494 upgrade Chainage 0+580 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden shrubs subject to agreement with the resident.

SLM 22 No. 53 (R494 upgrade Chainage 0+650 R):

The provision of appropriate indigenous semi-mature tree planting and shrub screening subject to agreement with the resident.

SLM 23 No. 54 (R494 upgrade Chainage 0+700 R):

The provision of appropriate semi-mature tree planting and shrub hedge planting subject to agreement with the resident.

SLM 24 No. 64 (R494 upgrade Chainage 2+420 R):

The provision of appropriate shrub planting subject to agreement with the resident.

SLM 25 No. 65 (R494 upgrade Chainage 2+720 R):

The provision of appropriate grass seeding and hedge planting subject to agreement with the resident.

SLM 26 No. 66 (R494 upgrade, mainline Chainage 2+700 R, slip rd. Chainage 60):

The provision of appropriate hedge planting of hawthorn (*Crategus monogyna*) and holly (*Ilex aquifolium*) subject to agreement with the resident.

SLM 27 Shannonside Business Park (R494 upgrade, mainline Chainage 2+800 R):

The provision of appropriate mixed tree and shrub planting subject to agreement with the appropriate party.

SLM 28 No. 69 (R494 upgrade, mainline Chainage 3+270 R):

The provision of appropriate semi-mature tree planting subject to agreement with the resident.

SLM 29 No. 72 (R494 upgrade, mainline Chainage 3+290 R):

The provision of appropriate shrub planting subject to agreement with the resident.

SLM 30 No. 42A Picnic Area (R494 upgrade, mainline Chainage 0+170-260):
The provision of lay-by and reinstatement of amenity area, with grassing and planting as appropriate. Path layout to be reinstated.

SLM 31 (R494 upgrade, mainline Chainage 0+625-790):
Compensatory scheme of tree planting for trees removed from woodland due to construction works.

SLM 32 No. 58 Drainage Ditch (R494 upgrade, mainline Chainage 1+720):
Protection of existing vegetation during drainage works and reinstatement compensatory planting following completion.

SLM 33 Fort Henry Estate (R494 upgrade, mainline Chainage 0+700 to 1+180 R):
Temporary acquisition of lands for stream regrading works/ channel enhancement works. Protection of existing vegetation during works and reinstatement compensatory planting along access road and pond, following completion.

SLM 34 No. 17A (Shannon Crossing, slip road north Chainage 0+025 to 0+080 S): Reinstatement of boundary walls will require replacement of garden shrubs and grassed area subject to agreement with the resident.

SLM 35 No.63 (R494 upgrade, mainline Chainage 2+380 R and 2+410 R west): Reinstatement of boundary walls, boundary hedge, garden shrubs and grassed area subject to agreement with the resident. Reinstatement of roadside shed also.

SLM 36 No. 46 (R494 upgrade Chainage 0+400 R):

The provision of appropriate indigenous semi-mature tree planting and shrub screening subject to agreement with the resident. Reinstatement of boundary walls and piers.

SLM 37 Group No. 58 (R494 upgrade Chainage 1+650 R):

Reinstatement of boundary walls, piers and garden shrub planting of dwellings 58a and 58b subject to agreement with the resident.

SLM 38 Dwelling No. 50 (R494 upgrade Chainage 0+465 R west):

Reinstatement of boundary, mature trees and garden shrub planting subject to agreement with the resident.

SLM 39 Dwelling No. 48 (R494 upgrade Chainage 0+480 R east):

Reinstatement of boundary walls, piers and garden shrub planting subject to agreement with the resident.

Specific mitigation measures are tabulated with Potential Landscape and Visual Impacts and Predicted Impacts in **Table 8.5 and Table 8.6**.

PLEASE NOTE:

1) *All planting and landscape mitigation proposals will comply with appropriate requirements for road operational safety, including planting of large trees at a safe distance from the carriageway (i.e. 8m from edge of carriageway or as required by project engineer). This may result, at detailed design stage, in the omission of some elements of the scheme described above if it is not possible to site same in a safe manner.*
2) *All planting and landscape mitigation proposals need to preserve sightlines. This may result, at detailed design stage, in the omission of some elements of the mitigation if it is not possible to site same in a safe manner.*
3) *All mitigation proposals contained herein are contingent on the acquisition of the lands in question. If, at procurement stage, it is not possible to acquire the lands, the relevant measures will be omitted.*

8.6.2 Residual Impacts

With the proposed mitigation measures, it is envisaged that the route and the environs of the route will have a high degree of absorption into the surrounding landscape. This will partly be achieved through the replacement and re-uniting of removed and severed sections of hedgerow. The proposed hedgerow planting of the boundaries of the route, will establish and integrate with the adjacent field patterns in the locality. It is anticipated that the predicted effects of the route will be absorbed after a 20-year establishment timescale.

8.7 Predicted impacts of the Scheme with Mitigation Measures

8.7.1 General

Predicted impacts are defined as the likely effects of the scheme with mitigation measures. They are assessed after a period of 1 year and 20 years – winter and summer. At this latter stage the vegetation along the route will have matured to its expected height (with some minor exceptions). The visual effects at this stage will be assessed to determine the degree of mitigation or amelioration which the landscape works will have at this point. The main and specific impacts are summarised in **Tables 8.5 and 8.6**.

8.7.2 Landscape and visual impacts

The predicted landscape impacts are generally moderate or slight due to the introduction of the proposed mitigation measures. These will reduce the potential impacts by integrating the proposed route with the surroundings. The overall landscape impact is considered to be moderate as the residual affect on the landscape character and context of the proposed site will be permanent but mitigated over time by appropriate planting and grading. The only exception includes the proposed bridge which will have a long term significant impact.

The predicted visual impacts are mitigated to a large extent by proposed woodland screen planting and native hedgerow planting but residual effects occur where the sensitive receptor is located within a very close proximity to the proposed route and the views are blocked or the visual amenity of the environment is affected. In general, the visual impacts are moderate to slight. The specific visual effects associated with the existing dwellings are described in detail in **Table 8.6**.

8.7.3 Sensitive receptors

The long term predicted effects of the route on sensitive receptors are discussed in detail below.

Existing dwellings

There are a total of 118 No. dwellings and 11 No. cluster groups within 500m of the mainline that have been assessed as part of this report. From this number 37 No. were considered to require specific mitigation planting. After a 20-year establishment period of mitigation planning, the most affected dwellings are as follows:

Dwelling group No. 15:

After woodland and shrub planting is established views to the northwest will remain intruded on by the construction of the slip road on fill but the screening of the embankments will improve the visual environment. This will reduce the overall visual impact to moderate.

Dwelling No. 32:

After the woodland planting is established views to the southwest will remain intruded upon by the construction of the roundabout, the road and bridge crossing. The approach to the bridge will be softened and its extent will be screened to reduce the overall visual impact to moderate for dwelling No. 32.

Dwelling No. 33:

After the woodland planting is established views to the northwest will remain intruded upon by the construction of the roundabout, the road and bridge crossing. The approach to the bridge will be softened and its extent will be screened to reduce the overall visual impact to moderate for dwelling No. 33.

Dwelling No. 65:

After the hedgerow planting is established views to the west will remain intruded upon by the construction of the Scheme on fill but the screening of the embankments will improve the visual environment. This will reduce the overall visual impact to moderate.

The impacts to the other dwellings identified in section 8.5.3(i) will have been reduced to slight by the establishment of mitigation planting over the course of this period.

Natural heritage areas

Lower River Shannon

After the riverbank woodland planting has established it will help screen the embankments on the approach to and from the bridge. It will also screen the abutments on both banks and integrate into the existing mature riverbank vegetation extending along the Shannon. It will not be possible to screen all of the bridge structure crossing over the River Shannon with mitigation planting however due to the artistic design of the bridge, it is considered that it will not detract from the overall visual environment at this specific location. It could be said that the proposed bridge will in fact provide a platform from which views of the surrounding scenic environment can be appreciated further.

Ballyvally Estate Boundary Trees

Once the replacement woodland planting has established around the revised boundary of Ballyvally House and over the steep embankments it will reduce the visual effects associated with the removal of much of the existing southern boundary trees by integrating the cut into the surrounding wooded areas. However; it will take longer than twenty years for the replacement planting to reach the same maturity as some of the existing trees found within the southern Ballyvally boundary.

8.8 "Do Nothing" Scenario

The do nothing impact refers to the non implementation of the scheme in its current form. The primary effect of no scheme would be that the impacts and effects as identified would not directly occur. In this regard the following issues are relevant:

(i) There is a need to bypass Killaloe town, to upgrade the R494 regional route and to add a two-way bridge crossing over the river Shannon to ease severe traffic congestion and improve road safety. The requirement for this access is comprehensively discussed in other sections of this report.

(ii) There will be a requirement for some solution to the transportation needs of the study area and interregional transport.

In the do nothing scenario, the effects to the landscape in the route corridor would not occur. In the longer term, some transportation solution would be required, which would also generate a series of landscape and visual effects. These effects are difficult to predict at this point in time but with the increasing development pressure that the towns of Killaloe and Ballina are experiencing it is likely that the available land bank will continue to decline (particularly on the lower slopes of the valley) and potential visual receptors will rise. These combined factors would certainly increase the cost of a proposed transport route but would potentially have greater negative landscape and visual effects also.

8.9 Difficulties in Compiling the Specified Information

Due to areas of dense planting and private properties whose boundary lines run right to the edge of the River Shannon, access was restricted in some areas adjacent to the proposed Shannon Bridge Crossing. No other difficulties were encountered.

8.10 Monitoring

8.10.1 Construction phase

Detailed landscape tender drawings and specifications for the works will be produced to ensure that the landscape work is implemented to the correct standard. This document will include treatment of existing vegetation, soil preparation, planting and maintenance and establishment. The contract works will be supervised by a suitably qualified landscape architect.

The initial works which will be carried out will include earth moving and the retention of mature trees along the sides of the route. All existing topsoil shall be removed and stored for later use.

The planting and seeding works will be undertaken with the completion of the various stages of the route. These areas will then enter into an establishment phase which will consist of weed control, replacement planting, pruning etc.

8.10.2 Operational phase

All landscape works will be in an establishment phase for the initial three years from planting. The company or authority responsible for the scheme will be responsible for the preparation of a management plan for the operational maintenance of the scheme which will include weed and litter control, and grass cutting.

8.11 Reinstatement

The proposed landscape development works will be in the form of grass seeding, tree and hedgerow planting. These works will be carried out by an appointed landscape contractor and will be supervised by a suitably qualified landscape architect or manager.

Table 8. 5 Summary of Potential Landscape Impacts, Proposed Remedial or Reductive Measures and Predicted Landscape Impacts (to be read in conjunction with text **Section 8.4, 8.5, 8.6,** and **8.7**)

Road Section	Landscape Classification	Potential Landscape Impact	Proposed Remedial or Reductive Measures	Predicted Landscape Impact
Subsection A: Killaloe Bypass chainage 0 – 1010 K	Begins in low lying landscape gently sloping down towards the river Shannon & surrounded by mature boundary hedgerows of Ballyvally House and predominately deciduous woodland. Land becomes elevated west of the R463 been described as upland undulating pasture with low fragmented hedgerows interspersed occasionally with mature Ash trees. The field sizes vary in size and shape. Route travels west on the urban fringe of Killaloe town and through broken linear settlement located along local roads.	Chainage 0+000 Large three arm roundabout on fill with slip roads causing a significant negative impact to the topography and local road alignment with associated localised mature tree and young wet woodland loss. Between chainage 0+040 K & chainage 0+320 K the Scheme crosses demesne lands and boundaries in significant cut, causing a significant negative topographical impact and loss in mature tree hedgerows listed in the county development plan to be protected. Small deciduous woodland to be removed at chainage 0+400 K results in a slight impact negative to existing vegetation. chainage 0+450 K - chainage 1+010 K: moderate negative impact on topography and landscape character though penetration of hedgerow boundaries and field severance. Route on a slight fill for the most part although becomes elevated briefly on a slight fill between chainage 0+680 K and chainage 0+720 K.	Specific shrub screening measures to front of properties within close proximity to the Scheme. Plant the Scheme and slip road boundaries with hedgerow containing tree and shrub species to replace those lost and to integrate road with retained Ballyvally hedgerow species. Plant general and wet woodland mix to the rear of the roadside hedgerow on fill and significant cut embankments. On passing through pastureland in slight fill or cut, plant fencelines with tree and hedgerow species indigenous to the area. Appropriate grass mix on slight cut and fill slopes. Plant side access road chainage 0+000 – chainage 0+110 K with indigenous hedgerow species to prevent headlight glare. Plant eastern side of road chainage 0+900 – 1+000 K with screen woodland mix to screen rear views into 3 no. dwellings.	The planting of deep cut slopes with a woodland mix will integrate them back into the wooded landscape. However; a moderate, negative, permanent impact will be the resulting effect due to the significant contrast in the levels of the Scheme and the surrounding existing landscape. A minimum requirement for this section is that an equal or greater area of proposed tree planting will replace the area of woodland removed. Slight permanent negative impact despite the planting of hedgerows to re-establish the severed field boundary hedgerows.

Road Section	Landscape Classification	Potential Landscape Impact	Proposed Remedial or Reductive Measures	Predicted Landscape Impact
Subsection B: Killaloe Bypass Chainage 1+010 K – 2+028 K	Generally elevated undulating pastures with dense hedgerows however the landscape falls in a south-easterly direction towards the Shannon river. Some fields exhibit intensive farm management practices where internal hedgerows have been removed to create larger field sizes. A number of third class roads (Hill and Shantraud) and a regional road (R463) radiate form Killaloe through the fields. Scattered linear settlement can be found along this road network. The most southerly end of this section contains pockets of low lying coniferous woodland and scrubland adjacent to the Ballyteige river dispersed throughout pastureland with high dense hedgerows.	Chainage 1+010 K – 1+760 K: moderate negative impact on topography and landscape character though penetration of hedgerow boundaries and field severance. Route typically fluctuates between been on a slight fill or in a slight cut. Construction of slip roads to realign disconnected third class road network as T-junctions with the Scheme, generates moderate negative impact on topography and field patterns. Locations of new slip roads with the Scheme are; at chainage 1+050 K west, at chainage 1+150 K east, at chainage 1+440 K west and at Chainage 1+480 K east. A small area of commercial coniferous forestry will be removed between chainage 1+760 K – chainage 1+850 K will result in a slight negative impact. Scrub and wetland trees located between chainage 1+850 K and chainage 2+028 K will be removed and the Scheme raised on fill will have a moderate negative impact. Construction of roundabout with the R463 and associated slip roads at chainage 2+028 K will have a moderate negative impact to the topography of the area, with localised loss of field hedgerow boundaries and scrubland/ wet pasture.	Plant side access road east of Scheme, chainage 0+110 K– chainage 0+220 K with indigenous tree and hedgerow species to prevent headlight glare. On passing through pastureland on slight fill or cut, plant fencelines with tree and hedgerow species indigenous to the area. Appropriate grass mix on slight cut and fill slopes. Plant screen woodland mix to front of 3no. dwellings west of side access road chainage 0+0160 K - chainage 0+269 K Plant appropriate woodland mix to side slopes of Scheme to reduce impact on topography and achieve integration with adjacent local vegetation.	Slight permanent positive impact due to increased / reintroduction of hedgerows planting where intensive farm practices have previously caused their removal. Slight permanent negative impact as the change to landscape topography will be integrated into the existing landscape pattern through the addition of the proposed planting measures.

Road Section	**Landscape Classification**	**Potential Landscape Impact**	**Proposed Remedial or Reductive Measures**	**Predicted Landscape Impact**
Subsection C: Shannon Crossing Chainage 0 – 0+860 S	Gently eastwardly sloping confluence of urban and agricultural landscape on the southern edge of Killaloe town. Settlement in the area could be described as individual linear dwellings along the local road network and river Shannon although a small clustered settlement is located at chainage 0+040 S. Mature deciduous hedgerows are located along the boundaries of the fields, large private gardens, canal line and riverbanks. A small cluster of coniferous woodland is located within the pasture also. Specimen mature trees can be found within the Clarisford Demesne. The mature hedgerows consist mainly of Beech, Ash and Oak. The river Shannon is the principal shaping element in this landscape.	Chainage 0+120 – 0+400 S: moderate negative impact on landscape character though penetration of original Beech Clarisford boundary hedgerow and field severance by the road on fill up to a max. height of 3m. Removal of a section of mixed mature woodland at chainage 0+270-440 S and crossing a local road at chainage 0+400 S is deemed moderately negative on the landscape character. Removal of area of mature trees and wet woodland along the east and west riverbank has a moderate negative impact. Spanning the canal and Shannon River with a major bridge structure (Chainage0+630 S – 0+820 S) results in a profound impact since it will cause a very intensive change over a limited area to the landscape character.	Plant screen woodland mix to front residential development north of chainage 0+000 S - chainage 0+120 S On passing through pastureland on slight fill or cut, plant fencelines with tree and hedgerow species indigenous to the area. Appropriate grass mix on slight cut and fill slopes. Plant appropriate woodland mix to side slopes of the Scheme to reduce impact on topography and achieve integration with adjacent local wooded areas and mature hedgerows. Plant screen woodland mix to southern boundary of dwellings Chainage 4+400 S - Chainage 6+400 S and Chainage 0+800 S - Chainage 0+860 S Plant screen woodland mix to northern boundary of dwellings 0+800 S - chainage 0+860 S	Slight permanent negative impact despite the planting of hedgerows and trees to re-establish the severed field boundary and riverbank hedgerows. The infill planting of an appropriate woodland mix will integrate the Scheme back into the wooded landscape. However; a slight, negative, permanent impact will be the resulting effect. A minimum requirement for this section is that an equal or greater area of proposed tree planting will replace the area of woodland removed. Significant permanent negative impact despite the appropriate woodland planting of disturbed ground and fill embankments surrounding the bridge abutments to integrate the structure into the existing riverbank vegetation. The sensitively designed chosen bridge structure will also help minimise its landscape impact.

Road Section	Landscape Classification	Potential Landscape Impact	Proposed Remedial or Reductive Measures	Predicted Landscape Impact
Subsection D: R494 Upgrade Chainage 0 – 1+265 R	Westwardly sloping confluence of urban and agricultural landscape on the southern edge of Ballina town. Individual linear dwellings flank the regional road network. The outward views from the R494 are mostly limited to tall roadside hedgerows, roadside dwellings and their front gardens. The roadside tree canopies at irregular intervals touch to form a small scale and enclosed spaces. Westward views of the River Shannon are rare. Medium sized irregular shaped fields are bordered by semi-mature hedgerows of predominately Ash. Small streams, drains and clusters of coniferous planting fronted with deciduous hedgerows are dispersed throughout this section.	Generally this section of the Scheme has a moderate negative impact on existing vegetation in the vicinity of the R494 as it involves the removal of sections of deciduous semi-mature hedgerows bordering pasture and coniferous plantations. The removal of mature specimen trees along the roadside and within private front gardens will cause a significantly negative landscape impact. The edges of commercial coniferous forestry (not deemed to be important in terms of landscape character) penetrated results in a slight negative landscape impact.	Reinstate garden vegetation lost due to realignment of the and private driveways (i.e. specific landscape measures as agreed with local residents). Plant the Scheme and slip road boundaries with hedgerow containing tree and shrub species indigenous to area to replace those lost and integrate road with retained hedgerows. Plant proposed woodland planting mixes including wetland woodland mix, scrub, general and grassland as appropriate on fill and cut embankments.	Slight permanent neutral impact through the planting of hedgerows and woodland mixes to re-establish the severed field boundaries and wooded areas. Moderate permanent negative impact through the planting of replacement specimen trees.

Road Section	Landscape Classification	Potential Landscape Impact	Proposed Remedial or Reductive Measures	Predicted Landscape Impact
Subsection E: R494 Upgrade Chainage1+265 R– 8+640 R	Individual linear settlement along the regional road network with the occasional scattered farmhouse and light industrial development. The topography slopes from high to low from east to west however; the nearer the R445 is, the less pronounced this topographical difference is. Medium to large sized irregular shaped fields are bordered by semi-mature hedgerows of predominately Ash, Willow, Hawthorn and Sycamore. Large coniferous plantings are dispersed throughout and are fronted by deciduous hedgerows. Views are restricted by the roadside hedges which are clipped at the sides but allowed grow in height. The Kilmastulla River and some small streams flow westward to meet the Shannon river.	The edges of commercial coniferous forestry (not deemed to be important in terms of landscape character) penetrated results in a slight negative landscape impact. Chainage 2+640 R – 3+250 R construction of the Scheme and side access roads on fill (reaching a max. height of 7m) generates a significant negative topographical impact. Kilmastulla river crossing at chainage2+630 R will remove a area of existing riparian vegetation and will result in a moderate landscape impact. A moderate negative impact is caused on the existing vegetation in the vicinity of the existing R494 as it involves the removal of long sections of deciduous semi-mature hedgerows bordering pasture and coniferous plantations. The removal of mature specimen trees along the roadside and within private front gardens will cause a significantly negative landscape impact.	Reinstate garden vegetation lost due to realignment of the Scheme and private driveways (i.e. specific landscape measures as agreed with local residents / landowner). Plant the Scheme and slip road boundaries with hedgerow containing tree and shrub species indigenous to area to replace those lost and integrate road with retained hedgerows. Plant proposed woodland planting mixes including wetland woodland mix, scrub, general and grassland as appropriate on fill and cut embankments. Sensitive grading of side slopes to achieve integration with local topography.	Neutral, slight, permanent impact through the planting of hedgerows and woodland mixes to re-establish the severed field boundaries, wooded areas and riparian vegetation. Moderate permanent negative impact through the planting of replacement specimen trees.

Table 8.6 Visual Impact Assessment – Potential impact, Mitigation and Predicted Impact
(to be read in conjunction with text section 8.4, 8.5, 8.6 and 8.7)

Ref No.	Building Type & Location	Nearest Chainage	Approx. distance from centre line	Type of view (assessed from the front of the property, except where indicated)	Components of view (main view from the front of property described, except where indicated)	Description of potential impact	Mitigation (see section 1.6)	Predicted Impact		
								Year 1	Year 20 (winter)	Year 20 (summer)
1	Large cluster of dwellings in Ballina town	NA	>500m	Distant front, side and rear views to the Scheme	The primary view for most on the lower slopes is west with the river in the foreground, housing, woodland and elevated rural fields on the valley opposite in the middle ground. Many houses do have long distance views of the valley opposite but rather shortened views of adjacent houses and trees.	M.I. during construction, thereafter M.I	NA	M.I.	S.I.	S.I.
2	Cluster of dwellings on the R463, Killaloe	NA	>120m north of realigned R463 slip road to Ogonnelloe	NA	Generally eastward views of Lough Derg, the R463, mature trees and hedgerows.	N.I.	N/A	N.I.	N.I.	N.I.
3a & 3b	2no. dwellings (Ballyvally House & Lodge)	House: Bypass Chainage 0+100 K Lodge: Bypass Chainage 0+0 00 K	House:180m Lodge: 25m	Side views to the Scheme Direct to roundabout and slip roads	North eastward views of mature trees, parkland and hedgerows. Eastward views of mature tree planting and woodland on the opposite side of the road.	M.I. during construction, thereafter S.I Sig.I. during construction, thereafter M.I	M4 H1 SLM H1	S.I. M.I.	I.I. S.I.	I.I. S.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigat-ion** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
4	3no. dwellings, Killaloe	Chainage 0+330 K Chainage 0+340 K Chainage 0+400 K	72m 78m 65m	Rear & side Rear Rear & side	Rear and side views of woodland & mature trees boundary trees of Ballyvally House.	Sig.I. during construction, thereafter M.I	M4	M.I.	S.I.	S.I.
5	Large cluster of dwellings in Killaloe town	NA	>200m	Distant front, side and rear views to the Scheme	Majority of views within town are of adjacent buildings of are in a NE direction of Shannon and valley opposite.	S.I. during construction, thereafter I.I	NA	I.I.	I.I.	I.I.
6	Cluster of dwellings Killaloe	From Bypass Chainage 0+300 K to Chainage 0+850 K	Between >100m and <200m	Rear and side views to the Scheme screened by existing vegetation & topographical effects.	Majority of front views in a NE direction of adjacent dwellings, fronting roads, garden vegetation, woodland with Ballina town and agricultural farmland in the background.	M.I. during construction, thereafter S.I	M4 H2	S.I.	I.I.	I.I.
7	4no. dwellings, Killaloe	Bypass Chainage0 + 920 K Chainage 0+960 K Chainage 0+980 K Chainage 0+985 K	58m 55m 85m 123m	Rear & side Rear & side Rear view Rear view	Rear and side views of boundary field hedgerows and pasture	M.I during construction, thereafter M.I M.I during construction, thereafter M.I S.I during construction, thereafter I.I I.I during construction, thereafter I.I	M3 H2 G2	M.I. M.I. I.I. I.I.	S.I. S.I. I.I. I.I.	S.I. S.I. I.I. I.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigat-ion** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
8	4no. dwellings on Hill rd	All located at Bypass Chainage1 +100 K Slip rd Chainage0 +020 Chainage0 +030 Chainage0 +055 Chainage0 +080	37m 31m 31m 35m	Side screened view to the Scheme and direct to slip road on fill Direct to slip road on fill	South and eastward views of Hill rd to front of property, roadside hedge and pasture. Southward views of Hill rd to front of houses, roadside hedges and pasture.	Sig.I during construction, thereafter M.I Sig.I during construction, thereafter M.I M.I during construction, thereafter M.I M.I during construction, thereafter S.I	M3 H2 G2	M.I. M.I. M.I. M.I.	S.I. S.I. S.I. S.I.	S.I. S.I. S.I. S.I.
9	5no. dwellings on Hill rd	All located at Bypass Chainage1 +100 K	>100m	Direct	Foreground southward views of coniferous garden hedging or deciduous roadside hedgerows screen outward views.	M.I during construction, thereafter S.I M.I during construction, thereafter S.I S.I during construction, thereafter I.I S.I during construction, thereafter I.I N.I during construction, thereafter N.I	N/A	S.I. S.I. I.I. I.I. N.I.	I.I. I.I. I.I. I.I. N.I.	I.I. I.I. I.I. I.I. N.I.
10	1no. dwelling	Bypass Chainage1 +245 K	>250m	Rear	North-eastward view to third class road and mature boundary conifers. Rear windows views of the surrounding fields.	M.I during construction, thereafter S.I	H2 G2	S.I.	I.I.	I.I.

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Ref No.	Building Type & Location	Nearest Chainage	Approx. distance from centre line	Type of view (assessed from the front of the property, except where indicated)	Components of view (main view from the front of property described, except where indicated)	Description of potential impact	Mitigation (see section 1.6)	Predicted Impact		
								Year 1	Year 20 (winter)	Year 20 (summer)
11	7no. dwellings on Hill rd	All located at Bypass Chainage1 +140 K	>125m - <290m	Direct & side	Garden vegetation and field hedgerows bounding the surrounding pasture.	S.I. (front oblique) during construction, I.I. thereafter S.I. (front oblique) during construction, I.I. thereafter M.I. (front oblique) during construction, S.I. thereafter S.I. during construction, I.I. thereafter S.I. during construction, I.I. thereafter S.I. during construction, I.I. thereafter N.I during construction, thereafter N.I	H2 G2	S.I. S.I. S.I. S.I. S.I. N.I.	I.I. I.I. I.I. I.I. I.I. N.I.	I.I. I.I. I.I. I.I. I.I. N.I.
12	2no. dwellings on Hill rd	Bypass Chainage0 + 880 K	>345m	Side	Both surrounded by mature hedgerows, which is the major component of their views outwards.	I.I during construction, thereafter N.I	N/A	I.I.	I.I.	N.I.
13	A small cluster of farmhouses and sheds	Bypass Chainage 0+880 K	>650m	Side	Main views are screened by mature boundary trees and hedgerows.	N.I during construction, thereafter N.I	N/A	N.I.	N.I.	N.I.
14	7no. dwellings on Shantraud Road	Bypass Chainage 1+460 K	>125m	Direct & side	5no. dwellings are located to the north of the road facing south with foreground views of garden vegetation, commercial sheds, 2m high dashed walls and adjacent houses. 2no. dwellings south of the road have north westerly views of a house opposite, mature trees, the road, agricultural lands and field hedgerows.	S.I. during construction, S.I. thereafter	M3	S.I.	I.I.	I.I.

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigation** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
15	3no. dwellings on Shantraud rd	Bypass Chainage 1+540 K	25m 60m 90m Slip rd Chainage 40 Chainage 70 Chainage 90	Direct & side	Front, rear and side views of adjacent dwellings, garden vegetation and field hedgerows bounding the surrounding pasture.	Sig.I during construction, thereafter Sig.I	SLM M3	Sig.I.	M.I.	M.I.
16	A cluster of dwellings on Shantraud rd	Bypass Chainage 1+500 K	>295m to the Scheme >100m to slip rd	Direct & side	The outward views of 2no. dwellings are screened by evergreen hedgerows and mature boundary trees. One of the houses has a easterly view of the adjacent agricultural fields and hedgerows from a small second level window. Majority of the remaining dwellings face in a southerly direction. Their main views are of the road, fields and hedgerows.	N.I during construction, thereafter N.I	N/A	N.I.	N.I.	N.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigat-ion** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
17	3no. dwellings on the R463	Bypass Chainage 2+020 K	80m 125m 155m	Oblique & side	Primary views are of a residential development opposite and a mature treeline. One dwelling also has a screened side view of low lying pasture and mature field hedgerows to the south west.	M.I. during construction, S.I. thereafter S.I. during construction, I.I. thereafter S.I. during construction, I.I. thereafter	M5 M3	S.I. I.I. I.I.	I.I. I.I. I.I.	I.I. I.I. I.I.
18	3no. dwellings on the R463	Bridge Crossing Chainage 0+050 S	>180	Direct & side	North westerly views of the R463, roadside hedgerows, adjacent houses, scrubland and agricultural fields.	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
19	Residential dev on the R463	Bridge Crossing Chainage 0+050 S	50m	Direct, rear & side	Outward views of mature trees, adjacent houses, low hedgerow and warehouse site.	Sig.I. during construction, M.I. thereafter	M3	M.I.	S.I.	S.I.
20	4no. dwellings on the R463	Bridge Crossing Chainage 0+000 S	>100m	Side	The primary front views are short distant and are of houses opposite, boundary roadside hedgerows, fields and scrubland. Indirect views of proposed compound area.	M.I. during construction, I.I. thereafter	M5 M4 M3	M.I.	I.I.	I.I.
21	2no. dwellings and sheds on the R463	Bypass Chainage 1+980 K	>300m	Direct & side	Outward front views of mature trees, fields and hedgerows. Rear views are of a coniferous woodland.	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.

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Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigation** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
22	2no. dwellings on the R463	Bypass Chainage 1+980 K	>500m	Direct & side	South east front views of adjacent fields and hedgerows.	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
23	Clarisford House	Bridge Crossing Chainage 0+390 S	190m	Direct & side	Outward front view of mature parkland setting.	M.I. at construction, S.I thereafter.	H1 M4	S.I.	I.I.	I.I.
24	1no. dwelling, Moys	Bridge Crossing Chainage 0+450 S	50m	Direct, side & rear	Outward front view of mature parkland setting.	M.I. at construction, S.I thereafter.	H1 M4	S.I.	I.I.	I.I.
25	1no. dwelling, Moys	Bridge Crossing Chainage0 + 530 S	40m	Oblique, side & rear	Mature trees, roadside hedgerow and fronting third class road.	Sig.I. at construction, M.I thereafter.	SLM M3	M.I.	S.I.	S.I.
26	9no. dwellings, Moys	Bridge Crossing Chainage 0+500 S	>60m	Side & rear	Mature garden vegetation, roadside hedgerow school buildings and sports pitches.	S.I. at construction, I.I thereafter.	NA	N.I.	N.I.	N.I.
27	Secondary level School, Coláiste Phobal Naomh Áine	Bridge Crossing Chainage 0+420 S	>250m	Side & rear	Wooded area, adjacent dwellings, roadside hedgerow and sports pitches.	S.I. at construction, S.I thereafter.	SLM M4	S.I.	I.I.	I.I.

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								Year 1	Year 20 (winter)	Year 20 (summer)
28	A cluster of dwellings on R494	R494 upgrade Chainage0 + 420 R	>200m	Side	The majority of the houses front onto a road and have prominent foreground views of nearby properties and mature trees.	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
29	1no. dwelling on R494	R494 upgrade Chainage 0+000 R Northern slip rd. Chainage 0+110	100m	Oblique rear	Front view of nearby properties and mature garden vegetation. Rear view of Shannon river, mature trees on opposing bank and garden hedgerows.	M.I during construction, thereafter S.I	M3	S.I.	I.I.	I.I.
30	1no. dwelling on R494	R494 upgrade Chainage0 +0 00 R Northern slip rd. Chainage 0+050	45m 13m	Direct front, side and oblique rear	Front view of tall coniferous garden hedge. Rear view of Shannon river, mature trees on opposing bank and garden hedgerows. Side view of hedgerow, wet woodland and neglected plot.	Sig.I during construction, thereafter M.I.	SLM M3 M4	M.I.	S.I.	S.I.
31	1no. dwelling on R494	R494 upgrade Chainage 0+000 R Northern slip rd. Chainage0 +050	74m 30m	Direct to slip road	Front view of tall coniferous garden vegetation, a low stone wall and the R494.	M.I during construction, thereafter S.I	SLM M3 M4	S.I.	I.I.	I.I.

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Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigat-ion** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
32	1no. dwelling on R494	R494 upgrade Chainage 0+000 R Northern slip rd. Chainage 0+020	55m	Direct to the Scheme	Front view of tall coniferous garden vegetation, a tall roadside Ash hedgerow and the R494.	Sig.I during construction, thereafter M.I.	SLM M3 M4	M.I.	M.I.	M.I.
33	1no. dwelling on R494	R494 upgrade Chainage 0+000 R	47m	Direct to the Scheme	Front view of a tall roadside Ash hedgerow, adjacent dwellings and the R494.	Sig.I during construction, thereafter M.I.	SLM M3 M4	M.I.	M.I.	M.I.
34	1no. dwelling on R494	R494 upgrade Chainage 0+025 R South eastern slip rd. (R496) Chainage0 +040	73m 32m	Direct to slip road	Garden vegetation, the R496, a small grassed open space and the rear of an adjacent single storey house.	M.I during construction, thereafter S.I	SLM M3 M4	M.I.	S.I.	S.I.
35	1no. dwelling on R496	R494 upgrade Chainage 0+025 South eastern slip rd. (R496) Chainage 0+040	103m 62m	Direct to slip road	Garden vegetation, the R496, and the rear of adjacent houses.	S.I during construction, thereafter I.I	NA	I.I	I.I	I.I

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								Year 1	Year 20 (winter)	Year 20 (summer)
36	1no. dwelling on R496	R494 upgrade Chainage 0+060 R	116m	Direct	Garden vegetation, the R496, and the rear of adjacent houses.	S.I during construction, thereafter I.I	NA	I.I	I.I	I.I
37	A cluster of dwellings on R496	R494 upgrade Chainage 0+100 R	>200m	Direct & side	The majority of the houses front onto the regional road and have prominent foreground views of nearby properties and mature tree cover.	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
38	1no. dwelling on R494	R494 upgrade Chainage 0+040 R	19m	Direct	A house on the opposing side of the road, the R494 and garden vegetation.	Sig.I during construction, thereafter M.I.	M3 M4	M.I.	S.I.	I.I.
39	1no. dwelling on R494	R494 upgrade Chainage 0+090 R	30m	Direct	Adjacent dwellings, the R494 and garden vegetation.	M.I during construction, thereafter S.I.	SLM	S.I.	I.I.	I.I.
40	2no. dwelling on R494	R494 upgrade Chainage 0+040 R Chainage 0+080 R	20m	Direct	Adjacent dwellings, the R494 and garden vegetation.	M.I during construction, thereafter S.I.	M3 M4	S.I.	I.I.	I.I.
41	1no. dwelling on R494	R494 upgrade Chainage 0+040 R	47m	Oblique rear	Garden vegetation, mature trees and the Shannon river.	Sig.I during construction, thereafter M.I.	M3 M4	M.I.	S.I.	S.I.
42	1no. dwelling (Inis Lua)	R494 upgrade Chainage 0+125 R	26m	Direct	Mature garden vegetation, mature trees and the Shannon river to west.	M.I during construction, thereafter S.I.	M4	S.I.	I.I.	I.I.

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								Year 1	Year 20 (winter)	Year 20 (summer)
43	1no. dwelling on R494	R494 upgrade Chainage 0+150 R	44m	Rear	Mature garden vegetation	M.I during construction, thereafter S.I.	SLM	S.I.	I.I.	I.I.
44	2no. dwellings (Journey's end & Friar's Hill)	R494 upgrade Chainage 0+230 R Chainage 0+270 R	45m 47m	Direct	Mature garden vegetation, boundary walls and roadside hedgerow on the opposing side of R494	S.I. at construction, I.I thereafter.	NA	I.I.	N.I.	N.I.
45	1no. dwelling on R494	R494 upgrade Chainage 0+340 R	50m	Direct	Lawn, a low boundary wall and semi-mature roadside hedgerow on the opposing side of the road.	Sig.I during construction, thereafter M.I.	SLM	M.I.	S.I.	I.I.
46	1no. dwelling (Molua)	R494 upgrade Chainage 0+370 R	39m	Direct	Front view is of specimen mature trees within its front garden, the R494 and a coniferous hedgerow opposite.	Sig.I during construction, thereafter M.I.	SLM	M.I.	S.I.	S.I.
47	1no. dwelling on R494	R494 upgrade Chainage 0+425 R	60m	Direct	Specimen mature deciduous and coniferous trees	Sig.I during construction, thereafter M.I.	SLM	M.I.	S.I.	S.I.
48	1no. dwelling on R494	R494 upgrade Chainage 0+460 R	42m	Direct	Mature roadside hedgerow on the opposite side of the R494	Sig.I during construction, thereafter S.I.	SLM	M.I.	S.I.	I.I.

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								Year 1	Year 20 (winter)	Year 20 (summer)
49	1no. dwelling on R494	R494 upgrade Chainage 0+500 R	51m	Direct	Mature garden trees and a partial view of the roadside hedgerow on the opposite side of the R494	Sig.I during construction, thereafter M.I.	SLM	M.I.	S.I.	S.I.
50	1no. dwelling on R494	R494 upgrade Chainage 0+475 R	30m	Direct	Mature garden trees, roadside hedgerow and the R494	Sig.I during construction, thereafter M.I.	SLM	M.I.	I.I.	I.I.
51	1no. dwelling on R494	R494 upgrade Chainage0 + 540 R	28m	Direct	Garden vegetation and a mature roadside hedgerow on the opposing side of R494.	M.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.
52	1no. dwelling on R494	R494 upgrade Chainage0 + 580 R	34m	Direct	Garden vegetation, the R494 and glimpses of the river Shannon through mature roadside vegetation on the opposing side of the road	M.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.
53	1no. dwelling & stables (White Oaks)	R494 upgrade Chainage 0+650 R	36m	Direct	Mature specimen garden trees, lawn, the R494 and adjacent avenue	Sig.I during construction, thereafter Sig.I.	SLM	Sig.I.	S.I.	S.I.
54	1no. dwelling on R494	R494 upgrade Chainage 0+700 R	74m	Direct	Mature roadside hedgerow and garden trees	M.I during construction, thereafter M.I.	SLM	M.I.	S.I.	I.I.

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Ref No.	Building Type & Location	Nearest Chainage	Approx. distance from centre line	Type of view (assessed from the front of the property, except where indicated)	Components of view (main view from the front of property described, except where indicated)	Description of potential impact	Mitigation (see section 1.6)	Predicted Impact		
								Year 1	Year 20 (winter)	Year 20 (summer)
55	1no. dwelling on R494	R494 upgrade Chainage 0+790 R	34m	Direct	Mature roadside hedgerow on the opposing side of the road, lawn and garden vegetation	S.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.
56	1no. dwelling (Ardglas) & sheds	R494 upgrade Chainage 1+100 R	>300m	NA	Pasture and boundary hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
57	1no. dwelling & sheds	R494 upgrade Chainage 1+330 R	95m	Direct	Pasture and boundary hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
58	3no. dwellings	R494 upgrade Chainage 1+640 R Chainage 1+680 R Chainage 1+740 R	29m 32m 45m	Direct	Garden vegetation, low boundary walls and semi-mature roadside hedgerow on the opposing side of the road	Sig.I during construction, thereafter S.I.	H1 SLM M5	M.I.	S.I.	I.I.
59	3no. dwellings	R494 upgrade Chainage 1+760 R Chainage 1+790 R Chainage 1+830 R	36m 38m 38m	Direct	Garden vegetation, low boundary walls or fences and semi-mature roadside hedgerow on the opposing side of the road	S.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.
60	1no. dwelling	R494 upgrade Chainage 1+910 R	38m	Direct	A managed two metre high roadside hedgerow and the R494.	S.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigat-ion** (see section 1.6)	**Predicted Impact**		
								Year 1	Year 20 (winter)	Year 20 (summer)
61	2no. dwellings	R494 upgrade Chainage 2+020 R Chainage 2+110 R	41m 31m	Direct	Garden vegetation, low boundary walls, mature trees and semi-mature roadside hedgerow on the opposing side of the road	S.I during construction, thereafter S.I.	H1	S.I.	I.I.	I.I.
62	2no. dwellings & sheds	R494 upgrade Chainage 2+300	102m 198m	Side & oblique direct	Pasture, adjacent outhouses and boundary hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
63	1no. dwelling & sheds	R494 upgrade Chainage 2390	10m	Direct	Low boundary garden wall, R494 and semi-mature roadside hedgerow on the opposing side of the road	Sig.I during construction, thereafter S.I.	H1 SLM	M.I.	I.I.	I.I.
64	1no. dwelling	R494 upgrade Chainage 2+420 R	18m	Direct	Low boundary wall, garden shrubs and agricultural sheds on the opposing side of the road	M.I during construction, thereafter S.I.	SLM	S.I.	I.I.	I.I.
65	1no. dwelling	R494 upgrade Chainage 2+720 R	50m	Direct	Low boundary wall, lawn, mature roadside hedgerow and houses on the opposing side of the road.	Sig.I during construction, thereafter M.I.	SLM M4	Sig.I.	M.I.	S.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	Building Type & Location	Nearest Chainage	Approx. distance from centre line	Type of view (assessed from the front of the property, except where indicated)	Components of view (main view from the front of property described, except where indicated)	Description of potential impact	Mitigation (see section 1.6)	Predicted Impact		
								Year 1	Year 20 (winter)	Year 20 (summer)
66	1no. dwelling	R494 upgrade Chainage 2 700 R Slip rd. Chainage 0+060	32m 8m	Direct	Low boundary wall, garden shrubs, mature roadside hedgerow and a house on the opposing side of the road	Sig.I during construction, thereafter Sig.I	SLM M4	Sig.I.	S.I.	I.I.
67	1no. dwelling	R494 upgrade Chainage 2+755 R	50m	Direct	Low boundary wall, low roadside hedgerow and tall evergreen hedges on the opposing side of the road.	M.I during construction, thereafter M.I.	M4	M.I.	S.I.	I.I.
68	2no. dwellings	R494 upgrade Chainage 2+800 R Chainage 2+890 R	41m 50m	Direct	Low boundary walls, garden shrubs, tall roadside fencing and warehouses on the opposing side of the road.	M.I during construction, thereafter M.I.	M4	M.I.	S.I.	I.I.
69	1no. dwelling & sheds	R494 upgrade Chainage 3+270 R	38m	Direct	Low boundary walls, mature coniferous garden trees and a low hedgerow on the opposing side of the road.	Sig.I during construction, thereafter Sig.I.	SLM	Sig.I.	S.I.	S.I.
70	1no. dwelling	R494 upgrade Chainage 3+300 R	22m	Direct	Low boundary walls, mature garden trees and a house on the opposing side of the road.	M.I during construction, thereafter S.I.	NA	S.I.	I.I.	I.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Ref No.	**Building Type & Location**	**Nearest Chainage**	**Approx. distance from centre line**	**Type of view** (assessed from the front of the property, except where indicated)	**Components of view** (main view from the front of property described, except where indicated)	**Description of potential impact**	**Mitigation** (see section 1.6)	Predicted Impact		
								Year 1	Year 20 (winter)	Year 20 (summer)
71	1no. dwelling	R494 upgrade Chainage 3+260 R	45m	Direct	Low boundary walls, wooden fencing, garden vegetation, mature coniferous trees and a house on the opposing side of the road.	S.I during construction, thereafter S.I.	S1 H1	S.I.	I.I.	I.I.
72	1no. dwelling	R494 upgrade Chainage 3+280 R	42m	Direct	Low boundary walls, garden vegetation, mature trees and a house on the opposing side of the road.	M.I during construction, thereafter S.I.	SLM	S.I.	I.I.	I.I.
73	2no. dwellings and sheds on the R445	NA	>150m	NA	N7, pasture and field hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
74	Cluster of dwellings on the R445 in Birdhill	NA	>390	NA	R445, adjacent buildings, pasture and field hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
75	Cluster of dwellings on the R445	NA	>450m	NA	R445, adjacent buildings, pasture and field hedgerows	N.I during construction, thereafter N.I	NA	N.I.	N.I.	N.I.
76	Picnic area on R494	R494 upgrade Ch. 170-260	Open space adjacent to PR	Direct	Mature vegetation, mature trees and the Shannon river to west.	M.I during construction, thereafter S.I.	SLM	M.I.	I.I.	I.I.

N.I. – No impact **I.I**. – Imperceptible Impact **S.I**. – Slight Impact **M.I**. – Moderate Impact **Sig.I**. – Significant Impact

Chapter 9

Material Assets

Chapter 9 Material Assets

9.1 Introduction

This section of the EIS discusses the impact of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement on Material Assets, which are Property and Land Use.

A road construction scheme may affect assets if it involves any of the following:

- Acquisition of land;
- Demolition of buildings;
- Revaluation of or change in the development potential of adjoining lands / properties.

The principal land use within the scheme is agriculture. Construction of the proposed scheme will require the acquisition of mainly agricultural land and residential, properties, as detailed in the sections below.

The area to be acquired from agricultural production is approximately 12.88 Ha.

The proposed road will directly impact on 21 agricultural land holdings by either severing them or reducing the area of the farm.

9.2 Methodology

An assessment of the existing agricultural environment was carried out through the completion of detailed farm surveys. The surveys assessed how the proposed road would impact on the current farming activities carried out on the land affected by the proposed route and what mitigation measures would be necessary to alleviate negative impact.

9.2.1 Impact

Impact is the overall effect of a road on a farm holding. The degree to which a new road impacts upon an individual farm depends on:

- Land take;
- The degree of severance;
- The type of farm enterprises carried out;
- Farm size;
- Impact on farm buildings and/or facilities;
- Impact on shelter.

The significance of effects of the proposed road on farms is assessed using the criteria presented in **Tables 9.1** and **9.2** which are based on:

- Advice notes on current practice in the preparation of Environmental Impact Statements (EPA, 2003); and
- Guidelines on the information to be contained in Environmental Impact Statements (EPA, 2004).

The criteria that define the corresponding impacts for this chapter were prepared by Philip Farrelly & Partners.

Landtake

Individual Fields

In general the larger the field size the more useful the field. This is particularly because of the ease of use of machinery in larger fields. Reduction in the field size results in increased costs.

Farm Holdings

Land take is one of the main impacts on a farm. The degree of the impact varies with the area of the land taken and the quality of the land taken. The impact of the loss of land on a particular farm is complex. Increasing production levels elsewhere can compensate for the loss of land. Furthermore land can be purchased or rented to replace land lost. However this land may not be adjacent to existing land and increased costs can result.

The location of the land taken is also a factor. For example land take on the main land parcel will have a greater impact on a fragmented farm holding than a land parcel which is removed from the main land parcel or has no farm buildings. Also in the case of a dairy farmer, taking land laid out as paddocks adjacent to a milking parlour would have a larger impact than taking land located on an outfarm.

The size of the farm affected is also of interest. In general, land take on a smaller farm would have a greater impact.

Intensity of Land Use

Farming systems can vary with regard to the intensity of use to which the land is put. In general the impact will be greater on more intensively farmed lands. This would often be the case on dairy farms and beef farms with high stocking rates.

Severance

General

Severance of a land parcel occurs when a road alignment splits a field or land parcel into two or more pieces. This results in the fragmentation of the farm into a greater number of management units. Severance is important because it affects the future management of the remaining land, which is not taken for the road scheme. It extends the impact of the road scheme outside the footprint of the actual land take. Severance is a significant residual agricultural impact of a road scheme. Access may involve a considerable distance to the severed area of land.

Severance of Individual Fields or Land Parcels

Farm holdings are more efficient in single land parcels. Fragmentation of farms results in greater costs due to increased livestock and grassland management involved in farming more than one unit e.g. movement of livestock between land parcels and increased travel distances for grassland, silage and tillage machinery.

Where farm buildings are located on the land parcel being severed the impact of severing these buildings from the land must be considered. Land isolated from the farm buildings is left without access to facilities previously available. The greater the area of land severed from the farm buildings the greater the impact. Constructing new farm buildings in certain cases can mitigate this impact. The impact of severance on farm buildings is particularly acute in the case of dairy farming where the dairy and milking parlour are severed from the grazing paddocks. The impact is greater because dairy cows require twice-daily access from the grazing area to a milking parlour.

Animal handling facilities such as cattle pens may be present for loading/unloading and treatment of livestock. The impact on severing such holdings can be mitigated by the replacement of the facilities on the severed area.

In many instances land parcels do not have any farm buildings or animal handling facilities. This may occur when the farm buildings are located on another part of the farm. Where it involves short distances it may be the traditional practice to walk livestock along the public road to the farm buildings.

The following significance criteria presented in **Table 9.1** are used to rank severance of individual fields or land parcels.

Table 9.1 Significance Criteria Used to rank Severance of Land Parcels

EPA Glossary of Impacts	Level of Impact	Criteria
Neutral, Imperceptible or Slight Impact	Not Significant	The route passes generally along the external field boundary leaving the bulk of the land in one unit. There is no severance caused.
Significant Impact: Positive or Negative	Minor	The route passes generally along the external boundary leaving the bulk of the land in one unit. There may be severance of a small area. Farmyard facilities are not affected.
	Moderate	The route passes through the land parcel causing severance. It is divided into two units. Access is available to the two areas. The severed area is less than one third of the land parcel. Where present, the farm buildings and facilities remain on the larger area.
	Major	The route passes through the land parcel causing severance. It is divided into two units and the severed area is greater than one third of the land parcel. There is no access to the severed area or it may be a by way of a considerable distance. Farm buildings and facilities are left on less than half the original area. In addition both areas may be irregularly shaped and less useful.
Profound or Significant Impact: Negative only	Severe	The route passes through the land parcel causing severance. It is divided into two units. There is no access to the severed area. The severed area is greater than two thirds of the land parcel. There is a loss of access to farm buildings and / or facilities.

Land take and severance are two areas which outline the effects of the proposed route on a field or land parcel. However many farm holdings may be fragmented and may consist of several land parcels. The proposed route may impact on the main land parcel consisting of farm buildings and facilities or on a second land parcel where no facilities are present. Although landtake and severance on both land parcels would be comparable, the overall impact on the farm holding would be significantly different.

Fragmented farms may also be affected by the proposed route on more than one land parcel. Different impacts on each land parcel may not accurately reflect the overall impact on the farm holding.

Other components that contribute towards the overall impact on a farm:

The Type of Farm Enterprise

Farm enterprise types of high stocking rates that are intensively farmed will be more severely affected by the proposed route. As explained above these would frequently be dairy farms and intensive beef farms. A reduction in the available forage area may result in a reduction in the number of dairy cows that can be maintained on the farm. A significant reduction in land take, or severance of the grazing paddocks from the farm buildings, may result in the farmer being forced to change the enterprise type to a less profitable enterprise.

Drystock enterprises such as beef and sheep are generally less affected than dairy farms. Stock on these farms are not moved from field to field as frequently as on a dairy farm. Although there is a significant impact, the farming practices on these farms can be adapted to mitigate the overall impact.

Tillage farms are generally less severely affected than livestock farms. Machinery can easily move from one land parcel to another although there are additional costs involved. Where remaining areas are of a less regular shape and size the remaining areas may be less suitable for arable purposes.

Impact on Farmyard Buildings and/ or Facilities

The removal of farm buildings and / or facilities on the farm will contribute towards the overall impact on the farm. This will depend on the type of farm buildings affected and extent that the facilities are affected.

Impact on Shelter

The removal of mature trees and strong hedgerows, which provide shelter to crops and livestock, especially younger stock, will have an impact on the farm holding. It will depend on the extent of the shelter removed and the type of enterprise.

It should be noted that this is an impact that is mitigated in certain cases by the replanting of boundary hedgerows and replanting of suitable tree species.

The following significance criteria presented in **Table 9.2** are used to rank the overall impact on a farm holding.

Table 9.2 Significance Criteria for Overall Impact on the Farm Holding

EPA Glossary of Impacts	Level of Impact	Criteria
Neutral, Imperceptible or Slight Impact	Not Significant	An impact is not significant where the farm enterprise suffers a slight inconvenience such as relocation of access or loss of shelter.
Significant Impact: Positive or Negative	Minor	Minor impact occurs where the farm enterprise suffers inconvenience as a result of the proposed scheme. Severance would not occur or is insignificant and the farm buildings and facilities would be left in place. Typically only a small portion of land would be removed at the boundary of the farm.

EPA Glossary of Impacts	Level of Impact	Criteria
	Moderate	Moderate impact occurs where the farm enterprise can be continued as before but with increased management or operational difficulties. While portions of the land would be severed the enterprise mix would be such that the farming system could continue perhaps with reduced stock numbers or additional labour, contractor or other charges.
	Major	Major impact occurs where the farm enterprise cannot be continued without considerable management or operational changes. There would be significant severance on the affected land parcel(s). `The route may affect farm buildings and / or facilities. Access to the severed portions of land can only be achieved through the use of non-farm roadways to access severed lands. Where the impact is major an enterprise change may be necessitated e.g. from dairy to drystock.
Profound or Significant Impact: Negative only	Severe	Severe impact occurs where the farm enterprise cannot be continued as a result of the proposed scheme. This would occur where land-take and severance was of such a nature to make the holding unworkable and/or where important farm buildings and facilities were removed. Impact of this degree would be rare and is most likely to occur on a dairy or stud farm.

9.3 Receiving Environment

In assessing the impact of the new road construction on agriculture, it is useful to compare the general agricultural activity at a national and county level with that of the area immediately affected by the development. This will indicate if there is any significantly unusual agricultural production taking place along the route of the road.

9.3.1 Agriculture in County Clare

County Clare has a total Utilisable Agricultural Area (U.A.A.) of 210,477 hectares (CSO Census of Agriculture, June 2000). This represents approximately 5.3% of the national agricultural land area. There are 6,720 farms in County Clare with the average farm size in the county being 31.3 hectares. This is similar to the national average farm size of 31.4 hectares.

Grassland based livestock farming is the dominant farm enterprise in Co. Clare. The predominant farm enterprise is specialist beef with a total of 4,722 farms (70.3% of total farms) involved. Specialist dairying enterprises are carried out on 1,265 farms (18.8% of total). A total of 598 farms (8.9% of total) are involved in mixed livestock farming. Specialist sheep, specialist tillage and crops as part of a livestock enterprise do not represent a significant percentage of farms in Co. Clare.

9.3.2 Agriculture in North Tipperary

North Tipperary has a total Utilisable Agricultural Area (U.A.A.) of 149,411 hectares (CSO Census of Agriculture, June 2000). This represents approximately 3.8% of the national agricultural land area. There are 3,855 farms in North Tipperary with the average farm size in the county being 38.8 hectares. This is considerably higher than the national average farm size of 31.4 hectares.

Grassland based livestock farming is the dominant farm enterprise in North Tipperary. The predominant farm enterprise is also specialist beef with a total of 1,875 farms (48.6% of total). Specialist dairying enterprises are carried out on 1,079 farms (28.0%). A total of 489 farms (7% of total) are involved in mixed livestock farming and specialist tillage accounts for 152 farms (2.6% of total).

9.3.3 Agriculture along the Proposed Route

The new road will pass through three Electoral Divisions (E.D.'s) of Killaloe, Ballina and Birdhill.

The topography is generally flat to undulating lowland with the land rising around the town of Killaloe consisting mainly of dry mineral soils. The land quality in the area is considered good with the land elevations mostly below 100 meters above ordnance datum. Agriculture in this area is dominated by grassland, with forestry also present.

Soil

The soil types within the study area were identified using the Soil Association Map of Ireland from *Soil Associations of Ireland and their Land Use Potential* (An Foras Taluntais, 1980). A soil association is a mapping unit on a soil map, which consists of two or more soils. A soil map is a representation of the distribution of soil types of a given landscape.

The study area falls within the following soil associations:

- Soil Association 14 - Grey Brown Podzolics 75%, Gleys 25%
- Soil Association 21 - Gleys 80%, Grey Brown Podzolics 20%
- Soil Association 43 - Gleys 60%, Brown Earths 20%, Peaty Gleys 20%

The most extensive soil types within the study area are 14, 21 and 43. Soil type 41 occurs predominately west of the Shannon, whereas soil type 21, 43 occurs east of the River Shannon.

9.3.4 Current Farming Enterprises

Table 9.3 presents the category of farming enterprise in the affected E.D.'s and how they compare with the national percentages for each category.

Table 9.3 Farms Classified by Farm Type within affected E.D.'s and Nationally

Farm/Enterprise Category	No. of Farmers within Farm Category	% of Total Farmers in Each Category	National % of Farmers in Each Category
Specialist Dairy	20	15	18.6
Specialist Beef Production	80	62	51.1
Specialist Sheep Production	0	0	8.6
Mixed Grazing Livestock	30	23	14.6
Specialist Tillage	0	0	3.3
Mixed crops & Livestock	0	0	2.6
Other	0	0	1.2
Total	**130**	**100**	**100%**

* Cells containing a 0 indicate that the amount in question was actually zero except where if the number is less than 10 it is rounded to the nearest 10.

The table indicates that grass based livestock enterprises predominate in the affected E.D's. The percentage of specialist beef is higher than the national average, with farms in the affected E.D.'s predominantly involved in beef production.

The distribution of farm sizes within the affected E.D.'s in comparison with national averages is presented in **Table 9.4.**

Table 9.4 Farms Classified by Farm Size within affected E.D.'s and Nationally

Farm Size	No. of Farmers	% of Farmers	National %
<10 Hectares	20	14.3	20.1
10 -<20 Hectares	30	21.4	24.2
20 - <30 Hectares	20	14.3	17.7
30 - <50 Hectares	40	28.6	20.9
50 - <100 Hectares	30	21.4	13.8
>=100 Hectares	0	0	3.3
Total	**140**	**100**	**100**

*The number of farms is shown to the nearest ten

Table 9.4 shows that the average farm size in the study area is slightly higher than nationally. There are a greater number of farms over 50 hectares in size, 21.4% of all farms, in comparison with the national average of 17.1%. Of all farms, 50% are less than 30 hectares in size in contrast with the national average of 62.0% for the same category. This reflects the larger farm structure in the region and means that a lower number of farms will be affected by the route than on a similar route elsewhere.

Table 9.5 illustrates the breakdown of the agricultural land use and the comparison with the national averages.

Table 9.5 Crop types in affected E.D.'s and the National Land Area Devoted to Crops and Grassland

Crop Types	Area within E.D.'s (ha)	% of Area	% of National Area under Crops and Pasture
Total Crops, Cereals, Fruit /Horticulture*	34	1%	9%
Total Pasture	2746	61%	51%
Total Hay	160	4%	9%
Total Silage	1236	27%	17%
Rough Grazing in use*	322	7%	14%
Total	4498	**100**	**100%**

* Some or all details are not made available at the DED level due to confidentiality and / or non-response

There are higher levels of grassland in pasture and silage to those of the national average. There is a significantly lower level of land under crops and rough grazing in the study area than the national average. The route chosen will not cause a significant reduction in area of any particular crop type.

9.4 Predicted Impacts on Agriculture

The alignment of the proposed scheme is through lowland, which consists of good agricultural range and usage. The main enterprises are beef and dairying, with forestry also present. The impact on agriculture of the new road construction will be limited to the farms directly traversed by the development.

9.4.1 Loss of Agricultural Land

Nationally there are approximately 3,936,567 hectares of agricultural land (excluding rough grazing) of which 3,535,443ha are in grassland based enterprises and 401,124 ha of cereal and non-cereal crop production. Approximately 10 ha of land will be lost to agricultural production as a result of this scheme. This loss, while significant to individual farmers, is not significant on a county or national level.

9.4.2 Individual Farm Impact

There are 21 land holdings affected by the construction of the new road. An agricultural consultant contacted all of these landowners, in order to carry out the following tasks:

- to conduct an appraisal of the farm facilities and layout, and;
- to gather data via a questionnaire to enable an assessment of the impact and mitigation measures required as a result of the road development.

Farms were categorised according to the following criteria:

- Total area of farm holding (hectares, ha)
- Enterprise type(s)
- Degree of overall impact
- Under major/severe overall impact
- Degree of land severance
- Buildings/facilities to be acquired
- New access facilities requiring provision

Table 9.6 presents summary details of the individual farm assessments and the anticipated impact of the new road on each farm.

Table 9.6 Summary of Individual Farm Assessments (Of 21 farms)

Category	No. of Farms	% of Farms
Farm Size (ha): -		
<10	9	42.86
10 – <20	4	19.04
20 – <30	0	0.0
30 – <50	3	14.29
50 – <100	5	23.81
>=100	0	0.0
Farm Enterprises: -		
Dairy	2	9.52
Equestrian Enterprises	1	4.76
Beef	4	19.04

Category	No. of Farms	% of Farms
Forestry	1	4.76
Tillage	0	0.0
Mixed Livestock*	2	9.52
Mixed Tillage & Livestock**	0	0.0
Leased	5	23.81
Other***	6	28.57
Overall Impact on Farm		
Not Significant	6	28.57
Minor	5	23.81
Moderate	9	42.86
Major	1	4.76
Severe	0	0.0
Under Severe/Major Impact (of 1 farms)		
Dairy Farms	1	4.76
Mixed Livestock & Tillage	0	0.0
Beef	0	0.0
Leased	0	0.0
Land Severance (of 24 parcels):		
Not Significant	16	66.67
Minor	3	12.5
Moderate	5	20.83
Major	0	0.0
Severe	0	0.0
Facilities to be acquired**** (ii)	1	4.76
Access required (i) (ii)	17	80.95

* Mixed Livestock includes any combination of cows, cattle, horses or sheep enterprises. It consists of one farm primarily involved in dairying.

** Mixed Tillage & Livestock includes any combination of cows, cattle, horses or sheep with tillage enterprises.

*** This category consists of seven farms, which includes two farms with a mixture of forestry and grass, one farm with forestry and beef, two plots of grass and two plots of non utilised agricultural area.

**** Facilities include farmyards, fodder storage facilities and animal handling and housing facilities. The affected facility consists of a pen for loading livestock.

(i) Access is deemed to be required where it has to be provided to a severed portion of land or a parcel where the access along the entire road frontage is removed. It includes cases where the access point or gates have to be replaced or restored on a land parcel.

(ii) In the case of access required or facilities required, the figure refers to the number of land parcels in each case. It does not relate to the number of farms. In some cases access may be required on more than one land parcel on a holding.

Of all affected farms 61.9% of them are in the farm size category of less than 30ha. This is slightly higher than the farm size at a local E.D level of 50% and similar to farm size at a national level of 62.0%. There are 23.8% of farms in the category over 50ha compared to 21.4% at local level and 17.1% nationally.

There are five holdings leased out to local farmers who are primarily involved in dairy/beef production. There are two mixed livestock farms along the route representing 9.5% of the farms affected. These farms both have dairy enterprises along with beef enterprises. There are two specialist dairy farms. There are no tillage farms along the route.

Overall Impact on Individual Farms

Prior to any mitigation measures being put in place, there are no farms on which the agricultural impact would be severe (see **Table 9.6**). There is one farm which would have a major degree of impact, which represents 4.76% of all farms assessed. There are eight farms, which would have a moderate degree of impact representing 38.1% of all farms. There are five farms, which would have a minor impact representing 23.08% of overall farms.

The farm that would experience a major overall impact is a dairy farm. Farmyard facilities will be affected on one farm, which consists of a pen for loading and handling livestock.

Without mitigation measures, this farm enterprise cannot be continued without considerable management or operational changes due to the combination of the type of enterprise, farm size, land take and the effects on farm buildings and facilities.

Table 9.7 shows details of the individual farm assessments and the anticipated impact of the new road on each farm.

9.5 Mitigation Measures

Mitigation measures detailed in this section relate to engineering accommodation works alone. Further measures to compensate farmers due to land acquisition, drainage works and loss of facilities will be agreed by the valuer at a later stage.

There are sixteen land parcels on which there are severed areas. The existing access points will be affected or a new access point off an existing road may be required.

On the severed areas where there is no access available new access will be required on these areas. The extent and complexity of such access provisions vary with each farm depending on the nature of the impact and the type of enterprise being carried out. In most cases simple gateways will suffice, while in other cases new accommodation roads may have to be constructed.

Table 9.6 summarises the level and nature of the impact the route will have on each individual farm and proposed mitigation measures relating to accommodation works.

9.6 Residual Impacts

Following recommended mitigation works relating to severance, the residual impact will be major on one farm or 4.76% of all farms. The level of farms with a major impact has not changed.

Eight farms would have a moderate degree of residual impact representing 38.1% of all farms. Five farms will receive a minor impact representing 23.8% of overall farms.

Table 9.7 shows the details of the individual farm assessments and a comparison of the overall impact with the anticipated residual impact of the new road on each farm following recommended mitigation works being carried out.

Table 9.7 Residual Impacts on the Individual Farms

Category	Overall Impact No. of Farms	Residual Impact No. Of Farms	Residual Impact % of Farms
Impact on Farm (Of 21)			
Not Significant	7	7	33.3
Minor	5	5	23.81
Moderate	8	8	38.09
Major	1	1	4.76
Severe	0	0	0
Of those with Severe/Major Impact:			
Dairy	1	1	4.76
Mixed Livestock	0	0	0
Beef	0	0	0

9.7 Construction Impacts and Mitigation Measures

The main impacts on agricultural activity during the construction phase of the new road will be:

- Construction noise;
- Dust;
- Restricted access to severed land parcels during construction;
- Disturbance of field drainage works;
- Disturbance of services.

The nature of each specific impact is as listed below.

9.7.1 Construction Impacts

Construction Noise

The activity of earth moving machinery, transport lorries and other ancillary vehicles will generate additional noise emissions in the immediate vicinity of the road construction. Noise can be of significance for farm animals (i.e. when noise becomes excessively loud). In general, animals become accustomed to regular noises and sounds. Intermittent noises can cause fright and distress. Blasting activity can be of particular concern with certain farm enterprises such as breeding and training of horses. Intermittent noises close to farm buildings, particularly milking parlours, can distress livestock.

Mitigation Measures

Good communication between the contractor and the landowners during the construction phase will prevent undue disturbance due to noise. The contractor will work to a Code of Practice. Further construction phase mitigation measures are discussed in **Chapter 11**.

Dust

Dust generated from the exposure of soil to the atmosphere during construction may cause annoyance or nuisance to the farmer and farm animals. The proliferation of dust during construction has a nuisance effect and, if produced in high volumes near milking parlours or on-farm bulk milk storage tanks, may constitute a risk as a source of contamination to the milk.

Livestock are at risk of eye irritations from high levels of windblown dust particles. This stress may reduce productivity and increase management difficulties, especially on dairy and equestrian farms.

Mitigation

Measures to control the reduction of dust will be put in place by the contractor. Good communication between the contractor and the farmers in the proximity of construction activities will facilitate on-going farm enterprises so that valuable livestock are kept as far away as possible from the construction work during critical times. Further construction phase mitigation measures are discussed in Chapter 11.

Restricted Access to Severed Land Parcels during construction

Access to severed land parcels will still be required during the road construction process. It is to be expected that there will be increased difficulties in providing such access during the construction phase due to the need to allow machinery and equipment continual movement along the construction corridor. This will conflict with the farmer's requirements to move livestock from one part of the farm to another in order to utilise the grazing area properly.

Mitigation

As in the case of mitigating noise and dust pollution, good communication between individual farmers and the construction authorities will minimise difficulties caused by the restriction of access to severed land parcels. Such communication will produce a workable arrangement, which will allow all parties to continue their work in return for some compromise to other parties. There also will be proper termination of existing boundaries. Maintenance of open access to all landholdings and properties is required.

Temporary fencing will be erected as required to delineate the site boundary and to minimise disturbance to adjacent lands. Farmers may need to move animals across the construction site while they await more permanent measures to be put in place and this will be facilitated by providing gates where needed until such time as the access arrangements are in place for these farmers when these gateways will be replaced by permanent stock-proof fencing.

Disturbance of field drainage works

It is to be expected that field drainage systems currently in situ will be disturbed and in places severed by the construction of the new road. These systems will be restored as part of the completed road works, but there may be impaired drainage in the period of time between initial disturbance and final reinstatement of such drainage works.

In the case of one farm an existing stream will require regrading as part of the drainage strategy for the scheme.

Mitigation

In cases where impeded drainage during construction will cause obvious difficulty to a particular landowner, temporary measures will be taken to allow waters to drain to less critical areas and so minimise the impact.

Disturbance of services

Ducting for piped watering systems on some farms is being severed. Access to either piped water or drinking points on watercourses will be removed through severance on other farms.

In some cases ducting will be required for the purposes of installing electric fencing to stock-proof non-roadside boundaries on newly severed land.

Mitigation

Ducting will be provided to take water supply and electric fencing across the proposed road. The location of these will be agreed in advance of road construction on an individual farm basis and put in place during the construction phase. Again some temporary measures may be needed, such as water tanks and battery power electric fencing to ensure that disruption to farming is minimized.

Table 9.8 Summary Table of Assessed Individual Farms

Farm Ref. No. (Ref. Figs 9.1 and 9.2)	Total area of farm holding (Ha)*	Farm Enterprise Impacted	Level of Overall Impact on Farm	Nature of Impact on Individual Land Parcels		Mitigation Relating to Severance	Level of Residual Impact on Farm
				Landtake (Ha)	Details of Impacts		
1	72.8	Forestry & Equine	Moderate	1.85	Severance – Minor Reduction in the area of the parcel Impact on Forestry	Provide access to the severed areas	Moderate
2	48.6	Dairy	Major	2.44	Severance – Moderate Reduction in the area of the parcel Loss of direct access to severed areas for dairy herd	Provide access to the severed areas	Major
3	13.4	Leased	Moderate	0.45	Severance - Moderate Reduction in the area of the parcel Loss of access to severed area	Provide access to the severed area	Moderate
4	2.6	Equine	Moderate	0.36	Severance – Not Significant Reduction in the area of the parcel	Restore access to affected area	Moderate
5	0.4	Beef	Moderate	0.13	Severance – Not Significant Significant reduction in the area of the parcel.	Restore access to affected area	Moderate
6	2.8	Leased	Minor	0.20	Severance – Not Significant Reduction in the area of the parcel		Minor
7	8.1	Leased	Moderate	0.83	Severance – Moderate Reduction in the area of the parcel	Provide access to severed area	Moderate
8	8.1	Leased	Moderate	0.87	Severance – Moderate Reduction in the area of the parcel	Provide access to severed area	Moderate

Farm Ref. No. (Ref. Figs 9.1 and 9.2)	Total area of farm holding (Ha)*	Farm Enterprise Impacted	Level of Overall Impact on Farm	Nature of Impact on Individual Land Parcels		Mitigation Relating to Severance	Level of Residual Impact on Farm
				Landtake (Ha)	Details of Impacts		
9	40.5	Forestry & Beef	Minor	0.64	Severance – Not Significant Reduction in the area of the parcel Impact on forestry		Minor
10	14.2	Non Utilised Agricultural Area	Moderate	1.01	Severance – Minor Reduction in the area of the parcel	Provide access to severed area	Moderate
11	12.1	Leased	Minor	0.59	Severance – Not Significant Reduction in the area of the parcel		Minor
12	1.2	Forestry	Minor	0.42	Severance – Minor Significant reduction in the area of the parcel. Removal of mature trees		Minor
13	1..0	Grass	Minor	0.23	Severance – Not Significant Reduction in the area of the parcel		Minor
14	44.1	Beef	Not Significant	0.087	Severance – Not Significant Slight reduction in the area of the parcel Impact on boundary hedgerow		Not Significant
15	8	Forestry & Grass	Not Significant	1.568	Severance – Not Significant Slight reduction in the area of the parcel Impact on boundary hedgerow and forestry Impact on existing access	Restore access to affected area	Not Significant
16	68.8	Mixed Livestock	Not Significant	0.36	Severance – Not Significant Slight reduction in the area of the parcel Impact on animal handling facilities	Restore access to affected area	Not Significant

Farm Ref. No. (Ref Figs 9.1 and 9.2)	**Total area of farm holding (Ha)***	**Farm Enterprise Impacted**	**Level of Overall Impact on Farm**	**Nature of Impact on Individual Land Parcels**		**Mitigation Relating to Severance**	**Level of Residual Impact on Farm**
				Landtake (Ha)	**Details of Impacts**		
17	68	Mixed Livestock	Not Significant	0.056	Severance – Not Significant Slight reduction in the area of the parcel	Restore access to affected area	Not Significant
18	89	Beef	Not Significant	0.52	Severance – Not Significant Slight reduction in the area of the parcel		Not Significant
19	1.2	Non Utilised Agricultural Area	Moderate	0.455	Severance – Not Significant Reduction in the area of the parcel Removal of access to house and lands	Restore access to house and lands	Moderate
20	57.1	Dairy	Not Significant	0.00	Severance – None Slight impact on field access	Restore access to affected area	Not Significant
21	14.6	Beef		0.601	Severance – Not Significant Slight reduction in the area of the parcel Removal of access to farm yard and mature trees	Restore access to affected area	Not Significant

9.8 Predicted Impact on Residential Properties

There are a number of areas along the scheme where there will be a predicted impact on material assets due to land acquisition at or adjacent to residential properties. For the R494 Improvement, the majority of this will consist of acquisition of road frontage for realignments or tying into the existing road alignment. The residents will experience some disturbance during construction phase but this is anticipated to be a temporary impact and as the contractor is obliged to work within a stringent set of construction limits and guidelines it is predicted that the overall impact will not be significant. In the case of one residence two existing streams will need to be regraded as part of the drainage strategy for the scheme. A pond feature associated with one of these streams will also require some regrading work.

There will be 2 residential dwellings acquired as part of the scheme. These properties are both located in Killaloe, one property is south of Ballyvally Demesne in the north of Killaloe town, while the other property is to the south of the town, to the east of the Shannon Bridge Crossing tie in point with the Killaloe Bypass. Two non residential properties will be lost as a result of the scheme which include a storage shed / garage on the Hill Road in the Killaloe Bypass section of the scheme and a farm shed on the R494 which fronts the road. The Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement will affect a number of residential properties where land will be acquired either permanently or temporarily and boundaries will be impinged upon. This will occur mainly along the R494 with widening or realigning of the existing road as well as at junctions and tie in points. In addition a number of properties along the R494 will require the realignment of driveways to access the improved R494. In some instances this will result in a requirement to remove and replace septic tanks situated in the front of affected properties. All septic tanks and their contents will be disposed of to an appropriately licensed landfill and all replacement septic tanks will be installed in line with current standards.

There will be significant positive impacts for residential development within Killaloe and Ballina and its environs. The proposed route creates opportunity and increases attractiveness for future development in areas zoned for low and medium residential development. These lands will be significantly more attractive to development with quality road infrastructure in place, although direct access to the Killaloe Bypass and Shannon Bridge Crossing sections from individual residences will not be provided. The provision of a second river crossing and a bypass to the frequently congested towns of Ballina and Killaloe and a speedier route to Limerick and environs will also encourage further development of lands both residential and industrial in Killaloe / Ballina.

9.9 Potential Impact on Killaloe / Ballina

There will be significant benefits as a result of the removal of vehicles from the centre of Killaloe and Ballina. This opens up the towns to development and creates a more attractive setting for users of services and facilities. As a heritage town this significantly increases attractiveness as a place to visit resulting in opportunity for development in tourism and the service industry. The introduction of the proposed scheme would provide shorter journey times for the populous within the region and for commuters in the region of Killaloe / Ballina and ameliorate the impact this current traffic strain has on the environs. Indirect impacts are likely to encourage development of Killaloe and Ballina for business and residential use.

In addition, the scheme will provide for a much in demand pedestrian footpath and cycleway. The provision of these facilities in general is assumed to make these modes of travel more attractive by reducing journey distances.
During the construction phase of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement there will be increased local employment opportunities directly as part of scheme construction and indirectly for suppliers of services.

The above considerations results in positive impacts for economic development of Killaloe / Ballina, reductions in journey times and reductions in vehicle costs e.g. fuel consumption.

9.10 Proposed Mitigation Measures for Residential Property

Compensation payments for loss of land and other injurious affection will be agreed with all residential property owners affected by land take for the scheme. Where part of the property or land surrounding a residential property is to be acquired, agreement will be reached with the owner of the property on the type of boundary treatment that will be provided. Where an access to a property is affected the access will be reinstated to match the existing as far as possible and be consistent with the Clare County Development Plan and North Tipperary County Development Plan as appropriate.

9.11 Residual Impacts for Property

Following mitigation the residual impacts for property is not significant.

Chapter 10

Archaeology, Architectural and Cultural Heritage

Chapter 10 Archaeology, Architectural and Cultural Heritage

10.1 Introduction

This section of the Environmental Impact Statement assesses the impact of the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement on archaeology, architectural and cultural heritage.

10.1.1 Location

The proposed development consists of three sections:

- Killaloe Bypass;
- Shannon Bridge Crossing;
- R494 Improvement.

The proposed Scheme and lands 50m to either side of the road centreline have been examined from an archaeological, architectural and cultural heritage perspective using documentary research, historic map evidence, aerial photography study, field inspection and consultation. Where sites of particular significance lie beyond this limit they have also been included.

10.1.2 Methodology

The recommendations outlined in *Guidelines for the Assessment of Archaeological Heritage Impacts of National Road Schemes* (NRA 2005a), *Guidelines for the Assessment of Architectural Heritage Impacts of National Road Schemes* (NRA 2005b), *Guidelines on the information to be contained in Environmental Impact Statements* (EPA 2002) and *Advice Notes on Current Practice (in the preparation of Environmental Impact Statements)* (EPA 2003) form the basis of this assessment of the proposed scheme on the archaeological, architectural and cultural heritage resource.

Archaeological monuments - including archaeological deposits with no surface expression - have statutory protection under the National Monuments Act 1930 (and as amended) and preservation in situ is the preference of the Department of the Environment, Heritage and Local Government (DoEHLG) for such monuments. Monuments listed on the Record of Monuments and Places (RMP) have specific protection under the 1994 amendment to the primary legislation. The position of the DoEHLG is outlined in *Framework and Principles for the Protection of the Archaeological Heritage* (DAHGI 1999a) and *Policy and Guidelines on Archaeological Excavation* (DAHGI 1999b).

Architectural monuments are protected as part of the specifications of the Planning and Development Act 2000. Under current legislation, a listed structure and its curtilage and other structures within that curtilage and their interiors are protected. The extent of that curtilage needs to be determined on a case by case basis as described in *Architectural Heritage Protection: Guidelines for Planning Authorities* (DoEHLG 2004).

The following list of sources were amongst those consulted:

- Documentary and cartographic evidence from the holdings of the County Clare Local Studies Library;
- Topographical Files of the National Museum of Ireland;

- Record of Monuments and Places;
- Sites and Monuments Record;
- Archaeological Inventory of County Tipperary;
- Register of Historic Monuments;
- National Monuments (as identified by the National Monuments Service (NMS) of the Department of the Environment, Heritage and Local Government (DoEHLG);
- Excavations Bulletin (www.excavations.ie);
- Aerial photographs (supplied by client);
- DoEHLG website www.archaeology.ie;
- Record of Protected Structures in County Clare (RPS);
- Record of Protected Structures in County Tipperary (North Riding);
- National Inventory of Architectural Heritage for County Tipperary (North Riding);
- National Inventory of Architectural Heritage for County Clare;
- Clare County Development Plan 2005-2011;
- Clare County Development Plan 2011-2016;
- North Tipperary County Development Plan 2005-2011;
- North Tipperary County Development Plan 2011-2016;
- Industrial Heritage Review of County Clare 2008;
- Clare Coastal Architectural Heritage Survey 2007/8;
- Irish Folklore Commission Schools Collection Scheme 1930s.

The entire route was walked and the location of potential areas of interest examined by appropriately qualified persons.

In addition to several landowners, the following individuals were consulted:

- Sébastien Joubert, Senior Archaeologist with the National Roads Authority;
- Simon Large, County Archaeologist with Clare County Council;
- Risteard Ua Crónín, Architectural Conservation Officer with Clare County Council;
- Martin Reid, National Monuments Service, Department of the Environment;
- Sean Kierse, local historian.

Specialised Survey

No specialised survey has been undertaken for this scheme at this stage, however an underwater survey was carried out as part of the route selection phase for the Shannon Bridge Crossing. The results of this assessment are briefly described below.

10.2 The Receiving Environment

10.2.1 Archaeological Heritage

Introduction

There are a large number of archaeological monuments and find spots (particularly in the River Shannon) in the vicinity of Killaloe and Ballina (**Figures 10.1 and 10.2**).

Many of these sites and artefacts are prehistoric in date (enclosures, standing stones, stone axes) and many are medieval (enclosures, ringforts, Christian sites) this reflects the significance of the Killaloe/Ballina River crossing from antiquity.

Record of Monument and Places (RMP) and Sites and Monuments Record (SMR)

The Record of Monuments and Places (RMP) is the primary source for identification of known archaeological sites. RMP sites are illustrated on **Figures 10.1 and 10.2**.

Two RMP sites lie within 100m of the proposed scheme. Site CL045-057 (**H7**) is a possible enclosure located in Knockyclovaun townland, Co. Clare. This site has no surface expression visible in the field and was originally identified by aerial photography. RMP site TN025-021 (**H40**) is the location of a holy well located on the now submerged Friar's Island in the River Shannon.

A number of standing stones and enclosures are recorded on the RMP within Creeveroe, Knockylovaun and Shantraud townands, although these are all over 150m west of the proposed Scheme. Of particular note is 'Beal Boru' (CL045-031), a large enclosure located north-east of the northern end of the Killaloe Bypass in Ballyvally.

A *fulacht fia* (CL045-061) is located east of the scheme in Knockyclovaun.

The proposed Scheme lies over 500m from Killaloe town (CL045-033) (**H35**) and its medieval monuments, including the cathedral, stone crosses, churches and a sheela-na-gig.

The site of a stone cross (CL045-050) is recorded south of the route close to the river edge and the locations of a holy well (TN025-021) and church (TN025-022) are recorded in the now-submerged Friar's Island in the river. The bridge across the Shannon is an RMP monument itself (CL045-03301 and TN025-09401).

On the Tipperary side of the river there are no monuments close to the proposed scheme, however a number of enclosures are located on the higher ground to the east of the route. Two standing stones, a ringfort, a church and graveyard and a castle (possible hall house) are located at the south of Ballina town, itself an RMP site (TN025-094) (H44).

Previous excavations

The results of archaeological investigations in Ireland are published in summary form in Excavations (Bennett 1987-2004). A search of the database was made for the townlands through which the proposed Scheme passes. With the exception of two sites that are outside the immediate study area, the archaeological investigations did not produce archaeological material.

Ballyvally	00E0314, 00D020, 00R069, no archaeological significance
Knockyclovaun	96E0113, *fulacht fia* NGR 1700/1729, not excavated (now RMP CL045-061), 05E0409 no archaeological significance
Creeveroe	02E1594, 02E1759, 03E0485, no archaeological significance
Shantraud	99E0172 Romanesque cathedral doorway
Moys/Roolagh	97E0135 no archaeological significance

Archaeological excavations were undertaken in advance of construction of the N7 Nenagh-Limerick High Quality Dual Carriageway in 2006-7 and the following sites were in townlands under consideration for the Killaloe Bypass; however all were some distance to the south of the study area:

Lackenavea (Egremont)	E2486, pits, burnt stone spreads
Gortybrigane	E2487, prehistoric settlement, fulacht fia, cremation burial E2488, early medieval enclosure, fulacht fia

Topographic files of the National Museum of Ireland

The Topographical files of the National Museum of Ireland (NMI) indicate the findspots of archaeological artefacts. These are often not very specific locations and commonly simply indicate the townland in which the artefact was found.

A list of stray finds from the topographical finds of the National Museum of Ireland is available in **Appendix 10.1**. Whilst none of these findspots can be placed within the area to be impacted upon by the proposed development this list is indicative of the potential for artefact recovery in the general area.

The Discovery Programme (Condit and O'Sullivan 1999) shows a greater number of finds in the townlands under consideration but many of these are also associated with the River Shannon and are not within the study area.

Cartographic sources

The earliest map with any degree of detail of the study area is the County Clare Grand Jury Map (**Figure 10.3**) dated 1787. This map shows Killaloe, the Bishop's Palace (Clarisford House) to the south and 'Ballyvelly Ho' to the north-west. 'Maigh' is marked, noting the townland of Moys and the 'Intended canal' is illustrated. On the Tipperary side of the river a road curves south from Ballina town – this road does not appear to correspond with the current R494, although this may be a result of the inaccuracies of the map. The map does not scale to modern standards and although the proposed Scheme has been overlain on **Figure 10.3** it is clear that the two surveys cannot be aligned.

The Ordnance Survey (OS) 1st Edition Maps at 6" to the mile (1842), show a pattern of field boundaries that are essentially unchanged today although some were subdivided into smaller units than are now present (**Figures 10.4 and 10.5**). The dense series of circular enclosures to the west of the proposed Scheme in County Clare are marked on the 1842 map, as are Ballyvally House and the associated gate lodge. Clarisford House and demesne are also marked to the south of Killaloe. The road layout south of Ballina is essentially as it is today, although the layout of dwellings shown along its length is different to those that now exist. Gortna House and Fort Henry are the large estates illustrated close to the scheme.

The Griffith Primary Valuation was conducted in the 1850s. Although the valuation generally used the existing 6" OS maps to mark the landholdings, it is noteworthy that the Tipperary survey utilised an updated map rather than the 1843 OS edition, with the railway between Birdhill and Ballina (completed in 1862) subsequently added.

At the end of the 19th century and the beginning of the 20th century a series of detailed 25" to the mile OS maps were produced. The sheets covering the Co. Clare part of the scheme were surveyed in 1893 and published in 1895-6, whereas the Co. Tipperary sheets were surveyed in 1902 and published in 1904. As these maps were produced at a larger scale they often provide more detailed illustrations of the layout of buildings and other features. Of particular note is a 'Stone Cross' marked in the grounds of Clarisford Palace that was not illustrated on the 1st edition map surveyed 62 years earlier.

The early 20th century saw a revision of the original 6" maps. Co. Clare Sheet 45 was resurveyed in 1915 (**Figure 10.6**) and again in 1938. Co. Tipperary was surveyed and published in 1938.

A number of small buildings are marked on the various OS editions between 1840 and 1938 on, or close to, the proposed Scheme but are no longer standing. It is possible that below-ground structural remains survive in some cases.

Areas of archaeological potential

The Killaloe – Ballina crossing of the River Shannon has been significant from the prehistoric period onwards. In addition to the locations of known archaeology are a number of areas that will be considered to have particular potential for the discovery of previously unrecognised archaeological remains.

H34 & H41: Shores of River Shannon

Whilst there are no specific archaeological monuments recorded in these zones within 50m of the proposed Scheme, rivers and lakes are generally considered to be of high archaeological potential. Intensive activity in this particular area throughout the prehistoric and medieval periods is attested to by the number of artefacts listed in the files of the National Museum of Ireland as having been recovered from this part of the River Shannon and Lough Derg, in addition to the concentration of monuments in the vicinity.

The river shores themselves may be the repositories of artefacts previously deposited in the water, and the fields immediately adjacent, including those that have subsequently been submerged, have the potential to contain subsurface evidence of prehistoric or later settlement or other activity.

The proposed crossing is located immediately to the north of the island on which the original monastic settlement of St Lua was located and therefore both river shores have the potential to contain related medieval features.

Military engagements have taken place a number of times at the fording point of the river, and doubtless on several other, unrecorded occasions. It is likely that embankments or other temporary defensive or offensive earthworks were constructed during these events, the details of which are not recorded on any maps but which may survive as sub-surface archaeological features. For example Edmund Ludlow (reproduced 1998) described how during the Cromwellian campaigns in 1651 Henry Ireton, stationed opposite Killaloe, ordered that a channel be dug in order to divert the river to allow it to be passable, or at least to give that impression to his enemy on the opposite bank.

Both river banks have been subject to development over the last few centuries which may have impacted on earlier archaeological remains. On the western side the Limerick to Killaloe Canal was constructed in the late 18th century whilst on the east the Limerick – Killaloe railway was built in the 1850s-1860s.

The western bank of the river (**H34**) lies, within the route corridor, in the old estate of Clarisford House and was, in the mid 19th century, occupied by parkland. On the

1840-1938 OS maps (**Figures 10.4 and 10.6**) a boat house and inlet are marked (**H31**), presumably for the use of the estate. Much of the river bank has since been built on with a number of private residences having access to the canal. The construction of the canal in the late 18th century left a narrow strip of the river bank separate from the mainland on which was the towpath and canal related buildings including a lime kiln.

The eastern bank of the river (**H41**), as it is seen today, rises steeply from the river level to the level of the current R494. The proposed Scheme crosses the line of the railway and passes through a field between dwellings where a possible mound (**H43**) was noted during the walkover for the earlier route selection report, but was not seen during the 2009 walkover survey.

It should also be noted that the river has been subject to dredging on several occasions over at least the last 250 years and the location of the dumps of dredged material is not, in many case, known. Should dredged material lie within the road take for the new crossing there is potential for artefacts to be discovered within the redeposited river gravel.

H36: River bed

The River Shannon itself is an area of archaeological potential. This potential is discussed below in more detail in the underwater section.

Greenfield archaeological potential

A large portion of the Co. Clare part of the scheme lies in previously undeveloped land, primarily pasture. The rich archaeological and historical background of the Killaloe area, with a number of prehistoric standing stones, early medieval enclosures and the medieval archaeology of Killaloe town itself, suggest that there may be surviving below-ground archaeological sites with no surface expression.

The hillsides in Ballyvally, Knockyclovaun and Shantraud townlands have potential for domestic and funerary sites, whereas the low-lying boggy ground in Shantraud and Moys would be a typical location for *fulachtaí fia*.

Although no particular zones have been marked on the accompanying maps, all greenfield areas will be considered to be of high archaeological potential.

Underwater archaeology

A detailed assessment of the archaeological potential of the underwater element of the proposed scheme was undertaken by Donal Boland at route selection stage for the Shannon Bridge Crossing (RPS 2006). The full report is included as part of the Shannon Bridge Crossing Report. The results of that assessment are summarised here.

General

The riverbed (**H36**) will be treated as an area of high archaeological potential throughout.

The route passes close to the flooded landscape of Friar’s Island which will be considered to be of very high archaeological potential.

Survey results

Desktop, geophysical and underwater surveys were carried out.

No shipwrecks are listed for the study area in the national register of wrecks.

Site surveys revealed no potential archaeological features on the proposed route, however it was considered that construction might impact on an area of riverbed adjacent to a stone culvert (**H37** - M3 in underwater archaeology report), a dry-stone wall (**H38** - SS2 in underwater archaeology report) and an unidentified magnetic anomaly (**H39** - M4 in underwater archaeology report).

Rivers and streams

In addition to the River Shannon, the proposed scheme crosses the Kilmastulla River (**H96**) and a number of small streams and water-filled ditches. These locations have potential for archaeological features or artefacts.

Field inspection

The proposed Scheme was walked on 10th June 2009 and on several dates between 25th August and 5th October 2009. On each occasion the weather was dry and this assisted the walkover survey. The walkover examined the route with regard to archaeological, architectural and cultural heritage aspects of the project.

At the northern end of the scheme, on the Clare side, the proposed roundabout opposite the entrance to Ballyvally House lies in thick woodland. At this point the road runs along the side of the hills overlooking the river and has been terraced into the hillside with the woods on the east being over 1m below the road level in places. No archaeological remains were apparent within the woods; however the thickness of the undergrowth and saplings made detailed study impossible.

The route crosses the road immediately south of the Ballyvally House Gate Lodge (**H2**), through a boundary that is little more than a line of trees and a fence. The route arcs across a steeply sloping lush pasture field, through a strip of planted trees and passes through the boundary of the Ballyvally estate. The boundary (**H4**) is formed by a wide strip of mature trees (the trees are marked on the historical maps) that has vertical earthen banks at either side, the north-western bank being stone-faced and has a stream flowing at its base. The south-eastern bank is also the townland boundary.

In Knockyclovaun townland the route passes through a private residence; this area was not examined. Further south is pastureland that continues through Shantraud. The location of the possible enclosure CL045-057 (**H7**) was carefully examined. The potential monument was recognised from aerial photography. On the ground it was noted that the enclosure location is marked by a large oak tree (**Plate 10.1**). From the air, and when in full leaf, the tree would appear circular. In the vicinity of the tree, the ground is undulating and at the time of the inspection the grass was closely cropped. This assisted the examination. There was nothing remotely like an enclosure visible. The road scheme aerial photographs do not show a circular enclosure at this location.

Plate 10.1 Location of CL045-057 (possible enclosure)

On the lower ground, in the part of Shantraud townland south of Killestry, and also in Moys townland to the west of the Clarisford Palace avenues, the land is rough reedy pasture with some potential for burnt stone deposits such as the typically Bronze Age cooking places (*fulachtaí fia*), although none with surface expression were identified.

A parcel of land between the R463 southern junction and the Clarisford Palace estate is occupied by a disused warehouse within a gravel yard (**H22**). The yard is overgrown with scrub and small trees. To the north-east of the yard a housing estate has recently been constructed. The boundary of the Clarisford Palace estate (**H23**) is formed by an earthen bank topped by mature trees in this area. The route passes through an area of mature trees immediately west of the Clarisford Palace avenues, then crosses the avenues (**H25**) and the pasture between them and into a private residence.

The residence, 'The Heronry' (**H26**), lies directly on the proposed Scheme, which passes through its grounds to the bank of the canal. The house is a concrete, architect-designed, dwelling built in the later 20th century (**Plate 10.2**) and a track runs from the road to the canal at the east. To the rear of the house is a lawn and pond and the area between the lawn and the canal is wooded. Where the track meets the canal there is a slight concave bay, with a series of rotten wooden posts in the water's edge (**Plate 10.3**), presumably the remains of a timber quay allowing access to boats (**H30**). South of this point, in a wooded area, the partially infilled remains of a channel can be seen parallel to the canal, 3m from its edge (**H30**). This channel is approximately 3m wide and survives no deeper than 0.5m deep (**Plate 10.4**), although presumably it once was deep enough to be filled with water as it appears that it curves to connect to the canal within the grounds of the property to the south. Approximately 8m inland of this channel is a line of mature beech trees that are sufficiently old to belong to the original Clarisford Palace Estate. West of the line of trees the wooded area is lower and rather wet and swamp-like. This wooded area is the general location of the stone cross marked on some of the 1921 and 1938 OS maps (**Figure 10.6**), however despite extensive searching no evidence was seen of any monument.

Plate 10.2 H25 20th Century house 'The Heronry'

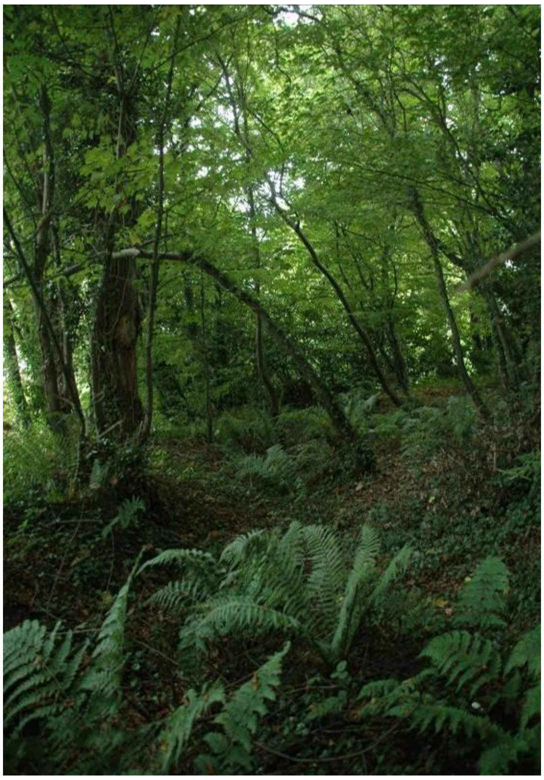

Plate 10.3 H30 bay and H32 Canal

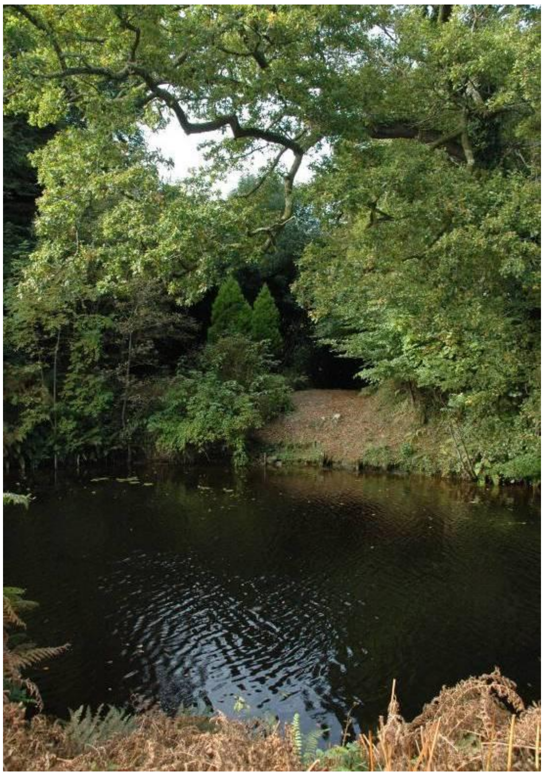

Plate 10.4 Partially infilled channel to rear of 'The Heronry' (eastward) (originally Clarisford Palace Estate)

The canal (**H32**) is somewhat neglected and falling into disrepair, with the banks slumping into the channel; however it is still used by small craft (**Plate 10.3**).

The narrow island between the canal and river is only accessible by boat and rarely visited by people, as a result it has a thick covering of bracken, small trees and scrub. The towpath of the canal is evident as a solid level area along the western edge of the island, although no surface can be seen at present. There is evidence of the remains of some buildings (**H33**), with one wall standing to a height of 1.60m (**Plate 10.5**). A raised area on the eastern half of the island is also bounded by a stone wall and on top of this is the footprint of another small building (**H33**, **Plate 10.6**). These buildings appear to broadly correspond with those indicated on the 1921 OS survey; there is no above ground evidence of the lime kiln seen on the 1st Edition map.

On the Tipperary side of the river, the route crosses the line of the railway (**H42**), now heavily overgrown and impossible to examine in detail. A deep and steep-sided cutting, filled with scrub and brambles, separates the railway from the rear of the properties along this edge of the river (**Plate 10.7**). The proposed Scheme passes through a boundary of mature ash and oak trees and across a small field of mown grass adjacent to the R494 road.

During the walkover survey for the Route Selection Study for the River Crossing a low grass-covered mound (**H43**) was observed in the field, however this was no longer apparent when the field was inspected in September 2009.

The route of the R494 was examined from the road. For most of its length the road is to be upgraded with just a few areas of rough pasture in adjacent fields and narrow strips at the front of a number of dwellings to be included within the scheme. A number of bridges and culverts will be impacted upon, including the railway bridge, and these are described in the Inventory below.

Plate 10.5 H33 Structural Remains

Plate 10.6 H33 Structural Remains

Plate 10.7 H42 Line of disused railway (on the right)

Summary of archaeological and historical background

The Killaloe/Ballina area has been significant for millennia, being an important crossing point of the River Shannon and the history of the study area is the history of the river crossing. Killaloe's importance as an ecclesiastical centre has led to a large number of histories of the diocese and town being written, including those by Dwyer (1878), Gwynn and Gleeson (1962) Kierse (2001, 2008), Murphy (1991, 1992) and

O'Murchadha (2008). There is, by comparison, far less information available about Ballina and the land on the eastern shores of the river.

Prehistoric Period

Although there is no evidence of Mesolithic (c. 8000-4000BC) activity in the immediate vicinity of the proposed Scheme, a site of this date was excavated at another potential fording point of the River Shannon south of Castleconnell. It is likely that Killaloe/Ballina was also an important crossing point during the Mesolithic period.

The earliest definitive evidence of human occupation of the area is demonstrated by the large number of Neolithic (c.4000-2500 BC) stone axes deposited in the River Shannon. It is believed that many of these items were probably deliberately deposited in a ritual fashion, rather than representing accidental losses. Neolithic occupation in the area is hinted at by a few artefacts recovered from a pre-ringfort phase of activity at Beal Boru and from stone axes found in the hills above Killaloe. Many of the copper, bronze and iron objects recovered from the river and its floodplains are likely to indicate a continuance of similar practices during the Bronze Age (c. 2500-600 BC) and Iron Age (c. 600 BC – AD 400).

The standing stones recorded in Creeveroe are probably Neolithic or Bronze Age in date and the *fulacht fia* (a burnt stone mound probably used for cooking) in Knockyclovaun is likely to be Bronze Age. It is probable that other undiscovered prehistoric sites such as the remains of dwellings, burials or *fulachtaí fia* survive in greenfield locations in the area. Recent excavations on the route of the new M7 Nenagh-Limerick revealed a high density of prehistoric domestic sites on the slopes of the Arra mountains south of Nenagh. The proposed Scheme for the Killaloe Bypass passes through a comparable landscape on a similarly important routeway.

Early Medieval Period (AD 400-1169)

The origins of Killaloe itself belong to the early medieval period when both the early church foundation of Cell-da-Lua (the church of St Lua or St Molua) and the secular site of Kincora (Ceann coradh – 'head of the weir') were established.

St Lua is thought to have founded a monastic establishment in the late 6th century. The earliest ecclesiastical site was located on Friar's Island (also known as Inis Lua and now in County Tipperary) in the River Shannon south of Killaloe and Ballina, although the focus of the settlement was later moved to the Co. Clare side of the river. Until 1929 the ruins of a 9th-10th century church stood on Friar's Island; however this building, the Oratory of St Lua, was moved stone-by-stone to the grounds of the Catholic Church of St Flannan, Killaloe in advance of the island being flooded during the Shannon Hydro Electric Scheme.

St Flannan, St Lua's successor who was consecrated as bishop in 639, is a patron of the diocese and parish and gives his name to the cathedral, the oratory and indeed the modern Catholic Church in Killaloe town. The feast day of St Flannan was traditionally celebrated on 18th December.

The importance of Cell-da-Lua increased during the later 11th and early 12th centuries and in 1111, at the Synod of Raith Bressail, it became the centre of a large diocese, essentially the basis for the current Diocese of Killaloe.

In the late 10th and early 11th centuries the settlement of Kincora (now buried beneath the centre of Killaloe town) grew in importance as the local Dal gCais dynasty rose to national prominence. Killaloe has long celebrated its association with Brian Boru (c.

940-1014), briefly High King of Ireland, who made Kincora his chief residence and also patronised the ecclesiastical site of Cell-da-Lua. The centre of power of the O'Brien kings moved to Limerick, however, during the reign of Muirchertach O'Brien (1089-1119).

The Annals contain numerous references to Killaloe. For example in 1050 an assembly of chieftains and clergy of Munster were called to the site by Donnchad, son of Brian Boru, to legislate against lawlessness caused by food shortages. Cell-da-Lua and/or Ceann Coradh were plundered or burned on several occasions, including in 1016, 1061, 1081, 1084, 1116, 1142, 1154 and again in 1185. Despite these troubles it appears that the ecclesiastical and secular settlements flourished during this period and in fact Cell-da-Lua was a renowned literary centre.

'Beal Boru' (CL045-031), a large earthen ringfort beneath a later Norman earthwork, appears to have been occupied until the early 12th century and is located on a promontory overlooking a fording point across the River Shannon. The site produced two Hiberno-Norse coins dating to the mid 11th century, an unusual find for the west of the country, suggesting the occupants were familiar with the use of coinage for trade.

It is likely that the first bridges across the Shannon were built, and destroyed, during this period. There is mention of a bridge in the 12th century Life of St Flannan, referring back to the early 8th century, and although the lives of saints cannot be taken as historical fact, it is not unreasonable to assume that there was a method of crossing the river without using a boat at the time when the early monastic settlement was established on Friar's Island. Certainly descriptions of 11th century events surrounding Brian Boru refer to a wooden bridge which was probably destroyed along with the town during the raids mentioned above. These earlier bridges need not have been located in the same place as the present crossing and it has been suggested that the river was previously spanned north of the town near Pier Head or close to Beal Boru.

The crossing point of the river was the reason for the establishment of Killaloe and it is likely that some settlement and defences were also constructed on the opposite side of the river during the same period, presumably in the area occupied by Ballina. The road south from Ballina to Limerick doubtless follows a long-established route.

The possible enclosure located adjacent to the proposed Scheme (CL045-057 – **H7**) may be of this date and the five enclosures on the high ground in Knockyclovaun (CL045-24, 25 27) and Creeveroe (CL045-23, 26) townlands probably also date to the early medieval period. On the Co. Tipperary side of the river enclosures in Roolagh (TN025-018) and Knockadromin (TN025-026, 027, 028) indicate that the area was occupied during the same period. It is noteworthy that it has recently been demonstrated that ringforts were being built and occupied into the medieval period in the west of Ireland and it is possible that in this Gaelic stronghold some of these unexcavated enclosures are later in date.

Medieval (AD 1169-1600)

During the medieval period Killaloe continued to thrive and a reference in 1185 to the borough of 'Kildalowe' suggests that the town was already established prior to the arrival of the Anglo-Normans, perhaps being dependant on Viking Limerick. Although the area had been granted by Henry II to Philip de Braose in 1177 he was unsuccessful in taking possession of the land and again in 1207 the English forces were repelled, although the later earthwork at Beal Boru may date to this raid.

Eventually in 1216 Anglo-Norman control was established when Geoffrey de Marisco erected a castle and installed an English bishop, however once the Pope removed the bishop in 1221 the town returned to local control.

St Flannan's Cathedral in Killaloe dates to the 13^{th} century, having been built to replace an earlier structure destroyed in a raid in 1185. St Flannan's Oratory nearby dates to the 12^{th} century. During The Reformation the cathedral became a place of Protestant worship with the first Protestant bishop appointed in 1570 and it remains today a Church of Ireland establishment.

The stone crosses of Killaloe probably date to the medieval period, although few stand in their original positions. Of particular note is a cross moved from Kilfenora to the grounds of the bishop's palace (Clarisford Palace) by Bishop Mant in 1820 and thence removed to the cathedral in 1834 (Kierse 2008, 309). Although a 'stone cross (site of)' is marked on the RMP, this is indicated as such on the 1893 survey and so pre-dates the removal of the Kilfenora cross. It is therefore likely that the Kilfenora cross is that indicated in the wooded area within the footprint of the proposed Scheme on the 1893 and 1915 surveys but not the later 1938 map (**H29**).

On the Tipperary side of the river, Ballina Castle (TN025-094002) was a Norman period defensive structure, reflecting the continuing importance of the crossing point. The location of the corresponding castle on the Clare side of the river is not clear but it may have been near the end of the current bridge.

It is not clear from the historical evidence at which times there was a bridge across the Shannon during the later medieval period. A number of 14^{th}-16^{th} century documents refer to the 'ford' of Killaloe suggesting there was no bridge but there clearly was one present in 1599 as it is recorded that it was broken by Red Hugh O'Donnell when he came to the town. It is likely that wooden bridges were built and destroyed on a number of occasions.

<u>Post-Medieval (AD 1600-present)</u>

The river crossing at Killaloe/Ballina continued to be important in the military campaigns of the 17^{th} century. Control of the bridge meant the ability to move troops to the west of the Shannon and provided access to Limerick.

During the Cromwellian campaign the river crossing at Killaloe/Ballina was again important. In May 1651 the commander of Cromwell's army, Henry Ireton, encamped at Ballina and facing him on the Killaloe side was a confederate force led by the Earl of Castlehaven (Kierse 2001, 36-41). Ireton's second in command, Edmund Ludlow, recorded in his diaries (reproduced 1998) that the Cromwellians dug trenches and lowered the ground, giving the impression that they intended to divert the river to make it fordable. Instead they secretly crossed the river at O'Briensbridge, going on the take Killaloe and eventually Limerick and Galway at which point the Cromwellian conquest of Ireland was complete.

The English Jacobite John Stevens, stayed in Killaloe in 1690 as troops marched from Limerick to relieve the besieged forces at Athlone. He was not impressed by the town describing the few 'tolerable' houses and the rest of the thatched cabins or cottages.

Despite losing out in importance to Limerick, Killaloe, and to a far lesser extent, Ballina, were thriving market towns during the later post-medieval period. The Shannon produced large catches of fish and eel and salmon weirs were utilised for this purpose. The development of the towns as a tourist destination was partly based on the reputation for the good fishing to be had in addition to a recognition of the 'romantic' beauty of the area and, as had always been the case, the prospects of the area continued to depend on the river.

The Limerick to Killaloe Canal (**H32**) was first proposed in the late 17^{th} century as part of a scheme to make the River Shannon navigable from Limerick through Lough Derg as far as County Leitrim. Work finally began in 1757 and boats first began to ply the route in 1799, controlled by the Limerick Navigation Company and during the 19^{th} century the Shannon Steam Navigation Company had its base at Killaloe and carried passengers and freight from O'Briensbridge north as far as Banagher. The construction of the national railway network in the mid to late 19^{th} century had a negative impact on the inland waterways of Ireland and the canal became obsolete when the river level was raised in the 1930s as part of the Shannon Hydro Electric Scheme.

During the 19^{th} century other large-scale engineering works were undertaken to regulate the flow of the River Shannon at Killaloe. In the 1840s the channel was deepened and a new weir was constructed north of the bridge in order to prevent winter flooding and further work was carried out in the 1880-1890s with the construction of sluices and further dredging taking place.

The improvements to the navigation of the river allowed the transport of commercial goods and vast quantities of slate were exported by boat from nearby quarries. The lime kiln shown on the 1842 map located on the spit of land between the canal and river within the Clarisford Palace estate was doubtless a commercial operation rather than for domestic use, located as it was adjacent to the major transportation route in the area. A water-powered marble factory was located on the banks of the canal in Killaloe town and hotels opened to cater for the increased tourist trade.

The Shannon Hydro-Electric Scheme, the construction of a hydro-electric power station at Ardnacrusha, began in 1925 and necessitated works in the river at Killaloe. In the early 1930s various sluice gates and the weir were removed and the river bed was dredged both above and below the bridge, at which time many of the archaeological artefacts recorded above were recovered. The result of the scheme was that the river level was raised substantially, inundating thousands of acres of land below Killaloe, including Friar's Island, the site of the original monastic settlement. It was at this time that The Oratory of St Lua was removed to Killaloe, although other elements of the island's archaeological heritage doubtless remain on the flooded island. In addition to destroying part of the heritage of the area the raised water levels saw the end of the salmon fishing industry for which Killaloe and Ballina had been renowned for centuries.

It is likely that these various improvements have disturbed, destroyed or flooded a large number of earlier features, such as eel weirs and fish traps, and that numerous artefacts were dumped along with dredged material.

The Killaloe-Limerick railway (**H42**) is another 19th century feat of engineering. It was first proposed in 1845 to connect Killaloe with Limerick by rail, via Birdhill, however parliamentary approval was slow and work didn't began until the 1850s. The first train ran in 1862, terminating downstream of Ballina, but in 1894 the line was extended to Killaloe Railway Station (actually located in Ballina) and again beyond the town to a terminus, wharfage and landing stage about half a mile upstream of the bridgehead. The railway closed in 1944 and little evidence of the route survives today.

Some of the standing post-medieval structures are discussed below in the section on Architectural Heritage.

10.2.2 Architectural Heritage

Introduction

A total of 71 sites, structures or properties lie within the study area, with Killaloe and Ballina towns and the bridge included in addition to all structures within 50m of the proposed road centreline. Of these, 27 are of some architectural merit with the remainder being late 20th or early 21st century dwellings, farm buildings or warehouses. In addition a number of new developments were observed during the walkover survey of the scheme that are not illustrated on the mapping in this report. These properties are not considered to be of architectural merit and are not referred to here.

Three of these structures, Ballyvally House Gate Lodge (RPS 440), Clarisford Palace (RPS 441) and the Killaloe-Ballina bridge (RPS 210) are on the Record of Protected Structures (RPS) and protected under the County Clare Development Plan as part of the specifications of the Planning and Development Act 2000. Under current legislation, a structure and its curtilage and other structures within that curtilage and their interiors are protected. The extent of that curtilage needs to be determined on a case by case basis as described in Architectural Heritage Protection: Guidelines for Planning Authorities (2004). The National Inventory of Architectural Heritage for County Clare survey is currently available online. In addition both Killaloe and Ballina towns include buildings listed on the relevant RPSs.

In a number of cases, sites of architectural merit also have archaeological or cultural importance and are mentioned in the relevant sections.

Large Houses / Estates

<u>***H2-H4**: Ballyvally House and Estate*</u>

H3: Ballyvally House is *'…a square, double pile, two-storey, three bay, gable-ended house, facing north, with a central front door. There are two bay, single storeyed wings with bowed ends on either side of the front. Each of the two first floor windows juts out on either side of the Ionic pillared porch. There are fine coach and utility houses facing the yard, which adjoins the rear of the house. The bowed gateway has niches and the quadruple pillars are surmounted by square banded globes. The driveway curves its way up to the house.*' It is likely that the present house lies on the site of a medieval tower.

The house is indicated on the 1787 Grand Jury Map of Clare and on all OS editions. On the 1840 edition, in addition to several outbuildings, a large formal garden is illustrated to the west of the house. On the 1938 edition the garden is shown in less detail and on modern maps the area is occupied by farm buildings. On the 1893 25" survey a well is indicated south-east of the house but this is not shown on later editions. The southern edge of the estate and some of the eastern approach are still wooded today.

H2: Ballyvally House Gate Lodge (RPS 440) is *'…a detached three-bay single storey gate lodge c.1820 with lancet-arched openings'*. The gateway to Ballyvally House comprises four stone-cut piers with moulded capping, globe finials and curved walls having square-headed pedestrian gates with keystones and dates to c 1800 (Co. Clare RPS).

H4: The southern boundary of the estate is formed by a strip of mature trees with earthen banks on either side. The northern side of the northern bank is stone-faced. The strip of trees is marked on the OS maps from 1840 onwards and it would appear that this is an original feature of the estate.

***H23-25, H30**: Clarisford Palace and estate*

H24: Clarisford Palace (RPS 441) is a detached five-bay, three-storey over basement structure with pedimented prostyle diastyle Tuscan portico to centre. Built as the palace of the Bishop of Killaloe between 1771-79, the house is now in private hands. The house was reroofed c. 1875 with hipped slate roof, dentilated [toothed] eaves and rendered chimneystacks Rendered walls with pilasters flanking door sidelights. Timber sliding sash windows, set in tripartite arrangement with continuous sill to centre first floor. Timber panelled half glazed door with timber cobweb fanlight, approached by flight of curved steps with wrought-iron railings. Retaining interior shutters. Detached six-bay two-storey rubble stone-built outbuilding. Cast-iron piers with cast-iron gates (NIAH).

The palace demesne was once extensive, occupying most of the northern part of Moys townland and can be seen as a wooded area on both the 1840 and 1938 OS editions. The proposed Scheme passes through the middle of the estate, north of the house, crossing the demesne wall (**H23**) and two sections of avenue leading to the house (**H25**). The land between the avenues and the canal to the east is illustrated on the early maps as wooded and on the 1893 survey, which is at a larger scale than the earlier map, a number of paths are marked running through the woods. A label saying ‘Stone Cross’ (**H29**) is in this area, however it is not clear exactly where the monument stands and after the 1921 edition this feature is no longer marked. This area is still wooded and now lies in the grounds of a private house.

On the 1840 OS map a small building is indicated on the western bank of the canal and on later editions this is marked as a boat house (**H31**). The walkover survey found no evidence of the boathouse remaining on the ground.

The walkover survey did, however, identify a number of features not marked on the maps at the edge of the canal within the road take for the proposed Scheme (**H30**). There is a small concave bay, with a series of rotten wooden posts in the water’s edge (**Plate 10.3**), presumably the remains of a timber quay allowing access to boats. South of this point, in the wooded area, the partially infilled remains of a channel can be seen parallel to the canal, 3m from its edge (**Plate 10.4**). This channel is approximately 3m wide and survives no deeper than 0.5m deep, although presumably it once was deep enough to be filled with water as it appears that it curves to connect to the canal within the grounds of the property to the south. Approximately 8m inland of this channel is a line of mature beech trees that are sufficiently old to belong to the original palace estate or to correspond with the construction of the canal.

A lime kiln and a small rectangular building (**H33**) are marked on the 1840 OS map on the narrow strip of land between the canal and river. These structures are not indicated the 1893 survey but two small buildings are illustrated in this location on the 1921 edition, although not on later maps. Some structural remains survive in this location (**Plates 10.5 and 10.6**) and these appear to be broadly comparable to the layout of the early 20th century buildings rather than the earlier ones.

***H70-H71**: Gortna House*

Gortna House is marked on the 1st Edition OS map as a complex of buildings set within wooded grounds. Access to the road is shown as being from the north, opposite the entrance to Fort Henry, although a small track is also illustrated at the south.

Later editions of the maps show few changes to the layout of the property and there are still two entrances to the estate from the road.

***H68** & **H74**: Fort Henry*

The house and grounds of Fort Henry are illustrated on the 1840 OS map with some paths and gardens marked. Two access points are evident, the northern one (**Plate 10.8**) being opposite the entrance to Gortna House and the southern joining the road at the Garrytineel/Kilmaglasderry townland boundary. Later maps show that both approaches have been cut by the railway line, now disused.

Plate 10.8 H68 Entrance to Fort Henry

Towns

***H35**: Killaloe town*

Killaloe town is a designated Architectural Conservation Area (ACA) in the County Clare Development Plan. The town is listed on the Records of Monuments and Places (RMP) and contains several structures listed on the RPS, including the Killaloe Bridge.

***H44**: Ballina town*

Although Ballina is not a designated ACA in the County Development Plan, there are two structures listed on the RPS within the town.

Bridges, culverts and underpasses

Ten bridges, culverts and underpasses lie within the study area, with most located along the existing R494 in Co. Tipperary.

__H35__: Killaloe-Ballina bridge

The bridge connecting Killaloe and Ballina is listed on the Clare Record of Protected Structures (RPS 210) as well as being an RMP site (CL045-03301 and TN025-09401). The bridge is described in the Industrial Heritage Review of County Clare (2008, 51) as a '*Thirteen-arched stone road bridge in good repair. Constructed of rubble limestone with coursed lime mortar joints. Concrete capping exists on parapets. Voussoirs [wedge-shaped stones] in good repair with cut ring stones over segmented arches. Cutwaters exist to south of vouissoirs. Soffits are in good repair with little evidence of render*.'

The current bridge incorporates several phases of building, including five surviving arches of the bridge that was probably built between 1715 and 1770. The western arch was added when the canal was constructed at the end of the 18th century, whilst at the eastern end the extension of the railway line in 1867 required an additional arch be built. Part of the bridge was swept away in a storm in 1821 and several phases of repair and replacement of small arches with wider spans took place during the 19th century. An iron lift bridge replaced one of the stone arches in the centre during the Shannon Hydro Electric Scheme in 1929 but has never been used since.

A plaque on the bridge commemorates four men shot there during by the British Army Auxiliaries during the War of Independence in 1920.

It is possible that the structure also includes elements of the 17th century stone bridge which historical sources would suggest stood in the same location.

Other bridges, culverts and underpasses

With one exception the remainder of the bridges and culverts impacted by the scheme lie on or close to the current R494. This road is indicated on the 1st Edition OS map and may well be earlier in date so it is likely that many of the river and stream crossings are early 19th century in date or earlier.

Cool Bridge (**H95**, **Plate 10.9**), where the R494 crosses the Kilmastulla River, is the most significant bridge, a single span stone arch. Adjacent to this bridge and probably constructed simultaneously, is an underpass (**H93**, **Plate 10.15**) on the northern side of the river allowing access beneath the road at river bank level.

Another small, double-arched, stone bridge (**H104**) over a stream is located at the extreme southern end of the scheme and would appear to be of some antiquity (**Plate 10.10**).

The others small streams are crossed by the road with concrete and steel bridges or pass beneath the road in concrete pipe culverts (e.g. **H89**, **Plate 10.11**). There is one small footbridge at the edge of the Fort Henry estate.

The bridge over the current railway line (**H99**) in Lackenavea (Egremont) townland was not examined in detail, however some elements could be seen to be of concrete and steel construction whilst others are of stone. The approach walls are stone.

Plate 10.9 H96 Cool Bridge

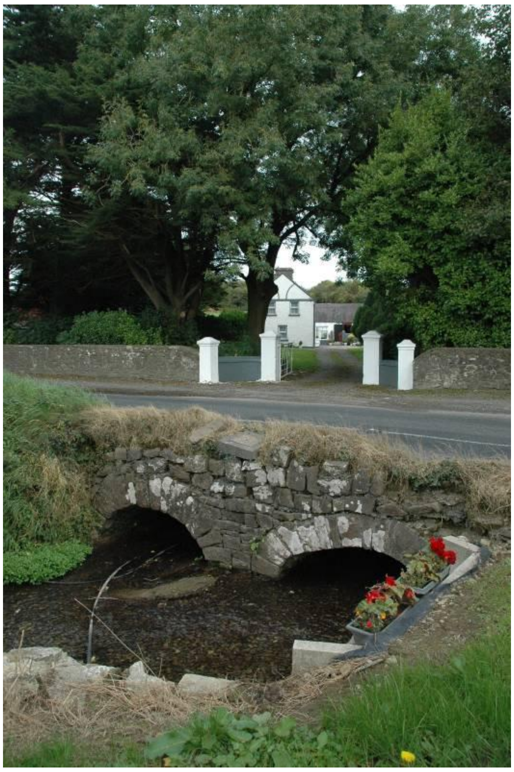

Plate 10.10 H108 Bridge and Farm H101, Background

Plate 10.11 H89 Culvert

Industrial Heritage Sites

The history of both the Limerick to Killaloe Canal and the Limerick to Killaloe Railway are described above in the archaeological background.

The canal (**H32**) is listed on the Clare Coastal Architectural Heritage Survey and recognised as being of regional importance. Although no longer used commercially, the canal remains a leisure boating facility. The canal is breached in places and connected with the river, including to the north of where it is crossed by the proposed Scheme. Within the footprint of the proposed scheme the sides of the canal are largely collapsed and the towpath is overgrown, although its line can be seen as a level area (**Plate 10.3**).

The lime kiln and other structures indicated on the early OS maps (**H33**) on the narrow strip of land between the canal and river are probably buildings associated with the utilisation of the canal as a means of transporting goods and materials. Some structural remains survive (**Plate 10.5** and **10.10**) but the undergrowth prevented a full inspection during the walkover survey.

After the Killaloe branch of the railway was closed in 1944 much (if not all) of the track was removed and the line fell into disrepair. Thick undergrowth prevented detailed inspection of the section where the route will cross (**H43**, **Plate 10.7**), but there is a substantial earthen embankment.

Farm Buildings

Two farms (**H91** and **H101**) that include early structures lie within the study area, although only one building will be directly affected by the proposed scheme on the Hayes' farm in Coolnadornory (**H91**). This stone shed (**Plate 10.12**) has a pitched slate roof, three doors (two on the south, one on the north) and a small window on the eastern end. Internally are some modern block divisions and the remains of a timber loft at the western end (**Plate 10.14**). This building is of architectural merit. Some other buildings at the northern end of the farm yard also incorporate early stone elements, but the remainder of the farm buildings are modern sheds.

Plate 10.12 H91 Farm Building

10.2.3 Cultural heritage

Townland names

Townland names provide information regarding topography and social activity. These are given below:

- Ballyvally Baile Uí Mhothla ‘homestead of the Mohilly (or Moakley) family’;
- Knockyclovaun Cnoc Uí Chlumháin ‘O Chlumháin’s hill’ or possibly ‘hill of the buzzard’;
- Creeveroe Craobh Rua ‘red branch’;
- Shantruad Sean tSráid ‘old street’ reputedly the road or street to Brian Boru’s palace;
- Killestry Cill Aistire ‘church of the doorkeeper’ (porter);
- Roolagh Rualach meaning not known;
- Garrynatineel Garraí na Tiníle ‘garden of the lime-kiln’;
- Kilmaglasderry Cill Mhac Laistre ‘church of the son of Laistre’;
- Knockadromin Cnoc na Dromainne ‘the hill of the mountain ridge’;
- Coolnadornory Cúil na dTornóirí ‘corner of the woodturners’ or ‘carpenter’s cornor’;
- Gortybrigane Gort Uí Bhriagáin ‘Brigane’s field’, or possibly ‘field of the standing stone’ as breagan in some parts of the country refers to a standing stone;
- Lackenavea (Egremont) Leacain na bhFia (Egremont) ‘the hillside of the deer’ or ‘flagstone of the deer’.

Townland boundaries

Townlands are an important landscape feature. These, the smallest recorded land divisions, are often of great antiquity and pre-date parishes and counties. Townland boundaries commonly utilise natural features such as streams, follow routeways, or are recognisable as substantial field boundaries that are easily distinguishable from the smaller field divisions.

Townland boundaries affected by the scheme in Co. Clare are:

- Ballyvally/Knockyclovaun;
- Knockyclovaun/Creeveroe;
- Creeveroe/Shantruad – note that the boundary changed between 1840 and 1938 OS editions, both are indicated on **Figure 10.1;**
- Shantruad/Killestry (twice);
- Shantraud/Moys.

Those in Co. Tipperary are:

- Roolagh/Garrynatineel;
- Garrynatineel/Kilmaglasderry;
- Kilmaglasderry/Knockadromin;
- Kilmaglasderry/Coolnadornory;
- Knockadromin/Coolnadornory;
- Knockadromin/Lackenavea (Egremont) (also parish boundary) – Plate 10.16;
- Lackenavea (Egremont)/Gortybrigane (also parish boundary).

The River Shannon is a townland, parish, barony and county boundary.

Townland boundaries are crossed fifteen times by the proposed Scheme, in some cases these crossings are also estate boundaries and are discussed under Architectural Heritage.

Folklore

Westropp

T J Westropp made a study of the folklore of Co. Clare in the early 20th century with several collections published between 1910 and 1913 (collectively reproduced 2000). Westropp recorded no stories, locations, superstitions or myths related to any of the townlands in the study area and made very little mention of the Killaloe area at all.

Irish Folklore Commission Schools Collection Scheme

The Irish Folklore Commission was established in 1935 and one of its earliest projects was a voluntary scheme whereby school pupils were encouraged to collect oral traditions from family and neighbours.

The pupils of Killaloe Boys School recorded the following stories in 1937-8:

'Hidden Treasure' was collected by Michael J Lynch from Frank Johnson (died 1934 aged 74) of Pier Head, Killaloe. Three locations of treasure are described as being in the waters of Lough Derg and the River Shannon. One of these is in Ballyvally townland, 200 yards north of Parker's boathouse (the Parkers being the owners of Ballyvally House at the time and the boathouse was located north of Beal Boru fort). Allegedly a crannog once stood in this spot and the inhabitants were killed in a raid, leaving their treasure hidden under the water. Another of the locations was in a marsh near Beal Boru and the treasure is supposed to have been hidden by Brian Boru himself, its secret location lost when he and his son were killed at Clontarf in 1014.

'Disasters' was collected from Michael Lewis (aged 70 at death) of Newtown, Killaloe, by Michael Lynch (aged 13). Amongst the tales of drownings and murders is a story of Brian Boru ambushing 'some boatloads of Danes' at a location called 'Casán', (Coosaun) about a mile below Killaloe, now submerged by the Shannon Hydro Electric Scheme. The burnings of the early town of Killaloe are mentioned, and it is said that on each occasion that the town was rebuilt it moved a little further north to reach its present position. The road from Killaloe to Ballyvally is mentioned as being the place where victims of an outbreak of cholera during the famine in 1847 were found dead, 'their mouths green from trying to eat grass on the roadside'.

Ballyvally is again mentioned in 'Bad Weather', heard by Michael J Lynch (aged 43) from his father Michael Lynch (aged 91 at his death in 1935) of St Lua St, Killaloe. Apparently a particularly violent storm occurred in 1907 and flooded Mr Parker's land at Ballyvally, tearing down trees, destroying the main road and drowning almost all his livestock.

'Clarisford' was recorded by Joseph Deane (aged 11) from his father Fred Deane (aged 54) of Clarisford, Killaloe. If they lived in Clarisford then presumably Fred Deane worked on the estate.

> 'I live in Clarisford. Clarisford is a patch of ground surrounded by a high wall. It is half a mile in length and a quarter of a mile in width. There are ten fields in it and two of them are got special names. The first one is called 'The Ram'

> field and the second one is called 'The Ass' field. There is a reason for them being called them names.
>
> For instance the first got its name from a Bishop who kept a number of asses. When they were finished working they were all put into the field and that is how it got its name
>
> The other field got its name from a well which is built in the middle of it. Long ago a number of rams were kept in it. Every night and every evening they used to go to the well for a drink and it is called the 'Ram field' ever after.
>
> Another very interesting place is the 'glen'. There is a small river running through it. Over the river there is a thick stone flag to serve as a bridge.
>
> Now printed on this stone flag there are some strange wrightings (sic). One is the head of a man and under it are some strange wrightings (sic).
>
> On the brink of the canal stands a small house. The house is made of galvanise, mostly the galvanise is nailed to thick wooden posts driven into the ground. Nobody ever goes near this house after dark as it is supposed to be haunted.
>
> Two years ago a big cement cross stood in the middle of the glen. But it was taken away by Mr Rafferty and it now stands in the prodistan (sic) Church.
>
> There is only one entrance to Clarisford and that is by the main entrance which is the front gates. On each side of the gate there are big cement pillars. The gate is made of thick strong iron. There are (sic) a long avenue leading from the gates to the house itself, on each side of the avenue there is a strong iron paling to protect the cattle in the fields on either side of the avenue. The avenue is about a quarter of a mile in length and four feet in width.'

This description of parts of the Clarisford Palace estate is informative. Perhaps the 'glen' is the wooded area in which a stone cross is indicated on the 1893 and 1921 maps. The removal of the cross two years prior to the collection of the information in 1937-8 would tally with references to the Kilfenora cross being moved in 1934 and it not being marked on the 1938 map. Although it is called a 'cement cross' it could easily have been stone as the stone gate pillars at the entrance to the estate are also referred to as being 'cement'. If this is the 'glen' then the whereabouts of the stone flag with 'strange wrightings' is unknown, although a meandering wet area in the woods to the rear of 'The Heronry' could correspond the description of a small river. Perhaps the haunted house described here is the boat house adjacent to the proposed Scheme, it is the only building marked on the historic maps within Clarisford estate 'on the brink of the canal'.

Table 10.2 Inventory

The archaeological, architectural and cultural heritage sites likely to be affected by the proposed Scheme option are listed below. Distances given are from the centreline of the proposed Scheme or slip roads, whichever is smaller.

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H1	Fig.10.1	None	-	Ballyvally	Culvert	Concrete culvert	Walkover	10m	Local	Direct, negative, significant	Record
H2	Fig. 10.1	Recorded Protected Structure	RPS 441, NIAH 20404510	Ballyvally	Gate House	Detached three-bay single storey gate lodge *c.*1820 with lancet-arched openings. At the gateway to Ballyvally House that comprises four stone-cut piers with moulded capping, globe finials and curved walls, square-headed pedestrian gates with keystones	Co. Clare RPS, cartographic sources (1840, 1893, 1915, 1938 OS)	20m	Regional	Indirect, negative, moderate	Ensure gate house and gateway not damaged during road construction works
H3	Fig. 10.1	None	-	Ballyvally	House and estate	Square, double pile, two-storey, three bay, gable-ended house with coach and farm buildings around yard at rear. Farm estate, park, woods.	Cartographic sources (1840, 1893, 1915, 1938 OS), Weir 1999	House – 180m Estate – on route	Regional	Indirect on house, direct on parts of estate, negative, significant	Visual impact on house minimised by road being in cutting. Boundary of new road to be in keeping e.g. stone wall or stone-faced bank

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H4	Fig. 10.1	None	-	Ballyvally/ Knockyclovaun	Estate boundary and townland boundary	Boundary of estate of Ballyvally House. Strip of mature trees with earthen banks either side, north-western bank stone-faced	Cartographic sources (1840, 1893, 1915, 1938 OS), walkover	On route	Local	Direct, negative, significant	Minimise loss of trees by design. Record. Archaeological test excavation
H5	Fig. 10.1	None	-	Knockyclovaun	Dwelling	20th century dwelling. Constructed between 1915 and 1938	Walkover	10m	None	No predicted impact	None
H6	Fig. 10.1	None	-	Knockyclovaun	Dwelling	20th century house	Walkover	On route	None	Direct, negative, will be removed Not significant	None
H7	Fig. 10.1 Plate 10.1	Recorded Monument	RMP CL045-057	Knockyclovaun	Enclosure (possible)	Possible enclosure recognised from aerial photograph. No evidence for enclosure on the ground	RMP archive, walkover	20m	Unknown, possibly national	Indirect negative impact on immediate location of monument. Potentially direct impact on outlying elements	Geophysical survey and archaeological test excavation. Full excavation and recording may be necessary.
H8	Fig. 10.1	None	-	Knockyclovaun	Garage	Small block-built garage.	Walkover	On route	None	Direct, negative, will be removed Not significant	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H9	Fig. 10.1	None	-	Knockyclovaun / Creeveroe	Townland boundary	Local road	Cartographic sources (1840 OS and later), walkover	On route	Local	Direct, negative, significant	Record
H10	Fig. 10.1	None	-	Creeveroe/ Shantraud	Townland boundary	Not visible on ground. Not townland boundary on 1840 map, moved during intervening years	Cartographic sources (1938 OS and later), walkover	10m	Local	Direct, negative, significant	Archaeological test excavation
H11	Fig. 10.1	None	-	Creeveroe/ Shantraud	Townland boundary	Not visible on ground. Was townland boundary in 1840 & 1893, not 1938	Cartographic sources (1840 - 1893 OS), walkover	10m	Local	Direct, negative, significant	Archaeological test excavation
H12	Fig. 10.1	None	-	Knockyclovaun	Dwelling	20th century semi-detached houses	Walkover	25m	None	Indirect	None
H13	Fig. 10.1	None	-	Knockyclovaun	Dwelling	20th century house	Walkover	25m	None	Indirect	None
H14	Fig. 10.1	None	-	Shantraud	Structures on 1st Edition OS map	Two small rectangular structures illustrated on 1st Edition OS map. No evidence seen on ground	1st Edition OS map surveyed 1840, walkover	10m	Local	No predicted impact	None
H15	Fig. 10.1	None	-	Shantraud	Dwelling	20th century house	Walkover	35m	None	Indirect	None
H16	Fig. 10.1	None	-	Shantraud	Dwelling	20th century house	Walkover	25m	None	Indirect	None
H17	Fig. 10.1	None	-	Shantraud/ Killestry	Townland boundary	Stream/trees	Cartographic sources (1840 OS and later), walkover	On route	Local	Direct, negative, significant	Record, archaeological test excavation

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H18	Fig. 10.1	None	-	Killestry	Structures on 1st Edition OS map	Two small rectangular structures illustrated on 1st Edition OS map	1st Edition OS map surveyed 1840	20m	Local	Direct, negative, potentially significant	Archaeological test excavation
H19	Fig. 10.1	None	-	Killestry	Structure on 1st Edition OS map	Small rectangular structures illustrated on 1st Edition OS map	1st Edition OS map surveyed 1840	5m	Local	Direct, potentially negative significant	Archaeological test excavation
H20	Fig. 10.1	None	-	Killestry/ Shantraud	Townland boundary	Stream/trees	Cartographic sources (1840 OS and later), walkover	On route	Local	Direct, negative, significant	Record, archaeological test excavation
H21	Fig. 10.1	None	-	Shantraud	Dwelling	20th century house	Walkover	30m	None	Indirect	None
H22	Fig. 10.1	None	-	Shantraud	Warehouse	Disused warehouse with overgrown gravel yard	Walkover	35m	None	Indirect	None
H23	Fig. 10.1	Curtilage of Recorded Protected Structure	Curtilage of RPS 441	Shantraud/Moys	Demesne boundary and townland boundary	In this location is earthen bank topped by mature trees	Co. Clare RPS, cartographic sources (1840 OS and later), walkover	On route	Regional	Direct, negative, significant	Minimise loss of trees by design. Record. Archaeological test excavation
H24	Fig. 10.1	Recorded Protected Structure	RPS 441, NIAH 20404514	Moys	Bishop’s Palace	Clarisford Palace. Detached five-bay, three-storey over basement structure. Built as the palace of the Bishop of Killaloe 1771-79. Now private dwelling	Co. Clare RPS, cartographic sources (1840 OS and later)	135m	Regional	Indirect, negative, significant – visual impact	Screening with appropriate tree planting. Boundary of new road to be in keeping.

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H25	Fig. 10.1	Curtilage of Recorded Protected Structure	Curtilage of RPS 441	Moys	Avenues	Two avenues leading through the estate to Clarisford Palace. Tarmac surfaced	Co. Clare RPS, cartographic sources (1840 OS and later)	On route	Regional	Direct, negative, significant	Record road structure during archaeological test excavation
H26	Fig. 10.1 Photo 10.2	None	-	Moys	Dwelling	20th century house - 'The Heronry'	Walkover	On route	None	Direct, negative – will be removed Not significant	None
H27	Fig. 10.1	None	-	Moys	Dwelling	21st century house	Walkover	20m	None	Indirect	None
H28	Fig. 10.1	None	-	Moys	Dwelling	20th century house	Walkover	20m	None	Indirect	None
H29	Fig. 10.1	None	-	Moys	Location of stone cross	Location of 'Stone Cross' labelled on 1893 25" OS map and 1915 6" OS map. Exact location not clear. Not seen during walkover survey. Probably moved to grounds of cathedral in 1930s – see folklore and documentary	Cartographic sources (1893, 1915 OS maps). Folklore Commission Schools Scheme, walkover	Possibly on route	Possibly national	Possibly significant negative direct impact, although exact location not clear	Archaeological test excavation

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H30	Fig. 10.1 Platess 10.3and 10.4	Curtilage of Recorded Protected Structure	Curtilage of RPS 441	Moys	Possible channel, bay and line of trees	3m wide channel, mostly infilled, parallel to canal. Concave bay with rotten wooden posts in waters edge. Line of mature trees probably corresponding with historic maps	Walkover	On route	Regional	Direct, negative, significant	Minimise loss of trees at design. Survey and archaeological test excavation
H31	Fig. 10.1	None	-	Moys	Structure on 1st Edition and later OS maps	Small rectangular structure illustrated on OS maps 1840-1938 and labelled as 'Boat House' on 1893 editions onwards. No visible remains on ground. Probable location has been converted to inlet for boats for new house adjacent to route.	Cartographic sources (1840, 1893, 1915, 1938 OS maps), walkover	25m	Local	No predicted impact	None
H32	Fig. 10.1 Plates 10.3	None	-	Moys	Canal	Canal, no longer in commercial use and poorly maintained, steep sided banks, collapsed stonework in places. Towpath on eastern side	Cartographic sources (Grand Jury map 1787, OS map 1840 onwards), documentary sources, walkover	On route	Regional	Direct, negative, significant. Canal will be preserved under culvert, tow path will be removed	Survey/record, archaeological test excavation of tow path. Monitoring of construction when canal bed exposed

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H33	Fig. 10.1 Plates 10.5 & 10.6	None	-	Moys	Structures on historic maps	Limekiln, rectangular structure and wall illustrated on 1st Edition OS map. Two rectangular structures and wall on 1915 survey. Not shown on later maps. Some structural remains seen during walkover	Cartographic sources (1840, 1915 OS surveys), walkover	On route	Local	Direct, negative, significant	Survey of standing remains and archaeological test excavation
H34	Fig. 10.1	None	-	Moys	Area of archaeological potential	Western banks of River Shannon. Although has archaeological potential area has been disturbed by canal and later development.	Walkover	On route	Unknown	Direct, negative, potentially significant	Archaeological test excavation
H35	Fig. 10.1	Recorded Monuments, Recorded Protected Structures, Architectural Conservation Area	CL045-033 (and sub-divisions). Bridge is RPS 210, NIAH 20300805	Moys	Historic town	Killaloe town, including cathedral, churches, stone crosses, bridge etc	RMP, RPS, ACA, cartographic sources, documentary sources	>500m	National	Indirect positive impact	None
H36	Fig. 10.1	None	-	Moys/Roolagh	River bed/ underwater and townland/ parish/ barony/ county boundary	Bed of River Shannon including submerged land	Underwater survey (Boland in RPS 2006)	On route	Unknown	Direct, negative, potentially significant	Detailed underwater survey. Archaeological monitoring of any dredging

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H37	Fig. 10.1	None	M3 in Boland underwater report	Moys/Roolagh	Underwater - stone culvert	Dry-stone culvert, possibly a drainage channel from the adjacent canal	Identified in underwater survey, Boland in RPS 2006	15m	Local	Indirect not significant	None
H38	Fig. 10.1	None	SS2 in Boland underwater report	Roolagh	Underwater – collapsed wall	Collapsed dry-stone walling, the remains of building or boundary wall. Note that would appear to be positioned in what used to be the channel between Friar's Island and the eastern bank of the Shannon	Identified in underwater survey, Boland in RPS 2006	10m	Unknown, possibly local or higher	Indirect not significant	None
H39	Fig. 10.1	None	M4 in Boland underwater report	Roolagh	Underwater – magnetic anomaly	Magnetic anomaly, possibly archaeological. Note that would appear to be positioned in what used to be the channel between Friar's Island and the eastern bank of the Shannon	Identified in underwater geophysical survey, Boland in RPS 2006	20m	Unknown	Indirect not significant	None
H40	Fig. 10.1	Recorded Monument	TN025-021	Friar's Island	Holy well – site of	Location of holy well on submerged Friar's Island	RMP, cartographic sources (1840 OS and later maps)	72m	National	Indirect, negative, potentially significant	Ensure silt does not wash downstream during construction
H41	Fig. 10.1	None	-	Roolagh	Area of archaeological potential	Eastern banks of River Shannon	Walkover	On route	Unknown	Direct, negative, potentially significant	Archaeological test excavation

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H42	Fig. 10.1 Plate 10.7	None	-	Roolagh	Line of railway	Line of Limerick-Killaloe Railway opened in 1862. Steep embankment, too overgrown to examine in detail during walkover	Documentary sources, cartographic sources 1860s onwards, walkover	On route	Regional	Direct, negative, significant	Survey/record
H43	Fig. 10.1	None	-	Roolagh	Mound	Overgrown mound identified during walkover for Shannon Bridge Route Selection. Not seen during 2009 walkover.	Route selection report (RPS 2006)	15m	Unknown	Direct, negative, potentially significant	Archaeological test excavation
H44	Fig. 10.1	Recorded Monument(s), Recorded Protected Structures	TN025-094 (and sub-divisions), two RPS structures in town	Ballina, Cullenagh (Templeachally Pr)	Historic town	Town, including bridge, site of tower house, weir	RMP, cartographic sources, documentary sources	>800m	National	Indirect positive impact	None
H45	Fig. 10.1	-	-	Roolagh	Dwelling	20th century bungalow	Walkover	25m	None	Indirect	None
H46	Fig. 10.1	None	-	Roolagh	Structure on 1st Edition OS map	Small rectangular structure illustrated on 1840 OS map and Griffith map but no later maps	Cartographic sources (1840 OS map, Griffith map)	6m	Local	Direct, negative, potentially significant	Archaeological test excavation
H47	Fig. 10.1	None	-	Roolagh	Structure on 1st Edition OS map	Small rectangular structure illustrated on 1840 OS map but no later maps	Cartographic sources (1840 OS map)	6m	Local	No predicted impact	None
H48	Fig. 10.1	None	-	Roolagh	Dwelling	20th century house	Walkover	15m	None	Indirect	None
H49	Fig. 10.1	None	-	Roolagh	Dwelling	20th century bungalow	Walkover	30m	None	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H50		None	-	Roolagh	Dwelling	20th century bungalow	Walkover	Adjacent – new access	None	Indirect	None
H51	Fig. 10.1	None	-	Roolagh	Dwelling	20th century bungalow	Walkover	Adjacent – new access	None	Indirect	None
H52	Fig. 10.1	None	-	Roolagh	Structure on 1st Edition OS map	Small rectangular structure illustrated on 1840 and 1893 OS maps and Griffith map but no later editions	Cartographic sources (1840 and 1893 OS maps, Griffith map)	5m	Local	Direct, negative, potentially significant	Archaeological test excavation
H53	Fig. 10.1	None	-	Roolagh/ Garrytineel	Townland boundary	Hedges/fences. Crosses roads. Some modern fences	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct, negative, significant	Record, archaeological test excavation
H54	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	20m	None	Indirect	None
H55	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century house	Walkover	20m	None	Indirect	None
H56	Fig. 10.1	None	-	Garrytineel	Dwelling	Small complex of buildings shown on 1902 25" OS survey, cottage is one of these so 19th or early 20th century date	Cartographic sources (1902 OS map and later)	10m	Local	No predicted impact	None
H57	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	5m – new access	None	Indirect	None
H58	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	15m – new access	None	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H59	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century house	Walkover	25m	None	Indirect	None
H60	Fig. 10.1	None	-	Garrytineel	Structures on 1840 - 1893 maps	Two small structures illustrated on 1840 OS, 1850 Griffith and 1893 OS maps	Cartographic sources (1840 OS, Griffith and 1893 OS maps)	4m	Local	Direct, negative, potentially significant	Archaeological test excavation
H61	Fig. 10.1	None	-	Garrytineel	Structure on 1840, 1850 and 1893 maps	Small structure illustrated on 1840 OS map and 1850 Griffith map, ruined on 1893 OS map	Cartographic sources (1840 OS, Griffith and 1893 OS maps)	6m	Local	Direct, negative, potentially significant	Archaeological test excavation
H62	Fig. 10.1	None	-	Garrytineel	Structure on 1893 and 1938 maps	Small structures illustrated on 1893 and 1938 OS maps	Cartographic sources (1893 and 1938 OS maps)	7m	Local	No predicted impact	None
H63	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	40m	None	Indirect	None
H64	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	30m	None	Indirect	None
H65	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century house	Walkover	30m	None	Indirect	None
H66	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	15m – new access	None	Indirect	None
H67	Fig. 10.1	None	-	Garrytineel	Gate Lodge	Gate Lodge for Fort Henry, recently renovated as private dwelling	Cartographic sources (1938 OS map – not on earlier maps)	15m	Local	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H68	Fig. 10.1 Plate 10.8	None	-	Garrytineel	Gateway	Entrance to and boundary of Fort Henry. Cast iron gates, stone piers, stone walls	Cartographic sources, walkover	Gate 6m, walls on route	Local	Direct, negative, significant –portion of boundary wall will be removed	Record gate and boundary. Minimise tree felling. Reconstruct boundary wall.
H69	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	44m – new access	None	Indirect	None
H70	Fig. 10.1	None	-	Garrytineel	House	Gortna House and grounds	Cartographic sources (1840, 1893, 1938 OS maps)	75m	Regional	Indirect	None
H71	Fig. 10.1	None	-	Garrytineel	Gateway	Entrance to Gortna House. Stone piers, walls	Cartographic sources (1840, 1893, 1938 OS maps), walkover	20m	Local	Indirect	Protect during construction
H72	Fig. 10.1	None	-	Garrynatineel	Dwelling	20th century bungalow	Walkover	25m	None	Indirect	None
H73	Fig. 10.1	None	-	Garrynatineel	Service station and garage	Modern petrol station and adjacent mechanic's establishment, concrete yard, fuel pumps etc	Walkover	15m	None	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H74	Fig. 10.2	None	-	Garrytineel	House	Fort Henry house and grounds	Cartographic sources (1840, 1893, 1938 OS maps)	190m	Regional	Indirect on house, direct on entrance roads at south and boundary (see H68)	Minimise tree felling to reduce visual impact. Avoid damage to entrance road during drainage works
H75	Fig. 10.2	None	-	Garrytineel	Culvert	Concrete culvert/bridge	Walkover	On route	Local	Direct, negative, significant	Record
H76	Fig. 10.2	None	-	Garrytineel	Bridge	Concrete and iron footbridge	Walkover	10m	Local	Direct, negative, significant	Record
H77	Fig. 10.2	None	-	Garrynatineel	Warehouses	Forthenry Business Park – warehouses and outlets. Not all on current maps	Walkover	30m	None	Indirect	None
H78	Fig. 10.2	None	-	Garrytineel/ Kilmaglasderry	Bridge	Concrete block bridge	Walkover	On route	Local	Direct	Record
H79	Fig. 10.2	None	-	Garrytineel/ Kilmaglasderry	Townland boundary	Stream/trees	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct	Record
H80	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20th century bungalow	Walkover	30m	None	Indirect	None
H81	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20th century bungalow	Walkover	35m	None	Indirect	None
H82	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20th century house	Walkover	45m	None	Indirect	None
H83	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20th century bungalow	Walkover	35m	None	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H84	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20^{th} century house	Walkover	40m	None	Indirect	None
H85	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20^{th} century house	Walkover	40m	None	Indirect	None
H86	Fig. 10.2	None	-	Kilmaglasderry	Dwelling	20^{th} century bungalow	Walkover	30m	None	Indirect	None
H87	Fig. 10.2	None	-	Kilmaglasderry / Coolnadorney	Townland boundary	Stream/trees	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct, negative, significant	Record
H88	Fig. 10.2	None	-	Kilmaglasderry / Knockadromin	Townland boundary	Trees/hedge	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct, negative, significant	Record
H89	Fig. 10.2 Plate 10.11	None	-	Kilmaglasderry / Coolnadornory/ Knockdrommin	Culvert	Concrete pipe for stream beneath road, concrete wall at east	Walkover	On route	Local	Direct, negative, significant	Record
H90	Fig. 10.2	None	-	Cool/ Knockadromin	Townland boundary	Road, southern kink no longer visible as passes under farm building	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct, negative, significant	Record

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H91	Fig. 10.2 Plates 10.12	None	-	Coolnadornory/ Knockadromin	Farm – on maps from 1840 onwards	Farm. Various buildings shown on historic maps, new barns etc in current use. Stone shed to be removed has pitched slate roof and remains of internal timber loft at west end	Cartographic sources (1840 OS and later maps), walkover	7m	Local (some buildings)	Indirect for most but direct, negative, significant for one building that will be removed	Record building to be removed.
H92	Fig. 10.2	None	-	Knockadromin	Dwelling	20^{th} century house	Walkover	18m	None	Indirect	None
H93	Fig. 10.2 Plate 10.15	None	-	Knockadromin	Underpass	Stone passage under road, similar construction to Cool Bridge and probably contemporary	Walkover	17m	Local	Indirect. Will be redundant	Record. Avoid disturbance during construction works
H94	Fig. 10.2 Plate 10.16	None	-	Knockadromin/ Lackenavea (Egremont)	Townland boundary	Substantial earthen bank	Cartographic sources (1840 OS and later maps), walkover	On route	Local	Direct, negative, significant	Record, archaeological test excavation
H95	Fig. 10.2 Plate 10.9	None	-	Lackenavea (Egremont)	Bridge	Cool Bridge over Kilmastulla River. Single span, cut stone, overgrown with ivy.	Cartographic sources (1840 OS map onwards), walkover survey	17m	Local	Indirect. Will be redundant so risk of deterioration if not maintained	Record. Avoid disturbance during construction works

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H96	Fig. 10.2	None	-	Lackenavea (Egremont)	River – archaeological potential	Kilmastulla River	Cartographic sources (1840 OS map onwards), walkover survey	On route	Unknown	Indirect, negative, potentially significant. New bridge will span river	Wade survey. Targeted test excavation
H97	Fig. 10.2	None	-	Lackenavea (Egremont)	Dwelling	Cottage – shown on 1840 OS map onwards. Extended from original.	Cartographic, walkover	6m – new access	Local	Indirect	None
H98	Fig. 10.2	None	-	Lackenavea (Egremont)	Business park	Business park – not all warehouses shown on maps	Walkover	25m – new access	None	Indirect	None
H99	Fig. 10.2	None	-	Lackenavea (Egremont)	Railway bridge	Bridge carrying road over railway. Walls on approach are stone but bridge is concrete block. Built between 1840 and 1862	Cartographic sources (not on 1840 OS map but on Griffith map and later maps)	On route	Local	Direct negative, significant. Bridge will be replaced	Record
H100	Fig. 10.2	None	-	Lackenavea (Egremont)/ Gortybrigane	Townland boundary	Track/trees	Cartographic sources (1840 OS and later maps), walkover survey	On route	Local	Direct, negative, significant	Record
H101	Fig. 10.2 Plate 10.10	None	-	Gortybrigane	Farm	Farm. Several buildings shown on historic maps	Cartographic, walkover	20m – new access	Local	Indirect on buildings, direct on boundary	Replace boundary with appropriate wall
H102	Fig. 10.2	None	-	Gortybrigane	Dwelling	20th century house	Walkover	45m	None	Indirect	None

Site no.	Figure/ Plate	Legal status	Reference no.	Townland	Site type	Description	Sources	Distance from route	Perceived significance	Impact	Mitigation measures
H103	Fig. 10.2	None	-	Gortybrigane	Dwelling	20th century house	Walkover	40m	None	Indirect	None
H104	Fig.10.2 Plate 10.10	None	-	Gortybrigane	Bridge	Stone bridge, two arches	Walkover	On route	Local	Direct	Record. Minimise impact by design
H105	Fig. 10.2	None	-	Gortybrigane	Dwelling	20th century house	Walkover	30m	None	Indirect	None

10.3 Impact Assessment

10.3.1 Impacts on Archaeological Heritage Sites

The impact of the proposed scheme on the archaeological heritage sites identified above is assessed as follows (NRA 2005a, sourced from EPA guidelines):

Types of Impacts

The following types of impact are recognised for the assessment of predicted impact of the proposed Scheme on the sites identified:

Direct Impact-	A direct impact is where an archaeological heritage 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-	An indirect impact is where a feature or site of archaeological heritage merit or its setting is located in close proximity to the footprint of a potential route alignment. These impacts may be ameliorated at the detailed design stage and with the implementation of mitigation strategies.
No predicted Impact -	No predicted impact occurs when the potential route does not adversely or positively affect a site

Quality of impacts

The impacts of the proposed route on the archaeological, architectural and cultural heritage environment are first assessed in terms of their quality i.e. positive, negative, neutral (or direct and indirect).

Negative Impact -	A change that will detract from or permanently remove a site from the landscape.
Neutral Impact -	A change that does not affect the archaeological heritage.
Positive Impact -	A change that improves or enhances the setting of an archaeological heritage site.

Significance of impacts

The significance rating is given for the impacts of the proposed route on the archaeological, architectural or cultural heritage:

Profound -	Applies where mitigation would be unlikely to remove adverse effects. Reserved for adverse, negative effects only. These effects arise where a 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 the 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 direct impact arises where a change to the site is proposed which though 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 a modern day development without damage and that all procedures used to facilitate this are reversible.
Slight -	An impact which causes changes in 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.

Impacts on Recorded Monuments

This proposed route has a direct negative impact on a single known archaeological monument (**H7** - possible enclosure CL045-057). As there is no above ground expression of the monument its extent cannot be ascertained and the impact may potentially be direct and significant.

The proposed Scheme will lead to a the reduction in through traffic which would have positive indirect impacts on Killaloe town (**H35** - CL045-033) and Ballina town (**H44** - TN025-094) and their monuments. The bridge between the towns (CL045-03301 / TN025-09401) would benefit particularly.

There will be no direct impact on the monuments on Friar's Island, however construction of the new crossing will be immediately upstream of the island and there may be some indirect impact.

Impacts on areas of archaeological potential

As with any road route through a greenfield landscape, there is the potential for uncovering archaeological sites with no above ground expression.

There is the potential for negative direct significant impact on the shores of the River Shannon (**H34, H41**) the river bed (**H36**) and greenfield zones within the route.

A possible mound (**H43**) identified during an earlier walkover survey will be directly significantly impacted upon.

Of the eleven locations where structures marked on historic maps lie within the study area, eight are within the proposed road take and there is potential for direct significant impact on any surviving below ground remains.

Underwater archaeology and watercourses

The proposed scheme will impact on the bed of the River Shannon (H36) during construction of the new bridge. In addition to the general potential of the river bed, three possible archaeological sites were identified during the previous underwater survey (**H37-9**). The level of impact on these sites will depend on the details of construction, although they may all be at risk of silt washing downstream during the works.

The Kilmastulla River (**H96**) is the largest of the other watercourses within the scheme. There will be a new single span bridge as part of the scheme so impacts are limited to construction activity.

Several small watercourses, streams and drains are crossed by the proposed Scheme on the Co. Tipperary section, the widening of the R494. Some of these will be deepened or widened to improve drainage.

10.3.2 Impacts on architectural heritage sites

The impact of the proposed scheme on the architectural heritage sites identified above is assessed as follows (NRA 2005b, sourced from EPA guidelines):

Perceived Significance

Each architectural heritage site identified is assessed for its significance, being of local, regional, national or international importance.

Sites listed on the Record of Protected Structures have importance categories already assigned and these have been extended to all elements within their curtilages.

Late 20th or 21st Century dwellings have been classed as of no perceived significance.

Types of Impacts

The following types of impact are recognised for the assessment of predicted impact of the proposed Scheme on the sites identified:

Direct Impact- A direct impact is where an architectural heritage feature or structure is physically located within the footprint of a potential route and entails the removal of part, or all of the structure, monument or feature.

Indirect Impact- An indirect impact is where a feature or structure of architectural heritage merit or its setting is located in close proximity to the footprint of a potential route alignment. These impacts may be ameliorated at the detailed design stage and with the implementation of mitigation strategies.

No predicted Impact - No predicted impact occurs when the potential route does not adversely or positively affect a site

Quality of Impacts

The impacts of the proposed route on the archaeological, architectural and cultural heritage environment are first assessed in terms of their quality i.e. positive, negative, neutral (or direct and indirect).

Negative Impact - A change that will detract from or permanently remove a site from the landscape.

Neutral Impact - A change that does not affect the architectural heritage.

Positive Impact - A change that improves or enhances the setting of an architectural heritage site.

Significance of Impacts

The significance rating is given for the impacts of the proposed route on the archaeological, architectural or cultural heritage:

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 of architectural heritage is permanently impacted upon leading to a loss of character and integrity. 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 capable of measurement but without noticeable consequences.

Impacts on Protected Structures

Three sites listed on the Record of Protected Structures (RPS) for County Clare will be impacted upon, these are discussed in turn in the context of their wider estates.

***H2-H4**: Ballyvally House Estate*

Ballyvally House Gate Lodge (**H2** - RPS 440) will be indirectly negatively impacted upon. Although Ballyvally House itself is not on the RPS, it will be considered that the entire estate is of architectural heritage merit. The proposed Scheme passes through the estate and breaches the southern boundary of mature trees and stone faced earthen bank (**H4**), having a significant negative impact upon these features. The setting of the house (**H3**) itself will be slightly affected too, although as the new road will be in a cutting in this location the visual impact will be lessened.

H23-5, H30: Clarisford Palace Estate

Clarisford Palace (**H24** - RPS 441) is itself over 100m from the proposed Scheme but there will be indirect impact on its setting and significant direct impact on various elements of its demesne. The western estate boundary of mature trees on an earthen bank (**H23**) will be breached, the avenues (**H25**) connecting the house with the cathedral will be severed and a wooded area adjacent to the canal will be crossed by the route. It appears from the available evidence that the route directly impacts on a possible quay, an infilled channel and a line of mature trees at the edge of the canal (H30).

Killaloe and Ballina

Killaloe-Ballina Bridge (RPS 210) will be indirectly positively impacted upon by the proposed scheme as the volume of traffic crossing the river at this point will be greatly reduced, improving the amenity of the bridge.

In addition, Killaloe town (**H35**), an Architectural Conservation Area in the Clare County Development Plan that contains several buildings listed on the RPS, will be indirectly positively impacted upon by a reduction in traffic passing through. Ballina town (**H44**) also contains two buildings listed on the Co. Tipperary RPS and will be similarly indirectly positively impacted upon.

Impacts on Other Structures

Direct impact on structures of architectural merit

There will be a direct impact on two sites of architectural merit, both of which are in Co. Tipperary.

Although not listed on the RPS for Country Tipperary NR, Fort Henry (**H74**) and its estate will be considered to be of architectural merit. This is a large estate and much of the grounds on the eastern side, adjacent at the R494 are heavily wooded. There will be a negative impact on the northern estate entrance and nearly 600m of the eastern boundary (**H68**) will be removed as the route curves 25m into the estate. The boundary varies along its length and it is not clear how much of the wall is from the original estate and how much relates to more recent road works. The access road at the south of the estate may be affected by drainage works in the adjacent stream.

A 19th century stone shed within the Hayes farm in Coolnadornory (**H91**) will be removed as part of the proposed scheme.

The farm at the south of the scheme (**H101**) will suffer loss of some of its boundary and also visual impact.

Indirect impact on structures of architectural merit

Although not listed on the RPS for Country Tipperary NR, Gortna House (**H70**) and its estate will be considered to be of architectural merit. The estate will not be directly impacted as the road alignment has been moved to avoid damage to the boundary and gateway (**H71**). The trees along the boundary at the edge of the R494 will screen the house and visual impact will be minimal.

Direct impact on structures of no architectural merit

Two modern dwellings (**H5, H26**) and an isolated garage (**H8**) will be directly negatively impacted by the proposed development and are scheduled for removal. As these structures are not considered to be of architectural merit the impact on the archaeological heritage is not significant.

Indirect Impact on Structures of No Architectural Merit

There will be indirect impact on 41 structures of no architectural merit, largely modern dwellings, farm buildings and warehouses. In most cases this will be visual impact or the removal of small parts of their grounds for the widening of the R494. None of these impacts are considered significant.

Bridges, Culverts and Underpasses

In addition to Killaloe bridge, mentioned above, five bridges, three culverts and one underpass will be impacted by the scheme.

The Cool Bridge (**H95**) over the Kilmastulla River will become redundant as a new bridge will be constructed over the river to the east. The adjacent underpass (**H93**) will be similarly preserved.

The bridge at the south of the scheme (**H104**) may be directly impacted depending on the final design.

The bridge over the railway (**H99**) will be removed and replaced.

Small culverts along the R494 will be impacted by the upgrade works and will generally be replaced or enlarged.

Industrial Heritage Sites

The Limerick to Killaloe Canal (**H32**) will be directly impacted by the scheme. On the completion of the project the canal will continue to flow through a culvert beneath the new road. The towpath currently lies along the eastern side of the canal at this point and will be removed in order to build the new bridge, but a walkway will allow pedestrian access along the western side of the canal bank.

The structural remains on the island between the canal and the river (**H33**) will be removed during construction.

The line of the Limerick to Killaloe Railway (**H42**) will be directly impacted by the eastern end of the new bridge.

10.3.3 Impacts on cultural heritage sites

Townland boundaries will be directly and significantly impacted upon in fifteen locations, including the River Shannon.

Other aspects of cultural heritage are dealt with alongside the archaeological and architectural heritage aspects of the scheme.

10.4 Mitigation

Recommendations for mitigation are made subject to approval by the National Monuments Section of the Department of Arts, Heritage and the Gaeltacht.

10.4.1 Mitigation of impacts on archaeological heritage sites

Recorded Monuments

There are no Recorded Monuments directly impacted upon by the proposed scheme, however possible enclosure CL045-057 (**H7**) may be indirectly impacted upon and associated features may be directly impacted. This potential site will be subject to geophysical survey and, based on the results of that survey, targeted archaeological test trenching and subsequent excavation if required.

The submerged Recorded Monuments on Friar’s Island (**H40**) may potentially be impacted upon during construction, although they lie some distance downstream of the proposed Scheme. The construction methodology will have to take account of this sensitive underwater area.

Areas of archaeological potential

There is potential for previously unrecorded below-ground archaeological remains to be present within the land take of the proposed development. Several areas have been highlighted as having especially high potential.

In conformity with archaeological best practice as outlined in National Monuments Section of the Department of the Environment, Heritage and Local Government guidelines (DAHGI 1999a and DAHGI 1999b) the entirety of the route will be subject to a programme of archaeological testing. This assessment will take the form of archaeological test trenching that examines at a minimum 10% of the total area of the selected road route. Should archaeological remains be encountered these will be subject to full excavation and further monitoring during construction may be recommended.

The banks of the River Shannon (**H34, H41**) will be subject to test trenching, with the especial note that if any dumps of material dredged from the river bed are encountered these may contain archaeological artefacts.

Greenfield areas, especially in the Co. Clare part of the scheme will be subject to test trenching.

The possible mound seen in Roolagh townland (**H43**) will be targeted during test trenching.

The locations of structures seen on historic maps but that are no longer standing will be targeted during test trenching. Where there is minor road widening taking place on the R494 it may not be possible to access the narrow strip of land made available prior to construction, in which case these areas will be subject to archaeological monitoring. Based on the results of the test trenching further excavation of these sites may be required, or they may be sufficiently recorded during the testing process. Consultation with the appropriate authorities will be necessary and decisions will be made on a case-by-case basis.

No construction activities take place outside the limits of the CPO without prior consultation with the site archaeologist as there may be archaeological sites in the fields adjacent to the proposed Scheme.

Underwater archaeology and watercourses

An underwater survey has already been carried out in the River Shannon for the proposed Scheme. The riverbed including the lands inundated in 1930 is considered to be of very high archaeological potential (**H36**). The original survey report recommended further detailed survey of the selected route.

If any dredging is required as part of the scheme the locations will be agreed in advance under archaeological advice and the dredging itself will be archaeologically monitored.

There is potential for indirect impact on archaeological features in the river downstream of the new crossing, for example by silt deposition. This will be mitigated against during construction.

Once detailed engineering and design decisions have been made a further assessment of the impact of the scheme on the three identified underwater sites (**H37-9**) will be made. It may be necessary to excavate these sites archaeologically prior to construction if they will be negatively impacted upon.

The Kilmastulla River (**H96**) will be subject to a wade and metal detector survey and targeted test excavation along its banks.

The small watercourses crossed by the scheme have not been assessed in detail. Any dredging for improved drainage will be monitored.

10.4.2 Mitigation of impacts on architectural heritage sites

Protected Structures

***H2-H4**: Ballyvally House estate*

Ballyvally House Gate Lodge (**H2**) will be protected from damage during construction. The gate will still function as an entrance to the estate, albeit with a new access connecting it to the new road.

The visual impact on Ballyvally House (**H3**) itself will be reduced by the fact that the road will be in a cutting at this point. The new boundary along the edge of the road take will reflect the current boundary.

The impact on the southern estate boundary (**H4**) of mature trees and stone-faced earthen banks may be minimised during detailed design, with an effort made to fell as few trees as possible. The boundary will be preserved by record, including a photographic and scaled drawn record, and test trenching during the archaeological testing.

***H23-25, H30**: Clarisford Palace estate*

The impact on the western estate boundary (**H23**) of mature trees and an earthen bank may be minimised during detailed design, with an effort made to fell as few trees as possible. The boundary will be preserved by record, including a photographic and scaled drawn record, and test trenching during the archaeological testing.

Clarisford Palace (**H24**) itself will suffer indirect visual impact and this will be minimised by screening and the erection of a suitable boundary.

The avenues (**H25**) are recorded cartograhically but will be targeted during archaeological test trenching to examine the make-up of the road and record earlier road surfaces and possible flanking features such as ditches. Further archaeological excavation may be required on the basis of the results of test trenching.

The partially infilled channel, the line of mature trees parallel with the canal and the slight bay with rotten wooden posts (**H30**) will be recorded with a written, drawn and photographic record being made. These features will also be targeted during archaeological test trenching and it may be necessary to undertake archaeological excavation of the channel and post structure.

The number of mature trees felled will be minimised during design stage, although as this is the location for the start of the new bridge there will probably not be a great deal of flexibility in the design. It is noted that although the line of trees would have originally been continuous along the edge of the canal, they only survive sporadically in the grounds of the new dwellings north of the proposed Scheme.

<u>H35, H44</u>*<u>: Killaloe and Ballina</u>*

No further mitigation is required for Killaloe and Ballina towns or for the Killaloe-Ballina Bridge for which the impact of the proposed scheme will be positive.

<u>Other structures</u>

Structures of architectural merit

The entrance to Gortna House (**H70, H71**) is immediately adjacent to the proposed works and will be protected during construction.

The northern gate and eastern boundary (**H68**) of Fort Henry (**H74**) will be preserved by record with a photographic and descriptive record being made. The felling of trees along the boundary will be minimised by design to reduce visual impact. The western boundary of the new road within the estate will be in keeping with the original that will be removed.

If it is not possible to avoid removing the farm building in Coolnadornory (**H91**) it will be preserved by record; this record will include, at a minimum, a photographic survey, brief written description and floor plan of each building. The ensuing records will be lodged in a well-established repository.

<u>Bridges and Culverts</u>

The Killaloe-Ballina Bridge requires no further mitigation.

Although the Cool Bridge (**H95**) over the Kilmastulla River and the adjacent underpass (**H93**) will be left intact, a photographic and descriptive record will be made.

The most desirable mitigation for the bridge at the south of the scheme (**H104**) is that impact be reduced by design, however if this is not possible the bridge will be preserved by descriptive, drawn and photographic record.

The mitigation for the other bridges, culverts and underpasses will be photographic and descriptive records. Although many of these features appear to be of no architectural merit the fact that the line of the R494 is an old route might indicate that there are early elements contained within the later features.

It may be necessary to carry out some of the recording during monitoring of construction works.

<u>Industrial Heritage Sites</u>

The impact on the Limerick-Killaloe canal (**H32**) has been mitigated by design on that it will continue to flow through a culvert beneath the new road. The towpath will be removed and this will be surveyed and examined by archaeological test trenching.

It will be necessary to survey the line of the Limerick-Killaloe Railway (**H42**) following scrub clearance.

The remains of industrial buildings on the island between the canal and river (**H33**) will be preserved by record. The site will initially be surveyed and will then be subject to targeted archaeological test excavation. It is likely that full archaeological excavation will be required in this area.

10.4.3 Mitigation of impacts on cultural heritage sites

Most of the cultural heritage features such as estate boundaries and industrial heritage sites are included in the archaeological or architectural sections above.

Townland boundaries

The impact on townland boundaries will be preservation by record. In many cases this can be done during test trenching, however it should be noted that it may be necessary to undertake the recording prior to site clearance if this is to be carried out in advance of archaeological testing. In the case of the boundaries that have been removed by agricultural activity the record will be made during archaeological test trenching.

Appendix 10.1

List of Stray Finds

Stray Finds from the Topographical Files of the National Museum of Ireland

<u>Co. Clare</u>

Killestry
1961:194 polished stone axehead, Deer Park
1961:195 polished stone axehead, Deer Park
1986:23 polished stone axehead, house foundation

Creeveroe
1948:89 stone axehead incomplete
1948:90 stone axehead incomplete
1948:91 stone axehead incomplete
1961:196 polished stone axehead
1961:197 polished stone axehead
1961:198 polished stone axehead
1961:199 polished stone axehead
1961:200 polished stone axehead
1961:201 polished stone axehead
1961:202 polished stone axehead
1961:203 polished stone axehead

Knockyclovaun
1969:835 whetstone?

Ballyvally
1985:67 blade tip dagger or rapier, bank of River Shannon
1986:1 pronged and slotted iron object, river bank at Kincora
1986:2 spur rowel, river bank at Kincora
1986:3 shoe buckle, river bank at Kincora
1986:4 shoe buckle, river bank at Kincora
1986:5 shoe buckle, river bank at Kincora
1986:6 lead fragment, river bank at Kincora
1986:21 copper alloy mount, river bank at Kincora
1989:85 16th c. long iron sword, R. Shannon W. side, above Killaloe off Cullenagh
1989:86 iron la tene? sword blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:87 iron la tene? sword blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:88 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:89 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:90 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:91 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:92 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:93 iron sword crannog blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:94 pistol flintlock gun, R. Shannon W. side, above Killaloe off Cullenagh
1989:95 bronze basal looped spearhead, R. Shannon W. side, above Killaloe off Cullenagh
1989:96 iron spearhead, R. Shannon W. side, above Killaloe off Cullenagh
1989:97 iron spearhead, R. Shannon W. side, above Killaloe off Cullenagh
1989:98 iron spear butt, R. Shannon W. side, above Killaloe off Cullenagh
1989:99 iron arrowhead, R. Shannon W. side, above Killaloe off Cullenagh
1989:100 iron axehead, R. Shannon W. side, above Killaloe off Cullenagh

1989:101 pronged and socketed iron object, R. Shannon W. side, above Killaloe off Cullenagh
1989:102 iron brooch, R. Shannon W. side, above Killaloe off Cullenagh
1989:103 iron sword blade, R. Shannon W. side, above Killaloe off Cullenagh
1989:105 zoomorphic pin, R. Shannon W. side, above Killaloe off Cullenagh
1989:107 flat axehead, R. Shannon W. side, above Killaloe off Cullenagh
1989:108 iron nail, R. Shannon W. side, above Killaloe off Cullenagh
1989:109 copper alloy sword, R. Shannon W. side, above Killaloe off Cullenagh
1989:110 iron sword (sabre), R. Shannon W. side, above Killaloe off Cullenagh
1989:111 pocket knife, R. Shannon W. side, above Killaloe off Cullenagh
1992:73 tubular copper alloy spear butt, R. Shannon W. side, above Killaloe off Cullenagh

Co. Tipperary

Roolagh
1960:512 polished stone axehead, River Shannon, Friar's Island

Knockadromin
1961:205 polished stone axehead, Summerhill

Chapter 11

Interrelationships / Interactions

Chapter 11 Interrelationships/Interactions

Each of the various environmental and related topics has been discussed separately. This chapter identifies the impacts of the mitigation measures included in the EIS on interdependencies in the existing environment. These have been identified in the following table.

Table 12.1 Matrix to Summarize Inter-relation of Environmental Topics and Issues

Receptor / Activity	Traffic	Human Beings	Noise and Vibration	Air Quality	Landscape and Visual	Terrestrial Ecology	Soils	Climate	Aquatic Ecology	Archaeology, Architecture & Cultural Heritage
Traffic		●	●	●	●	●			●	
Human Beings					●					●
Noise & Vibration		●								
Air Quality		●				●			●	
Landscape / Visual		●				●	●		●	●
Terrestrial Ecology					●					
Soils					●	●			●	
Climate										
Aquatic Ecology						●				
Archaeology, Architecture & Cultural Heritage		●			●					

● Key interactions/interrelationships effects highlighted.

The various interactions identified in this chapter have been discussed in each of the previous chapters in terms of the manner in which they affect each other. This chapter therefore provides a useful cross-reference for these items.

Chapter 12

Mitigation Measures - Summary

Chapter 12 Mitigation Measures – Summary

12.1 General

Mitigation measures are the measures proposed in order to avoid, reduce or where possible remedy the significant adverse environmental effects of the proposed development. Mitigation measures have been incorporated into the design of the proposed development and will be applied during both the construction and operation phase.

The following chapter provides a summary of the mitigation measures for the proposed Killaloe Bypass, Shannon Bridge Crossing and R494 Improvement as a whole, presented for each environmental topic.

12.2 Mitigation Measures for Human Beings

The following is a summary of the mitigation measures proposed in Chapter 6 of this Environmental Impact Statement.

12.2.1 Construction Phase Mitigation Measures for Community Impacts

Appropriate traffic management measures will be undertaken during the construction period to ensure that any adverse impact in terms of local community severance, by reason of diversions is kept to a minimum.

The contractor for the scheme will prepare a detailed Traffic Management Plan for the approval of the road authority prior to commencement of the works. The contract for the scheme will seek to minimise traffic disruption, but there will be some impact for the local community, especially for those who use minor local roads that cross the scheme, at junction tie-ins and along the R494 during improvement works.

The traffic management measures incorporated within the Traffic Management Plan will ensure measures to maintain all road and access affected by the works, or their replacements, and maintain traffic flows and existing accesses until such times as the permanent works have been completed.

Construction traffic will be limited to regional roads and will not be permitted to use the existing Killaloe Bridge. Local Roads, where possible, will be closed to heavy vehicles associated with the construction works.

Where temporary road closures and diversions occur, direct access across the works site will be retained for pedestrians and cyclists who otherwise would be severely affected by the scheme. This can be achieved through a number of measures such as on request pedestrian traffic lights where required.

Where road closures are required, in order to reduce community severance the contractor will be required to provide public notification of pending road closures

12.2.2 Operational Phase Mitigation Measures Community Impacts

No remedial or mitigation measures are required to minimise community severance as all practical provision has been made in the design of the scheme through maintenance of the existing road network with minimal diversion and disruption.

Along the Killaloe Bypass, Shannon Bridge Crossing and a section of the R494 a footpath and street lighting will be provided. Dedicated cycling facilities are to be provided throughout the length of the scheme and in the case of the R494 upgrade the cycle way provided is also designed to accommodate pedestrians. This measure will improve pedestrian safety and provide opportunity for new walking circuits of the town and its environs.

12.3 Mitigation Measures for Flora and Fauna

12.3.1 Mitigation for Designated Areas

The potential for direct impacts on the Lower River Shannon SAC during the construction of the Shannon and Kilmastulla River Crossings will be avoided, reduced and remedied by a suite of measures as detailed below:

Construction within the SAC:

- There will be no works permitted outside the identified land take area within the SAC;
- Design and construction method statements will be submitted to the IFI and NPWS for approval prior to commencement of construction;
- Where site investigation (including archaeological works) is required in the vicinity of or adjacent to the SAC and outside of the lands made available, these works will be supervised by an appropriately qualified ecologist and mitigation measures will apply;
- In the vicinity of the SAC the site boundary will be defined at the outset of construction using rigid timber or equivalent robust fencing. Within the site boundary fence, earth bunds will be constructed to contain surface water run-off and channel it to a silt trap before discharge. This will entail measures to ensure that suspended solids in any runoff (either direct or via small watercourses or field drains) into the River Shannon from the construction area, machinery access routes or any other source does not exceed 25mg/l. Among other measures this will require isolating the area where works are carried out from the river and pumping all runoff to sediment removal facilities;
- Prior to construction commencing, a detailed survey of the river bank in the vicinity of the proposed works will be undertaken to determine the status of the identified otter holt and couch and to check for any further potential features. Appropriate mitigation will be put in place under licence from the NPWS for encountered holts or couches. Artificial holts will be provided in the vicinity of both the Shannon and Kilmastulla crossings at locations and to specifications agreed with the NPWS;
- The location of in-stream piers have been selected to minimise damage or disturbance to pollan spawning habitat in the vicinity of the bridge;
- Bridge and approach road design shall incorporate best environmental practice and design in the control of road run-off and accidental spillage. Run-off shall be channelled through a spill-containment facility and hydrocarbon interceptor prior to discharge to the river;
- A sustainable drainage system will be installed on the new road which will prevent significant pollution to surface receiving waters. The system installed will have a proven capability of achieving and sustaining at least the following percentage pollution reduction in runoff:

Total Suspended Solids	85%
Heavy Metals	50 – 80%
Chemical Oxygen Demand	50%
Hydrocarbons	90%

- An emergency-operating plan shall be established to deal with incidents or accidents during construction that may give rise to pollution within the Lower River Shannon cSAC. This will include means of containment in the event of accidental spillage of hydrocarbons or other pollutants (including oil booms and soakage pads);
- The design of lighting for the bridge will take into consideration the requirement to avoid unnecessary light spill into the river and the adjacent river banks in order to minimize disturbance to fish, mammals and bats in the area.

12.3.2 Mitigation for Bats

Mitigation measures for the loss of roosts

- Mitigation measures to offset the loss of roosts are detailed below and follow the NRA Guidelines for the Treatment of Bats during the Construction of National Road Schemes and NRA Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes (National Roads Authority 2006).

A) Trees

- All retained trees will be subject to assessment for potential bat roosts prior to the commencement of road construction and both these (and those trees retained within the CPO lands) will be subject to appropriate felling measures as detailed in NRA Guidelines for the Treatment of Bats during the Construction of National Road Schemes (National Roads Authority 2006) once the construction of the scheme commences.

Avoidance

- The scheme has been designed to avoid the treeline of mature beech, sycamore and Scot's pine at chainage 0+750 R on the Ballina/Birdhill Road and will be fenced off during construction.

Protective measures

- Where possible, trees that are located very close to the CPO lands will be retained and afforded protective measures. Protective fencing will be erected outside the drip-line of the canopy of any retained trees in order to prevent damage by machinery, compaction of soil, etc. in accordance with BS 5837: 1991.

Provision of bat boxes

Prior to the removal of any trees that have potential to support roosting bats a bat box scheme will be erected in close proximity to those trees scheduled for removal. These works will be done a minimum of 6 months in advance of planned tree felling to allow bats to become accustomed to new roosting opportunities in the area. A variety of box types will be provided and the types to be used and their locations for erection will be decided by a licensed bat specialist and erected under their supervision.

Timing of tree felling

- All trees which are to be felled will be felled during the autumn months of September or October. In this way felling can be timed to coincide with the least vulnerable parts of the bats' lifecycle - namely over winter hibernation and summer breeding and avoid the bird breeding season.
- The felling of all trees, which have been identified as potential bat roosts shall be supervised by a bat specialist holding a bat handling licence issued by the National parks and Wildlife Service, (Department of Arts, Heritage and the Gaeltacht). If bats are encountered they will be removed by the licence holder to a bat box, to be sited on a nearby tree and the NPWS notified.
- Identified trees shall be felled carefully. Specific advice in relation to individual trees will be given on site by a bat specialist. Gradual dismantling of very mature trees that are likely to be hollow may be necessary to ensure the safety of any bats which may be roosting within significant sized boughs or in the trunk.
- Otherwise tree felling will be undertaken using heavy plant machinery. The tree will be inspected by a bat specialist, and left intact on the ground for 24 hours to allow any bats within them to escape prior to processing.
- Similarly all ivy covered trees (which are unmarked) along the route will be felled and left intact for 24 hours so that any roosting bats that may be present may have a chance to awaken and escape.

B) <u>Loss of roosts in structures or buildings</u>

- The private residence at chainage 0+275 K and the private residence at chainage 0+475 S are considered to be maternity roosts for both soprano pipistrelle and common pipistrelle and brown long-eared bats respectively.
- The other two buildings along the route (the shed/garage at chainage 1+100 K and the agricultural shed at chainage 2+400 R are both described as minor roosts and are both used by pipistrelle bats (likely to be soprano pipistrelle). The demolition of all of these buildings therefore requires a bat derogation licence from the National Parks and Wildlife Service.
- The stone culvert north of Cool Bridge at chainage 2+600 R was deemed to have very high potential as a hibernation roost and should this culvert require any strengthening works this will be done under the supervision of a licensed bat specialist who will identify any deep crevices which will be retained for use by bats or alternative roosts provided.

Erection of bat boxes

- In order to provide alternative roosting locations for bats a bat box scheme will be erected in close proximity to the locations of those buildings which have been confirmed as bat roosts. These works will be carried out a minimum of 6 months in advance of planned building demolition to allow bats to become accustomed to new roosting opportunities in the area. A variety of boxes will be provided and the types to be used and their locations for erection will be decided by a licensed bat specialist and erected under their supervision.

Demolition of buildings

- The demolition of each of the buildings in question will be scheduled for the winter months as bat numbers are known to be lower in buildings at that time.
- All buildings will be surveyed again immediately prior to demolition by a suitably qualified bat specialist to determine which, if any, contain bats.

- If no bats are found the building may be safely demolished immediately following on from the assessment. Demolition will be done with the expectation that bats may be found following the procedures recommended in the NRA Guidelines for the treatment of Bats during the Construction of National Road Schemes. The roof of such structures will be carefully removed by hand to protect any animals which may be beneath slates. Half the roof will be removed then the work will cease for 24 hours to allow any bats to leave before removing the remaining roof. If discovered, bats will be retained in a box until dusk and released on site.

C) <u>Bridges and culverts</u>

- Where re-pointing or pressure grouting of existing bridges/culverts, which have potential for roosting bats, is to be undertaken in the future, this will only proceed after an inspection of the structure for bat presence. Some crevices beneath bridges/culverts will be left open for bat use as deemed appropriate.
- Ready-made artificial roost units are available for inclusion in such situations and will be included on any new bridges over rivers. Bat 'Tubes' of the 750/6 design are suggested.

Table 12.3.1 Proposed mitigation measures for potential and confirmed bat roosts within 1km of the route

Map Ref. No.	Chainage	Description	Distance from roost or potential roost to the CPO	Potential/confirmed bat roosts	Proposed Mitigation Measures
2	0+000 K	Gate lodge, Ballyvally Estate	c.50m	Potential roost in gate lodge, mating roost in close vicinity	None required - offline
5	0+200 K	Private residence, Ballyvally Estate	c.180m	Confirmed roost – likely to be maternity roost for pipistrelles, mating roost	None required - offline
7	0+325 K	Area of mature woodland – ash, larch, beech	Online	Potential tree roosts, mating area	**A**
9	0+275 K	Mature treeline between property and Ballyvally	Online	Mating roost, potential tree roost	**A**
11	0+275 K	Private residence	Online	Confirmed soprano pipistrelle maternity roost, mating roost for common and soprano pipistrelles and Leisler's	**B**
10	0+280 K	Private residence	50m	Confirmed roost of a unidentified *Pipistrellus* sp.	None required - offline
12	0+400 K	Woodpiles at rear of private residence	10m	Hibernation roost	None required - offline
13	0+900 K	Mature oak with large crevice/split, broken boughs	Online	Potential tree roost	**A**
14	1+100 K	Local road at Knockyclovaun	Online	Mating activity	**A**
15	1+100 K	Private residence	50m	Likely soprano pipistrelle roost	None required - offline
16	1+100 K	Shed/Garage (Mr. Burns)	Online	Confirmed soprano pipistrelle roost	**B**
17	1+105 K	Treeline of three semi-mature beech – S side of road	Online	Potential tree roost	**A**
20	2+000 K	Local road	Online	Mating roost	**A**

Map Ref. No.	Chainage	Description	Distance from roost or potential roost to the CPO	Potential/confirmed bat roosts	Proposed Mitigation Measures
21	0+130 S	Treeline of mature beech	Online	Potential tree roost	**A**
22	0+100 S – 0+420 S	Area of mixed broadleaved woodland with treeline of old mature trees	Online	Potential tree roosts	**A**
23	0+400 S	Private residence, Clarisford Palace	160m	Confirmed minor roost – brown long-eared bat	None required - offline
25	0+475 S	Private residence	Online	Confirmed brown long-eared and soprano pipistrelle roost, mating roost, good diversity of species recorded	**B** **C**
26	0+600 S	Treeline of mature beech	Online	Potential tree roosts	**A** **C**
28a	0+660 S	Mature sycamore and beech on island	Online	Potential tree roosts	**A** **C**
32	0+820 S	Mature oak and ash in treeline	Online	Potential tree roosts	**A** **C**
34	0+500 R	Mature ash with good ivy cover	Online	Potential tree roosts	**A**
36	0+750 R	Treeline mature beech, sycamore, Scot's pine at Gortna House	Online	Mating roost	**A**
40	2+400 R	Agricultural outbuilding	Online	Minor pipistrelle roost	**B**
41	2+600 R	Stone culvert below R494	Online	Potential hibernation roost	**C**
42	2+600 R	Cool Bridge	Online	Potential hibernation roost	**B, C**
43	3+050 R	Dooly's Bridge	Online	Potential minor roost	**C**

<u>Mitigation measures and recommendations for the loss of commuting roosts and feeding areas</u>

- The loss of feeding areas and severance of commuting routes can be mitigated by several measures, which are detailed below and presented in the NRA Best Practice Guidelines for the Conservation of Bats in the Planning of National Road Schemes (National Roads Authority 2006).
- Specific measures for each site identified as a feeding area/commuting route are detailed in **Table 12.3.1**.
- Enhancement areas will be replanted with native species to re-create habitats lost as a result of the road development. These areas will also serve as feeding areas for bats. The areas will arise from lands made redundant e.g. road pavements no longer required and which can be planted over, small areas of severed land.

D) <u>Reconnection of severed linear habitats</u>

- Severed linear features such as hedgerows and treelines will be reconnected using semi-mature trees under planted with hedgerow species to compensate for the loss of treelines and hedgerows that are used by bats as commuting routes. These measures will also compensate for habitat loss and provide continuity in the landscape. Areas requiring such planting are detailed in **Tables 12.3.1 and 12.3.2**. The exact locations and specifications of such planting to ensure the safe passage of commuting bats over the road will be designed by a bat specialist in conjunction with the landscaping contractor at the planting/design stage. Native species will be used as they support more insect life than non-native varieties.
- Where farm/property access tracks are created a hedgerow will be created on both sides of the track to create a corridor effect which will be of benefit to both foraging and commuting bats.
- An advanced planting contract will commence as soon as possible in terms of the re-creation of linear features along the margins of the CPO fence line. This will ensure that the hedgerow develops as quickly as possible and will reduce the impacts of fragmentation of habitats for both bats and other wildlife by reconnecting severed linear habitats as per the EIS. Following this planting the boundary of this planted area closest to the CPO may require protective fencing to prevent damage to planted vegetation once road construction commences. The creation of enhancement areas which will also serve as foraging areas for bats will be completed once the general landscaping contract commences.

E) <u>Watercourses</u>

- Watercourses present along the route corridor will be enhanced by the planting of native shrubs along one or both banks. The planting of shrubs in such areas provides shelter in which insect numbers can accumulate and also provide a corridor along which bats can commute. These measures will also enhance these areas for wildlife in general. Native species of shrub such as holly, hazel and hawthorn will be used to provide a vegetation belt along watercourses to act as a shelter belt for foraging bats.

F) <u>Lighting</u>

- In general, bright lighting creates a barrier to commuting bats so lighting will be minimised along the proposed route. This will be done by either reducing the height of lamp standards, or by using cowled lights to limit the light spread to the area required for illumination.

- This is especially important for the proposed River Shannon crossing. Trees and wooded areas will be retained as close as possible to the crossing point, to maintain a corridor effect and encourage bats to pass under the bridge/culvert and utilise feeding habitat on both sides. Similarly it is important that the retained sections of the shelterbelt of woodland at Ballyvally and the areas of woodland at the new tie in with the R463 remain unlit.

It is a typical condition of bat derogation licences that these mitigation measures will be monitored by a licensed bat specialist for up to two years following the destruction of roosts in order to ensure that they are functioning appropriately. Where a bat box is not being used by bats it will be relocated in order to ensure bats may utilise them more efficiently as per NRA guidelines.

Table 12.3.2 Proposed mitigation measures for areas of importance as commuting routes or feeding areas for bats within 1 km of the route

Map Ref. No.	Chainage	Chainage	Description and Location	Distance from the CPO	Importance for bats	Proposed Mitigation Measures
1 & 6	0+000 K	0+000	Ballyvally Estate	c.50m	Frequent foraging along the R463. Potential roost in gate lodge, mating roost in close vicinity. Four bat species recorded in area.	**D** **C** between chainage 0+000 and 0+300 **G**
4	0+275 K	0+275	Private residence	Online	Foraging and commuting activity from and returning to confirmed roost. Three bat species recorded. Other roosts in close proximity.	**D** **E** between chainage 0+300 and retained hedgerows at 0+750
	0+750 K – 1+130 K	0+750 – 1+130	Area of improved grassland and hedgerows	Online	Likely to be used by pipistrelles	**D** **E** between chainage 0+750 and 1+130
16a	1+100 K	1+100	Local road at Knockyclovaun	Online	Medium – good levels of foraging activity for two species	**D** **E** between newly created access roads to carriageway and existing roadside hedges
	1+100 K – 1+500 K	1+100 – 1+500	Area of improved grassland and hedgerows	Online	Likely to be used by pipistrelles	**D** **E** between chainage 1+100 and 1+500
18	1+500 K	1+500	Local road at Shantraud	Online	High – good foraging area and commuting route from nearby roost, two pipistrelle species recorded	**D** **E** between newly created access roads to carriageway and existing roadside hedges
	1+500 K – 2+080 K	1+500 – 2+080	Area of improved grassland and hedgerows, conifer plantation and treelines	Online	Likely to be used by pipistrelles	**D** **E** between chainage 1+500 and 2+080 and between newly created access roads to carriageway and existing roadside hedges
19	2+000 K	2+000	R463 at Shantraud	Online	Medium – good levels of foraging activity of common pipistrelle	**D** **E** between newly created access roads to carriageway from roundabout and existing roadside hedges

Map Ref. No.	Chainage	Chainage	Description and Location	Distance from the CPO	Importance for bats	Proposed Mitigation Measures
19, 28, 28a, 29 & 30	0+000 S – 0+650 S	0+000 – 0+650	R463, improved grassland, treelines, hedgerows, mixed broadleaf woodland, private residences, pond, lowland depositing rivers	Online	High - rich foraging and commuting area for good diversity of bat species (seven species recorded), confirmed roost nearby and online	**D** **E** between chainage 0+000 and 0+900 **F** **G**
33	0+000 Rsouth to 3+300 R	0+000 south to 3+300	R 494 Ballina – Birdhill road, treelines, hedgerows, watercourses, improved agricultural grassland	Online	Locally important corridor for foraging bats, confirmed roost, potential tree roosts and hibernation roosts in the vicinity	**D** **E** between chainage 0+000 and 3+300 **F** **G**
38	1+100 R	1+100	Side road to R494 Ballina – Birdhill road	Offline	Commuting route for 2 pipistrelle species along watercourse	**D** **E** **F** **G**
39	2+300 R south to 2+750 R	2+300 south to 2+750	R 494 Ballina – Birdhill road near Cool Bridge	Online	Locally important corridor for foraging bats from roost to Kilmastulla River at Cool Bridge	**D** **E** **F** **G**

12.3.3 Mitigation for Habitats

Mitigation measures to avoid and reduce impacts on habitats along the proposed route are presented below. These measures may relate also to mitigating against impacts for fauna and vice versa.

Terrestrial Habitats

To avoid impacting on bird nesting sites, the vegetation within the defined working area will be cut back outside the peak bird nesting season of mid-February to August prior to the onset of works. The extent of bankside disturbance shall be kept to the minimum required for completion of the job.

Control of the movement of construction plant within the site, to ensure that the minimum area of ground would be disturbed outside the footprint of the works.

Within the scheme, the number of trees to be removed will be minimised and all trees to be retained will be afforded protection in accordance with the NRA Guidelines on the Protection of Trees on National Road Schemes (NRA 2006). The erection of all protective fencing will be undertaken prior to the commencement of any site works.

The loss of habitats along the route will be mitigated for by the landscape design associated with the proposed road improvements. The landscape design will use primarily native species and aim to recreate mixed species hedgerows and grasslands to compensate for the loss of these habitat types and will be undertaken in accordance with the NRA AGuide to Landscape Treatments on National Road Schemes (NRA, 2006).

Landscaping:

The impact of habitat loss and fragmentation on the movement of fauna will also be addressed by the design of landscaping for the scheme in tandem with the provision of passage facilities and guide fencing for various mammalian species.

Landscaping and design shall focus on the establishment of naturally occurring habitat types using predominantly native species to re-establish the linear corridor of vegetation along the river bank in accordance with *A Guide to Landscape Treatments for National Road Schemes in Ireland* (NRA, 2006).

Invasive Alien Species:

All soil imported for landscaping purposes will be screened and verified as free of noxious weeds and invasive non-native species such as Japanese Knotweed, Himalayan balsam and giant hogweed. Due care will applied to ensure invasive alien species of plant and animal are not inadvertently spread during the landscaping works.

In accordance with the NRA Guidelines *on The Management of Noxious Weeds and non-native plant Species on National Road Schemes* (2010) a pre-construction survey will be undertaken to map all locations of invasive alien species within or adjacent to the CPO. A specific management plan will be prepared detailing the various species distribution along the scheme, the treatment required during site clearance works, how to dispose of all material arising and an assessment of the risk of re-infestation from surrounding land.

Monitoring of the effectiveness of control measures will be undertaken post construction in accordance with the NRA guidelines.

12.3.4 Mitigation for Fauna

Specific measures are proposed for dealing with mammals below that tie in with generic measures prescribed above.

Otter:

- Mitigation for otter will require the provision of safe passage along all watercourses. This will be achieved by the incorporation of suitable mammal passage facilities within all culverts in conjunction with otter-proof fencing along the road network to prevent animals from accessing the carriageway. The specification for otter passage and fencing design will be in accordance with the *Guidelines for the Treatment of Otters Prior to the Construction of National Road Schemes* (NRA, 2007). The maintenance of water quality within the scheme is covered under mitigation for aquatic habitats. The movement of fish will be maintained on all watercourses by ensuring a minimum depth of water and flow velocity in all bridge and culvert designs (in accordance with *Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes* (NRA, 2006) in order to retain their suitability for otter.
- The potential otter holt on the island at chainage 0+640 S and the couch on the Kilmastulla River at chainage 2+620 will be examined pre-construction for signs of activity and if active, will be excluded during the appropriate season under derogation from the NPWS. Consultation with the NPWS will be required to define the exclusion process.
- Artificial holts will be provided in the vicinity of both the Shannon and Kilmastulla crossings in locations and according to designs agreed with the NPWS.

Badger:

- While the provision of otter passage within all river crossing designs will also serve for other mammal species including badger, specific badger underpasses in accordance with *Guidelines for the Treatment of Badgers during the Construction of National Road Schemes* (NRA, 2005) will be provided for in the vicinity of all locations where badger activity was recorded during the detailed winter mammal survey as detailed in Table 12.3.3. These locations are based on the current design and may be altered following development of the detailed design. Badger-proof fencing will be provided for a distance of 500m to either side of the underpasses in accordance with the NRA Guidelines and along the whole of the Killaloe Bypass. The feasibility of an underpass in the vicinity of Ballyvally Estate is however questionable as the road will be in deep cut though the wooded section where badger activity is concentrated.

Table 12.3.3 Locations for Badger underpasses or passage facilities along proposed route.

Chainage	Description
O+050 K	At eastern end of Ballyvally Estate.
0+700 K	At end of cut after Ballyvally Estate
1+760 K	In association with minor watercourse culvert at woodland edge.
0+140 S	In association with minor watercourse culvert at edge treeline.
0+600 S / 0+800 S	Along river and canal banks on both sides of River Shannon.
1+140 R	In association with watercourse culvert.
2+600 R	To north of Kilmastulla River at location existing dry culvert.

Fallow Deer:

- The prevention of fallow deer crossing the proposed road will require appropriate fencing throughout the Killaloe Bypass section of the scheme. Appropriate warning signage will also be provided for motorists using the proposed scheme.

Other mammals:

- Other species of mammal will benefit from the mitigation provided for otter and badger above in addition to the measures detailed under landscaping. Red squirrel is however, unlikely to benefit from such features and fragmentation of populations may occur.

Birds:

- Clearance of vegetation along the proposed route will take place outside of the breeding bird season (1st March to 31 August) in accordance with the Wildlife (Amendment) Act (2000). To compensate for the loss of habitat for bird species, landscaping proposals will primarily entail the use of native trees and shrubs.

12.3.5 Mitigation for Aquatic Habitat

- All design, construction and operation shall be carried out in accordance with *Guidelines for the Crossing of Watercourses During the Construction of National Road Schemes* (NRA, 2006).
- The storage of oils, hydraulic fluids, etc will be undertaken in accordance with current best practice for oil storage (Enterprise Ireland, BPGCS005).
- The pouring of concrete, sealing of joints, application of water-proofing paint or protective systems, curing agents, etc. will be completed in the dry to avoid pollution of the freshwater environment.
- All machinery operating in-stream will be steam-cleaned in advance of works and routinely checked to ensure no leakage of oils or lubricants occurs. All fuelling of machinery will be undertaken on dry land.
- Instream works (including erection and dismantling of temporary bridges, pile driving, etc., will be undertaken during the period 1st May to 30th September. This avoids the pollan spawning season (December to January inclusive) as well as that for salmonids. This will reduce the risk of accidental damage or siltation of spawning beds.
- A Class 2 Bypass Petrol/Oil Interceptor is to be provided at each outfall.
- Road runoff is to go through a stilling process to allow suspended solids to settle out (this may be in open ditches, ponds, hydrodynamic separators, etc.)
- All pollution control facilities and attenuation areas shall be fitted with a penstock or similar restriction at the outfall to the receiving channel to contain pollutants in the event of an accidental spillage.
- Dredged spoil if arising, will be disposed of under appropriate licence or permissions to an authorised spoil depository location.
- The risk of accidental transfer of the non-native invasive species will require adherence to current best practice protocol for avoiding the spread or transfer of all invasive animals and plants including zebra mussel (Dreissena polymorpha). These measures will be enforced during construction to ensure accidental spread does not occur on machinery or materials from / to the site.

The developers will also adopt any modified or updated approaches to invasive alien species control.

- Preservation of stream flows for movement of fish by ensuring a minimum depth of water will be maintained in the streams.
- Prior to any instream works being undertaken, the stretches of watercourse to be impacted will be surveyed for protected aquatic species (lamprey ammocoetes and freshwater crayfish) and appropriate salvage measures employed (under licence from the NPWS).
- A continuous bund will be built 10m from the stream to control suspended soils laden runoff from construction.
- Sediment collection mats will be placed at streams outflow in order to reduce the potential for discharge of silt laden runoff water to the streams.
- Work near surface water features will be carried out during drier months where possible.

12.4 Mitigation Measures for Noise & Vibration

12.4.1 Operational Noise Mitigation Measures

- Noise levels from the scheme and a suitable low noise surface in place have been predicted to be within the design goals as set down in the NRA Guidelines at all receiver locations assessed; therefore no further remedial measures are required.

12.4.2 Construction Noise Mitigation Measures

The contract documents will clearly specify that the Contractor undertaking the construction of the works will be obliged to take specific noise abatement measures and comply with the recommendations of BS 5228: Part 1 and the European Communities (Noise Emission by Equipment for Use Outdoors) Regulations, 2001.

During the course of the construction program, supervision of the works will include ensuring compliance with noise limits detailed in Table 12.4.1.

Table 12.4.1 Maximum Permissible Noise Levels at the Façade of Nearby Dwellings during Construction

Days & Times	$L_{Aeq\ (1hr)}$ dB	L_{Amax} dB(A)
Monday to Friday 07:00 to 19:00hrs	70	80
Monday to Friday 19:00 to 22:00hrs	60*	65*
Saturday 08:00 to 16:30hrs	65	75
Sundays and Bank Holidays 08:00 to 16:30hrs	60*	65*

Note * Construction activity at these times, other that required for emergency works, will normally require the explicit permission of the relevant local authority.

Normal working times will be 07:00 to 19:00 Monday to Saturday. Works other than the pumping out of excavations, security and emergency works will not be undertaken outside these working hours without the written permission of the Contracting Authority. This permission, if granted, can be withdrawn at any time should the working regulations be breached.

Works other than the pumping out of excavations, security and emergency works will not be undertaken at night and on Sundays without the written permission of the Contracting Authority. Night is defined as 19:00 to 07:00hrs.

When overtime and shift work is permitted, the hauling of spoil and delivery of materials outside normal working hours will be prohibited and the noise limits will apply.

The emergency work referred to above may include the replacement of warning lights, signs and other safety items on public roads, the repair of damaged fences, repair of water supplies and other services which have been interrupted, repair to any damaged temporary works and all repairs associated with working on public roads.

12.4.3 Vibration Mitigation Measures during Construction

The NRA Guidelines recommend that in order to ensure that there is no potential for vibration damage during construction, vibration from construction activities will be limited to the values set out in **Table 12.4.2**.

Table 12.4.2 Maximum Allowable Vibration Velocity

Allowable vibration velocity (Peak Particle Velocity) at the closest part of any sensitive property to the source of vibration, at a frequency of		
Less than 10Hz	10 to 50Hz	50 to 100Hz (and above)
8 mm/s	12.5 mm/s	20 mm/s

Measures shall be taken to minimize vibration due to plant and machinery on the site and no machine which uses the dropping of heavy weights for the purpose of demolition shall be permitted.

Ground vibration from additional traffic due to the development under consideration would be expected to be orders of magnitude less than that required to cause cosmetic or structural damage to buildings or lead to disturbance of occupiers, hence mitigation measures are not required in respect of the operational phase.

12.5 Mitigation Measures for Air Quality

12.5.1 Construction Phase Mitigation Measures for Air Quality

A dust minimisation plan has been formulated for the construction phase of the project. See **Appendix 7.4.2**.

12.5.2 Operational Phase Mitigation Measures for Air Quality

No mitigation measures will be required for air quality in the operational phase of the scheme.

12.6 Mitigation Measures for Climate

There are no mitigation measures required for Climate.

12.7 Mitigation Measures for Hydrology and Hydrogeology

12.7.1 Construction Phase Mitigation Measures for Hydrology and Hydrogeology

Hydraulic Impacts

Temporary Excavations

No locations for temporary excavations and borrow pits have been identified at this stage of the project. Should the need for borrow pits arise, a number of well established mitigation measures exist in relation to impacts on groundwater and surface water. The measures required in this process include:

- Identify the location of wells within 500m of the proposed borrow pit and undertake a well audit to determine likely hydraulic and hydrochemical impact.
- Identify the location of surface water bodies within 200m of the proposed borrow pit and identify whether the excavation of the borrow pit and lowering of the water table will impact on the surface water bodies (e.g. reduce baseflow, reduce runoff contribution, affect water quality by recharge flushing through exposed substrates).
- Where possible move the borrow pit to >500m from an operation well and >200m from a stream / river to mitigate impact by avoidance.
- Consider the need for dewatering of the borrow pit in advance or in tandem with excavation works and how the pumped water will be treated (water quality controlled) prior to outfall to ensure compliance with surface water regulatory limits for receptor streams and rivers.
- If excavations and borrow pits are being backfilled, ensure that the backfill is of "natural" ground origin, is of local origin and is inert in relation to leaching and mixing with underlying groundwater.

Supply Wells

The well impact assessment which has been carried out, based on available information, indicates that no significant impact has been identified on any of the operational wells identified and recorded. It should be noted that the number of such wells is expected to be minimal, given the existence of a municipal water supply system in Killaloe/Ballina.

- A comprehensive well audit will be carried out within a buffer distance of 1250m of the proposed alignment.
- The audit will allow for house-owners commuting to work and therefore will be undertaken over a number of weekends or evenings during the summer period (lighting).
- A short pump test (c.0.5hr) will be undertaken on each well in order to confirm yield, drawdown and calculate zone of contribution.
- This information will be processed and interpreted by a qualified hydrogeologist in order to confirm impact level on the well and appropriate mitigation measures.
- Potential mitigation measures are: well deepening, well replacement at a separate geographic location on the land holding, installation of a grout curtain or an alternative water supply.
- This assessment will be undertaken prior to the tender design stage to allow sufficient time to determine existing flow and hydrochemical conditions .
- The results of the well audit including pump tests will identify those wells that are at risk of hydraulic impact by the road scheme. All identified wells will be monitored on a monthly basis to check and provide factual evidence of impact.

In order to validate change in water levels, recording of existing levels is required, which at a minimum will be 3 months continuous monitoring prior to construction as part of a well audit.

Hydrochemical Impacts

Suspended Solids

In order to reduce this impact to meet compliance with regulatory limits of surface water quality and the requirements of the Water Framework Directive, the following mitigation measures will be incorporated into construction methodology:

- An interceptor drain will be installed upslope of the construction footprint in order to intercept and divert "clean" runoff water away from the exposed grounds, silts and clays of the construction area.
- The water that falls directly on the exposed earth materials will naturally flow to the lowest topography of excavations. This water will be collected into receptor drainage to a series of catch pits and settlement ponds and soakaways (rip-rap).
- The outfall will not discharge directly to any drains, streams or rivers, but indirectly through a percolation area following retention in catch pits and settlement ponds.
- In order to ensure no direct discharge to receptor waterways, the outfall from construction phase drainage will be placed no closer than 50m from receiving waterways including drains (to allow enough buffer distance for percolation and riparian vegetation attenuation).
- To ensure that discharge waters from the construction footprint are not causing suspended solids loading of receptor waterways, a sampling programme for Total Suspended Solids (TSS) including Nutrients (phosphorus, nitrate) and Total Petroleum Hydrocarbons (TPH) will be set up at locations where the road scheme is proximal to sensitive waterways. The results taken at both low and high flow will be checked against regulatory limits for compliance. Pollution control measures will, at a minimum, comply with HA 103 of UK DMRB.
- Monitoring of the receiving watercourses will be conducted during the construction phase and will be in line with the Water Framework Directive monitoring recommendations.

Hydrocarbons

In order to avoid and reduce this impact on the water environment, the following mitigation measures will be incorporated into construction methodology:

- If Above Ground Tanks (AGT's) are proposed for refuelling of plant equipment, then the fuel stations will require bunding to 110% volume capacity of fuels stored at the site. The bunded area will be drained by an oil interceptor and this drainage will be controlled by a penstock valve that will be opened to discharge storm water from the bund. A suitably qualified management company will take responsibility for management and maintenance of the oil interceptor and associated drainage on a regular basis, including decommissioning at the end of the construction phase.
- Alternatively, plant equipment can be refuelled by a mobile bowser which will refuel the plant near the area in which it is operating. This will eliminate the environmental and health and safety risk of hydrocarbon storage in above ground tanks (AGT's) but requires operational vigilance to ensure there are no leakage incidents during transfer. If a mobile bowser is used, refuelling will

take place on in-situ, unexcavated ground that is covered with vegetation and would be >100m away from any waterways or drainage.

- The plant equipment used on site will require regular mechanical checks and audits to prevent spillage of hydrocarbons on the exposed ground during construction. This will be part of the site environmental management system (EMS).
- All plant equipment will have a stock of synthetic absorbent mats or "spill-dry" sand in their cabins to contain and clean up minor spillages from plant equipment during re-fuelling or mechanical leakage.
- Larger spillages or leakage of hydrocarbons will be reported to the environmental manager for immediate clean up.
- If a significant hydrocarbon spillage does occur, the environmental manager shall have an approved and certified clean-up contractor available on 24-hour notice to contain and clean-up the spill.
- Monitoring of the receiving watercourses will be conducted during the construction phase and will be in line with the Water Framework Directive monitoring recommendations.

Other Dangerous Substances

With the exception of cement products, the list of chemicals / compounds that may be used for road construction is short and their volume of use and storage is low. These chemicals and compounds will be stored in designated locations within a bunded area of the site compound within secure can clearly labelled containers. The EMS will define the range of chemicals / compounds that will be used for the scheme and detail under what conditions they can be safely applied to ensure protection of the receiving environment, particularly of groundwater and surface water receptors.

Supply Wells

In addition to introduced contaminants, there is also the risk of mobilising residual trace elements or residual contamination in the aquifer (e.g. historic contamination) due to increased recharge over exposed sections of the scheme (excavations and cuts). The following mitigation measures are identified to anticipate, manage and resolve hydrochemical impacts to wells should they arise for the road scheme:

- Appropriate auditing will be carried out as part of the hydraulic well audit;
- Based on the findings of the well audit, those wells identified within 500m of the scheme will be sampled by means of carrying out appropriate chemical tests. The well audit will also identify other wells greater than 500m from the scheme which are considered to be at risk. These wells will also be tested;
- This sampling analysis of water quality will be undertaken as part of the three months continuous monitoring process prior to start of the construction phase of the scheme referred to above in relation to well yield. The purpose of this analysis is to determine water quality in the wells, presence of any pollutants, or evidence of elevated trace elements prior to road construction;
- The wells will be sampled according to the "audit" parameter list under Irish Drinking Water Regulations, which is currently defined in Tables A and B of Part 1 of SI No. 106 of 2007;
- After the initial sampling, the same wells will be sampled at quarterly intervals during the construction phase of the project for the relevant check parameter list contained in Table A of Part 2 of SI 106;
- Any changes in chemistry will be notified to the environmental manager of the scheme as well as to the local authority;

- Where hydrochemical impacts are identified that exceed Irish Drinking Water Regulations, intervention and corrective measures will be undertaken to ensure safe drinking water supply is provided to any affected well owners;
- At the completion of the construction phase, another post-construction "audit" sampling event will be undertaken in order to sign off and confirm avoidance of contamination of relevant wells by the road scheme;
- To reduce recharge and stabilise groundwater movement and chemistry at the end of construction, landscaping and re-vegetation of exposed grounds will be carried out for any sections where trace metals may have become elevated during the construction phase (as evidenced by independent sampling).

12.7.2 Operation Phase Mitigation Measures for Hydrology and Hydrogeology

Hydraulic Impacts

Cuts & Excavations

Assumptions about water levels have been based on the observations recorded in the standpipes installed as part of the ground investigation process; these will be reviewed as part ofthe three months monitoring process to be carried out prior to construction.

Flood Risk to River Shannon

The bridge design layout proposed has been selected to ensure it does not cause flooding either upstream or downstream of the bridge crossing.

Road Runoff

"The design of this scheme has included provision for storm water attenuation. Storm water attenuation ponds will have adequate capacity to cater for the fifty year rainfall event. Flows will be restricted to greenfield runoff rates by a flow control device at the outlet. Ponds will permanently contain a 300mm depth of water to encourage plant life develop over time which will also act as a water quality treatment facility".

In addition to these design measures, the following mitigation measures are also included in road drainage design:

- For sensitive parts of the site where runoff volume may overwhelm baseline hydrology, that attenuation / retention ponds are installed at the end of road drainage prior to outfall. Retention ponds will "hold" back road runoff until a storm event passes and afterwards release the runoff water at a controlled discharge rate to natural drainage (avoid "spiking" of hydrograph).
- A hydraulic evaluation has been undertaken for all road drainage outfall points in order to determine the impact on receiving waterways. It is proposed in the Design that a stilling process, either by means of retention ponds or hydrodynamic separators be provided to all road runoff outfalls.
- The use of retention ponds as part of runoff discharge treatment has the dual role of discharge control and water volume retention and also provides water quality control for discharge waters.
- A programme of inspection, auditing and maintenance of the road scheme drainage and water quality pollution control system will be undertaken for the scheme. The design of these pollution control schemes is such that, once properly maintained, the pollutant levels will be kept within required limits (i.e. 25mg/l of suspended solids).

Hydrochemical Impacts

Road Runoff

The following pollution control measures are recommended for road runoff water quality control:

- Retention ponds proposed as a runoff discharge and volume control measure to prevent hydraulic loading of receiving waterways, as well as providing associated water quality control;
- The volume holding capacity of the retention / attenuation pond will provide "buffer" time for an emergency response team to contain and clean up the contamination;
- A petrol interceptor will be installed as a "final cleansing" system for discharge water quality in light of the designation status (SAC and pNHA) and sensitivity of the receiving waters to contamination from road runoff or a larger scale accidental release event;
- Closed (sealed) drainage will be installed for those parts of the scheme that transverse the Lower River Shannon SAC and where aquifers are characterised by extreme vulnerability. Elsewhere, the aquifer status of the underlying groundwater and the attenuating properties of overlying subsoils will provide sufficient protection of underlying groundwater.

Accidental Spillage

In combination with the other water quality mitigation measures it is anticipated that the local authority will have a 24 hour "Spill and Clean Up" contractor signed up to provide an immediate response to accidental spillage. Appropriate mitigation measures including interception systems will be included in the scheme to assist this process.

12.8 Mitigation Measures for Soils & Geology

Excavations and Surplus Excavated Materials

- Any earthworks surplus volume can be reduced by steepening the side-slopes in rock cuttings. For design purposes they have been assumed at 2H: 1V (horizontal: vertical) which is much shallower than is generally stable in rock. Due to the size of the cuttings, the side slopes may need to be this shallow if rock is persistently poor. Slopes which are considered at risk from erosion are to be topsoiled and seeded as soon as possible to prevent the deterioration due to weathering effects. Further ground investigation will provide information allowing optimised cut volumes possibly using ground improvement techniques, subject to consideration of perceived environmental benefits.
- All suitable material excavated within the cut sections shall be used to the greatest possible degree as fill material on the development. Storage of such soilsl if required during the construction phase will be in designated on/off site facilities.
- If any soft ground is present, excavation of soft materials or preconsolidation of the soil will be required prior to placing any embankments.
- Topsoil will be removed from all temporary access roads in advance of construction and will be stored. Following removal of temporary road materials the underlying soil will be scarified, the topsoil replaced and seeded.

Contaminated Lands

- All contaminated lands including areas of made ground that have tested positive for excess levels of contamination and areas that support the invasive alien plant Japanese knotweed shall be disposed of in accordance with legislative requirement with due regard for the impact on the disposal site and where possible material will be utilised in landscaping of the development.

Groundwater

- Contamination of ground water though pollution of surface water by road drainage will be mitigated by means of suitable drainage system;
- Oil interceptors will be provided in order to prevent runoff of pollutants to river;
- Closed drains will be used in areas where there is potential interaction between the drainage water;
- An emergency plan to deal with accidental spills will be drafted;
- Any land drains or pipes served along the route will be connected into new pipes or ditches;
- Appropriate drainage will be provided to collect seepage water and slope angles provided suitable for materials in side slopes;
- A monitoring programme for reading of the existing groundwater monitoring installations installed during the initial site investigation at the sites will take place.

Soil Erosion Prevention

- Exposed areas will be re-vegetated as soon as practicably possible;
- Surface of overburden and topsoil mounds will be vegetated;
- Where practical there will be a progressive restoration of construction areas, the areas of topsoil overburden stripping will be limited and sumps and lagoons will be available to cope with all reasonable anticipated conditions;
- Stockpiling will be within bunded areas;
- Temporary fencing will be erected on site indicating the route to be taken by vehicles in order to minimise compaction of soils outside of areas proposed for excavation;
- On completion of construction, reinstatement will take place, Stock piled soils will be backfilled and landscaped in accordance with best engineering practice.

12.9 Mitigation Measures for Landscape and Visual Impacts

The proposed landscape treatments are illustrated on **Figures 8.1 to 8.9** and have been devised with reference to the National Roads Authority document "*A Guide to Landscape treatments for the National roads Schemes in Ireland*". It is recommended and fully expected that at the detailed stage a site specific set of landscape treatments will be devised within the framework offered by this assessment and with further reference to the relevant NRA Guidelines.

A suitably qualified landscape architect will devise the landscape drawings and specification for the proposed scheme during the detailed design stage in consultation with a suitably qualified ecologist. Consultation with a suitably qualified arboriculturist is required for the successful and safe retention of existing mature trees where possible. These documents will include for the treatment of the existing vegetation, soil preparation, seeding, planting, maintenance and establishment works. The specific landscape proposals that are put forward at the design stage must also adhere to the guidelines for road safety with respect to sightlines and the placement of planting at appropriate distances from the carriageway. In addition, requirements put forward in the ecologists report will be implemented.

The plants selected for the landscape treatments are found in the existing landscape and are appropriate to the local soil types and climatic conditions. The breakdown of the proposed landscape treatments, which have been devised to achieve the objectives for landscape mitigation, are as follows:

- H1: In order to re-establish hedgerow corridors that have been severed by the route the fencelines are to be established with native hedgerow material. Similarly, the removal of hedgerows with a screening function to front coniferous plantations must be re-established also. The only exceptions to this are where specific views of the surrounding landscape are to be preserved or where an alternative treatment is appropriate such as alongside urban areas. The native hedgerow material will include species which widely occur in the existing landscape area; these are – Hawthorn (*Crataegus monogyna*), Blackthorn *(Prunus spinosa*), Willow *(Salix aurita)* and Ash *(Fraxinus excelsior).*
- H2: In some instances where semi-natural hedgerows or treelines have been severed such as those alongside urban areas or original demesne boundaries, an alternative hedgerow treatment is more appropriate order to re-establish these hedgerow corridors. The semi-natural hedgerow material will include species such as – Hawthorn (*Crataegus monogyna*), Beech (*Fagus sylvatica*), Oak (*Quercus petraea*) and Ash (*Fraxinus excelsior*).
- M3: At specific areas, there will be a requirement for particular screening of properties. These will be established in woodland with a specific emphasis on quick establishment of a woodland screen, with larger material to create woodland screening and effective woodland in the long-term. Species to be included are: Scots Pine *(Pinus sylvestris*), Holly (*Ilex aquifolium*), Ash (*Fraxinus excelsior*), Oak (*Quercus petraea*), Birch (*Betula pendula*), Alder (*Alnus glutinosa*), Hawthorn (*Crataegus monogyna*), Willow (*Salix alba*). Some areas will be planted with SM3, which is a combination of M3, S1 and G2.
- M4: Selected areas are to be established with woodland (using a mixture of evergreen and deciduous both native and naturalised tree and shrub material) in order to provide visual screening, stabilise embankments, and for ecological reasons. Where screening is not a priority, this planting will be carried out in conjunction with scrub mix (S1) and wet grassland (G2), in order to create a mosaic of habitats. Species to be included are: Oak (*Quercus petraea*), Ash (*Fraxinus excelsior*), Beech (*Fagus sylvatica),* Birch (*Betula pendula*), Holly (*Ilex aquifolium*), Hawthorn (*Crataegus monogyna*), Scots Pine (*Pinus sylvestris*) Willow (*Salix caprea*), Buckthorn (*Rhamnus frangula*), Hazel (*Corylus avellana*) and Dogwood (*Cornus sanguinea*). Some areas will be planted with SM2, which is a combination of M4, S1 and G2.
- M5: Throughout the study area there are copses beside streams and riverbanks of wet woodland. These are generally scrubby in make-up and distributed at random in the boggy or low-lying areas in particular. In order to integrate the proposed route into the landscape it is proposed to plant copses or strips of appropriate tree species along the route. Species to be included are: Birch (*Betula pendula*), Willow (*Salix aurita, Salix caprea, Salix cinerea*), Alder (*Alnus glutinosa*), Pine (*Pinus sylvestris*) and Larch (*Larix decidua*). These areas of planting are to be integrated with scrub mix (S1) and wet grassland (G2) to create a mosaic of habitats.

- S1: Selected areas are to be established with scrub in order to provide variety, stabilise embankments, and for ecological reasons. This planting will be carried out in conjunction with wet woodland (M5), woodland (M4) and wet grassland (G2), where appropriate, in order to create a mosaic of habitats. Species to be included are: Holly (*Ilex aquifolium*), Hawthorn (Crataegus monogyna), Blackthorn (Prunus spinosa), Hazel (*Corylus avellana*) Spindle (*Euonymus europaeus*), Willow (*Salix caprea*), Buckthorn (*Rhamnus frangula*) and Dogwood (*Cornus sanguinea*).
- G1: Grass verges immediately alongside the carriageway (min. 1.0m width), slip roads, roundabouts and side roads are to be established with a low maintenance grass seed mix, consisting predominantly of indigenous fescue grasses.
- G2: Where screening is not a requirement semi-natural grasslands are to be established, in conjunction with other types of planting (selected from above) to create a mosaic of habitat types. The existing soil and climate prescribes the use of either dry grassland or a wet grassland mix. The wet grassland mix will include a range of suitable species such as Red and Sheep's Fescue (*Festuca sp*.), Bents (*Agrostis sp*.), rushes (*Juncus sp*.), Iris (*Iris pseudacorus*) and other locally occurring grassland species. However; the selection of suitable grass species at the detailed design stage will take into account the angle of the slope and soil characteristics of specific locations for the compilation of appropriate grassland mixes. Reference is to be made to the ecologist's report in devising this appropriate species list.
- D1: Drains and swales are to be established using a specific grass seed mix of predominately fescue grasses to stabilise the slopes, but that will not impede the flow of water once established.
- In the construction process, the excavation and grading of all areas will be carried out in a sensitive manner to marry in the new formations with the existing landscape. Sharp ridges or overly steep embankments will be avoided where possible.
- With regard to the setting out and arrangement of planting this will be carried out using naturalistic planting arrangements associated with those already found in the landscape and in order to create a mosaic of habitats. For example, in wet woodland areas this may involve planting clusters of plants at wider randomised spacings. Where screening is required and a general covering of plants to integrate the scheme close planting densities of 1 plant per 2.2 square metres will be followed. Plant woodland mixes on significant cut embankments in varying widths in order that the linearity of the road is not emphasised and variety is maximised. Planting guidelines laid down by the NRA are to be referred to in this regard.
- Road verge or bank planting will consist of 'bare root transplants', 'whips' and 'feathered trees' which, due to their smaller stock size at time of planting, will adapt more easily to the disturbed ground and exposed site conditions. All plants are to be positioned in the locations and in the required numbers and centres indicated on the agreed planting plan.
- Existing semi-mature and mature tree groupings within the landtake area will be retained wherever practicable and protected through the erection of fencing prior to the commencement of construction works on site. The fence must remain intact for the duration of the works and will exclude any construction related activities. The fence type, installation method and location to be advised by a suitably qualified landscape architect. A suitably qualified arborist will assess the condition of the retained trees during and post construction works

(and in particular will advise on the risk of windthrow, particularly where the route divides a large woodland area).

- All trees, shrubs, transplants, hedging material and ground cover planting shall be guaranteed for a period against death, deformation, die-back, or disease other than that caused by malicious damage.
- The contractor will prepare a landscape maintenance plan after the implementation of the scheme. All landscape works will be in an establishment phase for the initial three years. This will include (a) Weed and litter control including monitoring particularly during the early growing seasons of the landscape maintenance contract (b) Grass cutting and replacement of failed plants (c) Compliance with all health and safety standards in particular with regard to maintenance works during the operation phase of the road.
- Redundant sections of the disused road network will be reinstated as grassland, scrub or woodland where appropriate.
- Areas of particular significance in terms of landscape design considerations along the route, such as roundabouts shall be given a specific treatment. Individual dwellings visually impacted upon where the route passes very close to the property shall be treated, where necessary, with specific landscape measures (SLM), as appropriate to the conditions e.g. appropriate species selection e.g. evergreen, rapid establishment, height etc., if one of the above more general treatments is not suitable.

SLM 1 Ballyvally Roundabout (Chainage 0+000 K)

This roundabout offers an opportunity to create a landscape or artistic feature at the entrance to Killaloe.

SLM 2 No. 3B Ballyvally Gate Lodge (Killaloe Bypass, Chainage 0+000 K):

The provision of appropriate screen planting of maximum mature height of 4m to provide a balance between, aesthetics, screening and allowing light in to the property. Special design consideration must be given to this dwelling since it is a protected structure. Species to be included are: hazel (*Corylus avellana*) and holly (*Ilex aquifolium*) subject to agreement with the adjoining resident.

SLM 3 Group no. 7 (Killaloe Bypass, Chainage 0+900 K, 0+950 K & 0+980 K):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 4 Group no. 8 (Killaloe Bypass, Chainage 1+110 K, eastern slip rd. Ch 30, 40, 60 & 80):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 5 Group No. 15 (Killaloe Bypass, Chainage 1+150 K, eastern slip rd. Chainage 30 & 70):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 6 Roundabout (on the R463 Killaloe to O'Briensbridge) Shannon Crossing Ch 0+000

This roundabout offers an opportunity to create a landscape or artistic feature.

SLM 7 Group No. 19 (Shannon Crossing, Chainage 0+040 S):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the properties, subject to agreement with the adjoining residents.

SLM 8 No. 25 (Shannon Crossing, Chainage 0+500 S):

Appropriate screen planting to provide a balance between, aesthetics, screening and allowing light in to the property, subject to agreement with the adjoining resident.

SLM 9 No. 30 (R494 upgrade, slip rd. north Chainage 0+050):

The realignment and widening of the existing R494 will require reinstatement of garden boundary treatment. Appropriate screen planting south of the dwelling to provide a balance between, aesthetics, screening and allowing light in to the property. All works subject to agreement with the resident.

SLM 10 No. 31 (R494 upgrade, slip rd. north Chainage 0+050):

Driveway realignment will require reinstatement of garden lawn subject to agreement with the resident.

SLM 11 No. 32 (R494 upgrade, slip rd. north Chainage 0+020):

Driveway realignment and installation of retaining walls will require reinstatement of lawn and garden herbaceous border subject to agreement with the resident.

SLM 12 No. 33 (R496 upgrade, slip rd. southeast Chainage 0+020):

Driveway realignment and installation of retaining walls will require reinstatement of lawn, garden shrubs and small trees subject to agreement with the resident.

SLM 13 No. 34 (R496 upgrade, slip rd. southeast Chainage 0+040):

Installation of retaining walls will require reinstatement of lawn and garden shrubs subject to agreement with the resident.

SLM 14 No. 38 (R494 upgrade Chainage 0+040 R):

Driveway realignment and installation of retaining walls will require reinstatement of garden shrubs subject to agreement with the resident.

SLM 15 No. 39 (R494 upgrade Chainage 0+090 R):

Driveway realignment and installation of retaining walls will require reinstatement of garden hedging and shrubs subject to agreement with the resident.

SLM 16 No. 40 & No. 41 (R494 upgrade Chainage 0+050 R):

Appropriate screen planting north of the dwelling to provide a balance between, aesthetics, screening and allowing light in to the property, subject to agreement with the adjacent residents.

SLM 17 No. 43 (R494 upgrade Chainage 0+150 R):

Installation of retaining walls will require reinstatement of rear garden hedgerow subject to agreement with the resident.

SLM 18 No. 45 (R494 upgrade Chainage 0+340 R):

Driveway realignment will require reinstatement of garden lawn subject to agreement with the resident.

SLM 19 No. 47 (R494 upgrade Chainage 0+425 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden trees subject to agreement with the resident.

SLM 20 No. 49 (R494 upgrade Chainage 0+500 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden trees subject to agreement with the resident.

SLM 21 No. 52 (R494 upgrade Chainage 0+580 R):

Driveway realignment will require reinstatement of garden lawn and planting of garden shrubs subject to agreement with the resident.

SLM 22 No. 53 (R494 upgrade Chainage 0+650 R):

The provision of appropriate indigenous semi-mature tree planting and shrub screening subject to agreement with the resident.

SLM 23 No. 54 (R494 upgrade Chainage 0+700 R):

The provision of appropriate semi-mature tree planting and shrub hedge planting subject to agreement with the resident.

SLM 24 No. 64 (R494 upgrade Chainage 2+420 R):

The provision of appropriate shrub planting subject to agreement with the resident.

SLM 25 No. 65 (R494 upgrade Chainage 2+720 R):

The provision of appropriate grass seeding and hedge planting subject to agreement with the resident.

SLM 26 No. 66 (R494 upgrade, mainline Chainage 2+700 R, slip rd. Chainage 60):

The provision of appropriate hedge planting of hawthorn (*Crategus monogyna*) and holly (*Ilex aquifolium*) subject to agreement with the resident.

SLM 27 Shannonside Business Park (R494 upgrade, mainline Chainage 2+800 R):

The provision of appropriate mixed tree and shrub planting subject to agreement with the appropriate party.

SLM 28 No. 69 (R494 upgrade, mainline Chainage 3+270 R):

The provision of appropriate semi-mature tree planting subject to agreement with the resident.

SLM 29 No. 72 (R494 upgrade, mainline Chainage 3+290 R):

The provision of appropriate shrub planting subject to agreement with the resident.

SLM 30 No. 42A Picnic Area (R494 upgrade, mainline Chainage 0+170-260):
The provision of lay-by and reinstatement of amenity area, with grassing and planting as appropriate. Path layout to be reinstated.

SLM 31 (R494 upgrade, mainline Chainage 0+625-790):
Compensatory scheme of tree planting for trees removed from woodland due to construction works.

SLM 32 No. 58 Drainage Ditch (R494 upgrade, mainline Chainage 1+720):
Protection of existing vegetation during drainage works and reinstatement compensatory planting following completion.

SLM 33 Fort Henry Estate (R494 upgrade, mainline Chainage 0+700 to 1+180 R):
Temporary acquisition of lands for stream regrading works/ channel enhancement works. Protection of existing vegetation during works and reinstatement compensatory planting along access road and pond, following completion.

SLM 34 No. 17A (Shannon Crossing, slip road north Chainage 0+025 to 0+080 S): Reinstatement of boundary walls will require replacement of garden shrubs and grassed area subject to agreement with the resident.

SLM 35 No.63 (R494 upgrade, mainline Chainage 2+380 R and 2+410 R west): Reinstatement of boundary walls, boundary hedge, garden shrubs and grassed area subject to agreement with the resident. Reinstatement of roadside shed also.

SLM 36 No. 46 (R494 upgrade Chainage 0+400 R):

The provision of appropriate indigenous semi-mature tree planting and shrub screening subject to agreement with the resident. Reinstatement of boundary walls and piers.

SLM 37 Group No. 58 (R494 upgrade Chainage 1+650 R):

Reinstatement of boundary walls, piers and garden shrub planting of dwellings 58a and 58b subject to agreement with the resident.

SLM 38 Dwelling No. 50 (R494 upgrade Chainage 0+465 R west):

Reinstatement of boundary, mature trees and garden shrub planting subject to agreement with the resident.

SLM 39 Dwelling No. 48 (R494 upgrade Chainage 0+480 R east):

Reinstatement of boundary walls, piers and garden shrub planting subject to agreement with the resident.

12.10 Mitigation Measures for Material Assets

12.10.1 Agronomy Operational Phase Mitigation

On the severed areas where there is no access available new access will be required on these areas. The extent and complexity of such access provisions vary with each farm depending on the nature of the impact and the type of enterprise being carried out. In most cases simple gateways will suffice, while in other cases new accommodation roads may have to be constructed.

12.10.2 Agronomy Construction Phase Mitigation

Construction Noise

Good communication between the contractor and the landowners during the construction phase will prevent undue disturbance due to noise. The contractor will work to a Code of Practice.

Dust

Measures to control the reduction of dust will be put in place by the contractor. Good communication between the contractor and the farmers in the proximity of construction activities will facilitate on-going farm enterprises so that valuable livestock are kept as far away as possible from the construction work during critical times.

Restricted Access to Severed Land Parcels

Temporary fencing will be erected as required to delineate the site boundary and to minimise disturbance to adjacent lands. Farmers may need to move animals across the construction site while they await more permanent measures to be put in place and this will be facilitated by providing gates where needed until such time as the access arrangements are in place for these farmers when these gateways will be replaced by permanent stock-proof fencing.

Disturbance of Field Drainage works

In cases where impeded drainage during construction will cause obvious difficulty to a particular landowner, temporary measures will be taken to allow waters to drain to less critical areas and so minimise the impact.

Disturbance of Services

Ducting will be provided to take water supply and electric fencing across the proposed road. The location of these will be agreed in advance of road construction on an individual farm basis and put in place during the construction phase. Again some temporary measures may be needed, such as water tanks and battery power electric fencing to ensure that disruption to farming is minimized.

12.10.3 Residential Properly Mitigation Measures

Where an access to a property is affected the access will be reinstated to match the existing as far as possible. Where septic tanks are to be impacted, replacement tanks will be provided that match current standards.

12.11 Mitigation Measures for Archaeology, Architecture & Cultural Heritage

Recommendations for mitigation are made subject to approval by the National Monuments Section of the Department of the Environment, Heritage and Local Government.

12.11.1 Mitigation of impacts on archaeological heritage sites

Recorded Monuments

There are no Recorded Monuments directly impacted upon by the proposed scheme, however possible enclosure CL045-057 may be indirectly impacted upon and associated features may be directly impacted. This potential site will be subject to geophysical survey prior to construction and, based on the results of that survey, targeted archaeological test trenching and subsequent excavation if required.
The submerged Recorded Monuments on Friar's Island may potentially be impacted upon during construction, although they lie some distance downstream of the proposed Scheme. The construction methodology will have to take account of this sensitive underwater area.

Areas of archaeological potential

There is potential for previously unrecorded below-ground archaeological remains to be present within the land take of the proposed development. Several areas have been highlighted as having especially high potential.

In conformity with archaeological best practice as outlined in National Monuments Section of the Department of the Environment, Heritage and Local Government guidelines (DAHGI 1999a and DAHGI 1999b) the entirety of the route will be subject to a programme of archaeological testing. This assessment will take the form of archaeological test trenching that examines at a minimum 10% of the total area of the selected road route. Should archaeological remains be encountered these will be subject to full excavation and further monitoring during construction may be recommended. The possible mound seen in Roolagh townland will be targeted during test trenching.

The banks of the River Shannon will be subject to test trenching, with the special note that any material dredged from the river bed may contain archaeological artefacts. Greenfield areas, especially in the Co. Clare part of the scheme will be subject to test trenching.

The locations of structures seen on historic maps but that are no longer standing will be targeted during test trenching. Where there is minor road widening taking place on the R494 it may not be possible to access the narrow strip of land made available prior to construction, in which case these areas will be subject to archaeological monitoring. Based on the results of the test trenching further excavation of these sites may be required, or they may be sufficiently recorded during the testing process. Consultation with the appropriate authorities will be necessary and decisions will be made on a case-by-case basis.

No construction activities take place outside the limits of the CPO without prior consultation with the site archaeologist as there may be archaeological sites in the fields adjacent to the proposed Scheme.

Underwater Archaeology and Watercourses

An underwater survey has already been carried out in the River Shannon for the proposed Scheme. The riverbed including the lands inundated in 1930 is considered to be of very high archaeological potential (**H36**). The original survey report recommended further detailed survey of the selected route.

If any dredging is required as part of the scheme the locations will be agreed in advance under archaeological advice and the dredging itself will be archaeologically monitored.

There is potential for indirect impact on archaeological features in the river downstream of the new crossing, for example by silt deposition. This will be mitigated against during construction.
Once detailed engineering and design decisions have been made a further assessment of the impact of the scheme on the three identified underwater sites (**H37-9**) will be made. It may be necessary to excavate these sites archaeologically prior to construction if they will be negatively impacted upon.

The Kilmastulla River (**H96**) will be subject to a wade and metal detector survey and targeted test excavation along its banks.

The small watercourses crossed by the scheme have not been assessed in detail. Any dredging for improved drainage will be monitored.

12.11.2 Mitigation of impacts on architectural heritage sites

Protected Structures

***H2-H4**: Ballyvally House estate*

Ballyvally House Gate Lodge (**H2**) will be protected from damage during construction. The gate will still function as an entrance to the estate, albeit with a new access connecting it to the new road.

The visual impact on Ballyvally House (**H3**) itself will be reduced by the fact that the road will be in a cutting at this point. The new boundary along the edge of the road take will replicate the existing boundary conditions.

The impact on the southern estate boundary (**H4**) of mature trees and stone-faced earthen banks may be minimised during detailed design, with an effort made to fell as few trees as possible. The boundary will be preserved by record, including a photographic and scaled drawn record, and test trenching during the archaeological testing.

***H23-25, H30**: Clarisford Palace estate*

The impact on the western estate boundary (**H23**) of mature trees and an earthen bank may be minimised during detailed design, with an effort made to fell as few trees as possible. The boundary will be preserved by record, including a photographic and scaled drawn record, and test trenching during the archaeological testing.

Clarisford Palace (**H24**) itself will suffer indirect visual impact and this will be minimised by screening and the erection of a suitable boundary.

The avenues (**H25**) are recorded cartographically but will be targeted during archaeological test trenching to examine the make-up of the road and record earlier road surfaces and possible flanking features such as ditches. Further archaeological excavation may be required on the basis of the results of test trenching.

The partially infilled channel, the line of mature trees parallel with the canal and the slight bay with rotten wooden posts (**H30**) will be recorded with a written, drawn and photographic record being made. These features will also be targeted during archaeological test trenching and it may be necessary to undertake archaeological excavation of the channel and post structure.

The number of mature trees felled will be minimised during design stage, although as this is the location for the start of the approach embankment for the new bridge there will probably not be a great deal of flexibility in the design. It is noted that although the line of trees would have originally been continuous along the edge of the canal, they only survive sporadically in the grounds of the new dwellings north of the proposed Scheme.

Other structures

Structures of architectural merit

The entrance to Gortna House (**H70, H71**) is immediately adjacent to the proposed works and will be protected during construction.

The northern gate and eastern boundary (**H68**) of Fort Henry (**H74**) will be preserved by record with a photographic and descriptive record being made. The felling of trees along the boundary will be minimised by design to reduce visual impact. The western boundary of the new road within the estate will be in keeping with the original that will be removed.

If it is not possible to avoid removing the farm building in Coolnadornory (**H91**) it will be preserved by record; this record will include, at a minimum, a photographic survey, brief written description and floor plan of each building. The ensuing records will be lodged in a well-established repository.

Bridges and Culverts

Although the Cool Bridge (**H95**) over the Kilmastulla River and the adjacent underpass (**H93**) will be left intact, a photographic and descriptive record will be made.

The most desirable mitigation for the bridge at the south of the scheme (**H104**) is that impact be reduced by design, however if this is not possible the bridge will be preserved by description, drawn and photographic record.

The mitigation for the other bridges, culverts and underpasses will be photographic and descriptive records. Although many of these features appear to be of no architectural merit the fact that the line of the R494 is an old route might indicate that there are early elements contained within the later features.

It may be necessary to carry out some of the recording during monitoring of construction works.

Industrial Heritage Sites

The impact on the Limerick-Killaloe canal (**H32**) has been mitigated by design on that it will continue to flow through a culvert beneath the new road. The towpath will be removed and this will be surveyed and examined by archaeological test trenching.

It will be necessary to survey the line of the Limerick-Killaloe Railway (**H42**) following scrub clearance.

The remains of industrial buildings on the island between the canal and river (**H33**) will be preserved by record. The site will initially be surveyed and will then be subject to targeted archaeological test excavation. It is likely that full archaeological excavation will be required in this area.

12.11.3 Mitigation of impacts on cultural heritage sites

Townland boundaries

The impact on townland boundaries will be preservation by record. In many cases this can be done during test trenching, however it should be noted that it may be necessary to undertake the recording prior to site clearance if this is to be carried out in advance of archaeological testing. In the case of the boundaries that have been removed by agricultural activity the record will be made during archaeological test trenching.